Rethinking Beauty Packaging: Beyond Recycling to True Sustainability

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01 Executive Summary

The transition to sustainable beauty packaging cannot be achieved through recycling alone. Beauty products require packaging that protects complex formulations, maintains shelf life and meets demanding safety, performance and aesthetic standards. These requirements have created packaging formats, including pumps, droppers, sachets, applicators and small components, that are often too small, complex or contaminated to be effectively recycled, even when their constituent materials are technically recyclable.

This report argues for a broader approach to packaging sustainability, extending the traditional Reduce, Reuse, Recycle hierarchy with three additional principles: Replace, Renew and Replenish. This means replacing problematic packaging with materials suited to realistic end-of-life pathways, renewing virgin fossil carbon with sustainably sourced biological carbon, and designing materials that can safely return to biological systems where appropriate.

Bio-based, biodegradable and compostable materials offer targeted solutions, particularly for small-format packaging, mixed-material components, flexible sachets and product-contaminated packaging. Commercial innovations from ELEMIS, Xampla, Futamura, CHANEL and Sulapac demonstrate their potential to meet demanding beauty-sector requirements while reducing dependence on fossil resources. However, material performance, safety and environmental benefits must be independently demonstrated, and compostable solutions require appropriate collection and treatment infrastructure.

UK packaging policy must also evolve to recognise environmental outcomes beyond recyclability. Current Extended Producer Responsibility (EPR) and Plastic Packaging Tax (PPT) frameworks provide limited recognition of renewable carbon or alternative end-of-life pathways. This becomes increasingly important with the planned inclusion of waste incineration in the UK Emissions Trading Scheme from 2028, introducing additional economic implications for fossil-derived packaging.

The report recommends evolving the Recyclability Assessment Methodology (RAM) into a broader Sustainability Assessment Methodology (SAM) that considers recyclability alongside lifecycle carbon emissions, renewable feedstocks, resource efficiency, chemical safety, persistence and environmental fate. Supporting reforms should include recognition of renewable carbon within PPT, better alignment of packaging and climate policies, investment in organic recycling infrastructure and clearer standards for biomaterials.

The central message is clear: sustainable packaging policy should reward demonstrated environmental performance, not recyclability alone. By combining resource efficiency, renewable carbon, safer material design and credible end-of-life pathways, the UK beauty industry has an opportunity to lead the development and adoption of a new generation of sustainable packaging solutions.

02 Introduction

The transition to more sustainable beauty packaging cannot be achieved through recycling alone. Beauty packaging must protect complex formulations, deliver long shelf lives, meet stringent safety and performance requirements, and provide the functionality and aesthetics expected by consumers. These demands have produced packaging systems dominated by small formats, flexible films, and complex multi-material components that are often inherently difficult to collect, sort, and recycle. The challenge is therefore not simply how to recycle more packaging, but how to ensure that the materials used, the carbon from which they are made, and their eventual end-of-life pathways deliver the best overall environmental outcome.

Packaging waste in the UK remains a major environmental issue. Annually, the UK generates around 12 million tonnes of packaging waste[1]. Under the most recent methodology (2024), about 75.2% of all packaging waste placed on the market was recycled or recovered[2]. Looking at material breakdowns, paper and cardboard remain the largest component; in 2024, the recycling rate for paper and cardboard reached 86.4%. In contrast, plastic packaging remains more problematic, with only 53.7% of plastic packaging waste was recycled in 2024[10].

Addressing this challenge sits within a much wider UK transition towards more sustainable packaging and materials, driven by the need to reduce packaging waste, move away from virgin fossil resources and develop new circular material systems. The emerging UK bioeconomy provides an important opportunity to support that transition.

In the UK, various current and anticipated government policies and industry initiatives, including The UK's Modern Industrial Strategy 2025[3], the National Materials Innovation Strategy[4] The UK Packaging Pact[5], the Delivering a Net Zero National Health Service Strategy[6] see bio-based chemicals, materials and products as being central to delivering economic and environmental benefits. The UK is exceptionally well-positioned to lead the next wave of advanced materials innovation. Market research indicates that the UK bio-based materials sector has the potential to grow into a £4.2 billion domestic industry[7], supporting more than 35,000 UK jobs in design, R&D, production, and supply-chain activity.

Beauty packaging represents a particularly important opportunity. The UK discards nearly 90 billion plastic items each year, the second highest rate of plastic waste per person in the world[8] - while the British Beauty Council estimates that up to 95% of beauty packaging is thrown away, with much ultimately going to landfill or incineration[9]. The challenge is not simply the quantity of packaging used, but its design. Beauty products frequently depend on small-format and complex multi-material components - including pumps, closures, sachets, applicators and travel-size formats - that are difficult or impossible to process through conventional recycling infrastructure.

This creates a strong case for looking beyond recycling alone. Bio-based and biodegradable materials can complement reduction, reuse and recycling by providing alternative solutions for packaging formats for which conventional recycling is technically or economically impractical. Renewable feedstocks can reduce dependence on virgin fossil carbon, while appropriately designed biodegradable and compostable

[1] https://fiauk.co.uk/updated-uk-statistics-on-waste
[2] https://www.gov.uk/government/statistics/uk-waste-data/uk-statistics-on-waste
[3] Department for Business and Trade: The UK's modern Industrial Strategy, 2025
[4] Henry Royce Institute, National Materials Innovation Strategy, 2025
[5] Waste and Resource Action Plan (WRAP), UK packaging Pack, 2025
[6] NHS, Delivering a net zero national health service, 2020
[7] National Materials Innovation Strategy - Henry Royce Institute
[8] Environmental Investigation Agency, *The UK Government Must End Its Waste Colonialism by Banning Plastic Waste Exports Now* (London: Environmental Investigation Agency, 2025).
[9] British Beauty Council, 'Packaging', *Planet Positive Beauty Guide* (London: British Beauty Council, 2023).

materials can provide alternative end-of-life pathways for applications that would otherwise become residual waste. Beauty therefore provides a valuable opportunity to demonstrate how material innovation and the bioeconomy can help address some of the limitations of the UK's existing packaging system.

At the same time, growing awareness of the environmental and potential health impacts associated with plastic pollution and microplastics is changing expectations of the materials used in everyday products. The combined global economic and health costs of plastic pollution have been estimated at up to $1.5 trillion annually, increasing pressure on businesses and governments to consider not only how packaging is managed at end of life, but also the materials from which it is made[10]. This is driving interest in alternative materials that can reduce reliance on virgin fossil resources, minimise persistent pollution, and deliver improved environmental performance. Bio-based materials have the potential to form part of this transition, particularly in applications such as cosmetics and personal care where material safety, product compatibility, and performance are critical. Together, these pressures encourage brands, material innovators, and policymakers to consider sustainability from the earliest stages of packaging design.

Beauty and personal care packaging encompasses a diverse range of formats, from simple bottles and tubes to technically complex pumps, pipette droppers, compacts, sachets and travel-size products. This report considers primary and secondary packaging across skincare, haircare, colour cosmetics, fragrance, oral care, deodorants and body care, with particular attention given to formats that present the greatest sustainability challenges. These include small-format items such as minis, samples and sachets, and multi-component assemblies such as pumps, dispensers and closures, which are frequently difficult to collect, sort and recycle through existing infrastructure.

Against this backdrop, the paper explores the role that bio-based, biodegradable and compostable materials could play in creating more sustainable packaging systems for the beauty sector. It examines the technical and practical limitations of current approaches to packaging circularity, identifies high-impact applications where material innovation could provide viable alternatives, and considers the policy and infrastructure changes needed to support their adoption and scale-up. The aim is to provide a practical framework for brands, policymakers, and material innovators seeking to reduce packaging waste, dependence on fossil-derived materials, and the wider environmental impacts of beauty packaging.

Section Summary

- *Recyclability is not a reliable measure of sustainability for beauty packaging, since many formats cannot be captured or processed even when the material itself is recyclable.*
- *Up to 95% of beauty packaging is discarded, mostly to landfill or incineration.*
- *The global cost of plastic pollution is estimated at $1.5 trillion annually, which is increasing pressure on brands and regulators to address material choice, not just disposal.*
- *The UK bio-based materials sector could grow into a £4.2 billion industry supporting over 35,000 jobs, giving the British beauty sector a strategic economic reason to lead on adoption.*

[10]Thalia Bofiliou, Liz Houston and Rumi Mahmood, *Microplastics: Macro Risks and the Cost of Inaction* (London: Planet Tracker and MSCI Institute, October 2025).

03 UK Beauty Sector Overview

The UK beauty sector is a significant contributor to the national economy, employing 418,000 people in 2023 - more than the real estate sector - and generating over £7.3 billion in tax revenues[11]. The UK beauty and personal care market reached USD 13.2 billion in 2025, with consumer spending increasing by 6.6% in real terms[12]. However, the sector's scale and continued growth also have implications for material use and waste. As more beauty and personal care products enter the market, so too does the volume of packaging, increasing the importance of developing packaging systems that can accommodate sector growth while reducing waste and environmental impact.

The beauty sector utilises a wide range of materials for packaging, such as traditional materials like glass, aluminum, paper, plastic, alongside novel and alternative bio-based materials. Of these, plastic is the most prevalent, making up an estimated 64.5% of the cosmetics packaging market in 2024[13]. Common polymers used in beauty packaging include polypropylene (PP) for caps and closures, polyethylene terephthalate (PET) for bottles and jars, and polyethylene (PE) for bottles and tubes. Beyond plastics, glass remains an important material, particularly for premium skincare and fragrance packaging, while metals such as aluminium are widely used in aerosols, tubes and compacts. Paper and cardboard are predominantly used for secondary packaging, such as cartons and boxes, but are increasingly incorporated into composite formats, including paper-plastic tubes, as brands seek to reduce their use of conventional plastic packaging.

Biomaterials are increasingly being explored as a means of addressing the sustainability challenges associated with beauty packaging due to their unique characteristics and material properties. These encompass a diverse range of materials that may be derived from renewable biological resources, designed to biodegrade under specified conditions, and/or certified for home or industrial composting. The market for these alternatives is expanding rapidly: the global bio-based packaging market was valued at approximately $11.29 billion in 2025 and is forecast to grow at an annual rate of 12.4%, reaching $36.42 billion by 2035[14].

This report focuses primarily on materials that combine bio-based feedstocks with biodegradable or compostable end-of-life characteristics, including cellulose, polyhydroxyalkanoates (PHAs), alginate, carrageenan and mycelium-based materials. As these terms describe distinct material characteristics and should not be used interchangeably, Table 1 defines the key terminology used throughout the report.

Across government, industry, and consumer sectors, there remains significant confusion about the differences between bio-based and biodegradable materials[15]. As a result, bio-based and biodegradable materials are often grouped together under a single umbrella, obscuring their distinct benefits, performance characteristics, and environmental benefits.

A common example of this misunderstanding is the term *'bioplastic'*. Frequently used as a catch-all label, it fails to differentiate between plastics derived from biological sources (bio-based), those capable of breaking down under specific conditions (biodegradable), and those that combine both attributes. Such lack of clarity has far-reaching consequences for policy development, market growth, and consumer perception, ultimately slowing the shift toward genuinely more sustainable material systems.

For clarity, please find definitions of key terms used in this report in Table 1, and Figure 1.

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[11] British Beauty Council and Oxford Economics, *The Value of Beauty*, 3rd edition (London: British Beauty Council, August 2024).
[12] Mintel, *UK Beauty and Personal Care Retailing Market Report* (London: Mintel Group, February 2025)
[13] ResearchAndMarkets, *Cosmetics Packaging Market: Materials, Products and Applications* (Dublin: ResearchAndMarkets, December 2024).
[14]Precedence Research, "Bio-Based Packaging Market Size, Share and Trends 2026 to 2035," accessed July 22, 2026, https://www.precedenceresearch.com/bio-based-packaging-market.
[15] BB-REG-NET, Plastic definitions in UK regulations, 2025

Table 1. Distinctions between different biobased and biodegradable material characteristics[16] [17] [18].

Term	Definition
Bio-based	Derived wholly or partly from renewable biological sources such as plants, algae, or microorganisms.
Biodegradable	Designed to break down through microbial activity into natural substances such as water, carbon dioxide, and biomass under specific environmental conditions. May be derived from biological or fossil sources
Compostable	A subset of biodegradable materials that meet specific standards (such as BS EN 13432:2000) for biodegradation and disintegration under specified composting conditions. These standards ensure that materials break down within a defined timeframe in defined conditions (e.g. ambient or industrial temperature), leaving no toxic residues and contributing to compost quality. **Home compostable**: breaks down in a standard garden or home compost bin, at lower, ambient temperatures (between 20°C and 30°C), without the need for industrial conditions. These materials will typically still biodegrade naturally in nature due to low temperature requirements. **Industrial compostable**: requires the higher temperatures (58°C ± 2°C) and conditions of an industrial composting facility to break down fully. Materials that are only industrially compostable will generally not degrade properly in a home compost bin and can contribute to persistent pollution in the environment.

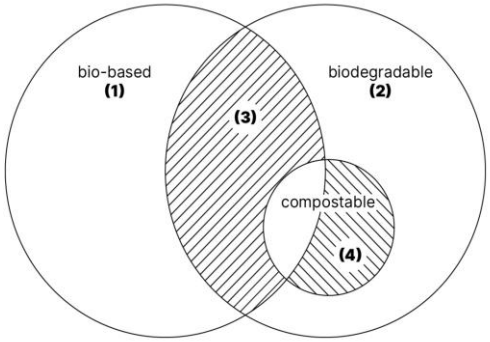

Figure 1. Biomaterials: Biobased (1), Biodegradable (2), and Compostable (3)
Image Source: *Plastic Solutions Review, 2025*

Section Summary

- *The UK beauty sector employs 418,000 people and generates £7.3 billion in tax revenue.*
- *The global bio-based packaging market is valued at $11.29 billion and is forecast to reach $36.42 billion by 2035.*
- *Biomaterials are increasingly being explored as a means of addressing the sustainability challenges associated with beauty packaging due to their unique characteristics and material properties.*
- *Biomaterials is an umbrella term that includes bio-based, biodegradable, and compostable, which describes distinct material characteristics.*

[16] Gavins, J. (2025) *Effective Communication to Advance the Modern Industrial Bioeconomy: How to Talk About Bio-based and Biodegradable Materials*. BB-REG-NET / University of Sheffield.
[17] TÜV AUSTRIA, *OK compost HOME: Initial Acceptance Tests* (Doc Ref: OK02-e, Edition D, March 1, 2012), accessed July 22, 2026,
[18] TÜV AUSTRIA, *OK compost INDUSTRIAL: Certification Scheme* (Doc Ref: PD-BA-TABE-CERT-BIO-CS-001_OKI_EN, edition F, January 1, 2022), accessed July 22, 2026,

04 Beauty Packaging Technical Requirements

Beauty packaging presents a distinct set of technical challenges compared with many other consumer-goods applications. Packaging must not only contain and protect the product, but maintain formulation stability, functionality, appearance and consumer experience throughout its intended lifetime. This creates a particularly high-performance threshold for emerging bio-based and compostable materials.

Compatibility with Formulations

Beauty and personal-care formulations can be chemically complex, containing combinations of water, oils, alcohols, fragrances, surfactants, active ingredients and other compounds that may interact with packaging materials. The packaging therefore needs to withstand prolonged contact with both aqueous and oil-based formulations, as well as volatile or chemically active ingredients.

The pack must provide sufficient barrier performance to prevent leakage, evaporation, moisture transfer, and oxygen ingress, while avoiding migration, swelling, cracking, delamination, or other interactions between the formulation and packaging material. Packaging can also influence product characteristics including fragrance, colour, texture, and efficacy. Regulatory guidance similarly recognises the importance of assessing cosmetic stability in both inert containers and the packaging intended for commercial use, to identify stability problems induced by the container or packaging system[19].

This can present a particular challenge for some biomaterials. Cellulose and other naturally derived materials, for example, can be hydrophilic and therefore require modification or additional barrier functionality for applications involving prolonged exposure to water-based formulations. Conversely, oils, fragrances, and alcohol can create different compatibility requirements.

A useful commercial example is N°1 de CHANEL, where CHANEL and Sulapac developed a lid made from approximately 90% bio-based materials, including FSC-certified wood chips and camellia seed shells. The incorporation of camellia seed shells created a technical challenge because the material is naturally hydrophilic. More than 40 material trials were reportedly required to achieve the required resistance to heat and moisture while retaining the aesthetic and sensory characteristics expected of luxury packaging[20].

This example demonstrates that substituting fossil-derived plastics is not necessarily a straightforward material-for-material replacement. Bio-based feedstocks may require significant formulation and engineering development before they can meet existing packaging specifications.

Barrier technology is consequently a key area of innovation. Sulapac, for example, has subsequently developed a bio-based barrier material specifically for the inner layer of cosmetic jars. The material is designed to reduce water evaporation from water-based cosmetic formulations while retaining 98% certified bio-based content[21]. Such developments show how bio-based packaging systems can be engineered around the compatibility requirements of beauty formulations rather than relying solely on the inherent properties of the underlying biomaterial.

Other approaches combine fibre-based structures with barrier technologies. L'Oréal, for example, has worked with Paboco and packaging suppliers on fibre-based bottles for cosmetic applications, illustrating

[19] European Commission, Scientific Committee on Cosmetic Products and Non-Food Products Intended for Consumers (SCCNFP), *Guidelines for the Safety Assessment of the Finished Cosmetic Product*, including guidance on physical stability and packaging compatibility
[20] N° 1 de CHANEL – New range of beauty with sustainable Sulapac material
[21] TDS-Sulapac-Barrier-ID-10333.pdf

the industry's wider efforts to overcome the barrier and structural limitations associated with replacing conventional plastic packaging[22].

Any alternative bio-based material must therefore demonstrate compatibility, chemical resistance, and barrier performance appropriate to formulation and application. In some cases, this may require coatings, liners, multilayer structures, or other barrier technologies. These additions must be assessed in relation to material sourcing, recyclability or compostability and the overall environmental performance of the finished pack.

Shelf Life

Beauty products may remain within manufacture, distribution, retail and consumer environments for extended periods. During this time, packaging may be exposed to variations in temperature, humidity, light and mechanical stress while still being expected to maintain both the quality of the formulation and the functionality and appearance of the pack.

Shelf stability is therefore normally assessed using a combination of real-time and accelerated stability testing. ISO/TR 18811:2018 provides an international technical framework for stability testing of cosmetic products and identifies elevated-temperature testing as one possible approach. Conditions commonly referenced include approximately 30°C, 37°C, 40°C, 45°C and 50°C, with test duration and conditions selected according to the product and application[23].

Importantly, accelerated ageing should not be interpreted through a universal conversion such as “12 weeks at 40°C equals 24 months at room temperature”, because ISO/TR 18811 recognises that the diversity of cosmetic formulations, packaging systems and storage conditions means that no single stability protocol can apply to every cosmetic product. The US FDA likewise notes that cosmetic shelf life depends on the type of product and its conditions of use and storage. Temperature, moisture, sunlight and exposure to air can contribute to changes in colour, texture, odour and microbiological stability, while emulsions may separate and volatile components may be lost over time[24].

Manufacturers should instead establish and justify testing conditions appropriate to the formulation, packaging and intended market. Cosmetics Europe similarly recommends that stability programmes reflect the conditions a product is likely to encounter during storage, transport, retail and consumer use, including temperature, light, humidity and physical stresses[25].

This requirement to determine produce shelf life creates a particular challenge for biodegradable packaging. A material designed to biodegrade under appropriate end-of-life conditions must nevertheless remain functionally stable for potentially several years before disposal. Premature moisture absorption, hydrolysis, deformation, embrittlement or loss of barrier properties would make a material unsuitable, regardless of its environmental credentials.

Again, commercial development provides useful evidence of the challenge. In developing bio-based caps for LES EAUX DE CHANEL, CHANEL and Sulapac reportedly spent two years developing a three-layer cap containing 91% bio-based material. Forty-eight iterations were required to achieve the required combination of temperature resistance, appearance, grip, sensory characteristics and functionality[26]. This

[22] L’Oréal’s latest innovation for more sustainable packaging: The paper bottle
[23] ISO, *ISO/TR 18811:2018 — Cosmetics — Guidelines on the Stability Testing of Cosmetic Products*, International Organization for Standardization, 2018.
[24] U.S. Food and Drug Administration, *Shelf Life and Expiration Dating of Cosmetics*, FDA.
[25] Cosmetics Europe/CTFA, *Guidelines on Stability Testing of Cosmetic Products*, 2004.
[26] Sulapac - LES EAUX DE CHANEL – Elegance and simplicity with a sustainable SULAPAC cap on top

illustrates the level of optimisation that can be required even for a relatively simple packaging component such as a fragrance cap.

British material science company Shellworks tackles this by designing its Vivomer material to stay stable during normal use, only breaking down once it reaches a home compost or other natural environment. Vivomer is a bio-based polymer produced by microorganisms, engineered to perform like conventional plastic while in use, then broken down naturally by microbes commonly found in soil and water. Wild, the UK refillable personal care brand owned by Unilever, uses Vivomer for its full body wash bottle as a core part of their refill system, showing the material can handle the heat and moisture of daily shower use. The success of the Vivomer bottle demonstrates that biomaterials can match the performance of conventional plastics while offering sustainability improvements to both material origin and end of life.

The technical challenge is therefore not simply to develop materials that are bio-based or biodegradable, but to engineer packaging systems that combine renewable feedstocks, long-term functional stability, formulation compatibility and credible end-of-life performance. The strongest opportunities are likely to be materials and packaging systems in which degradation is effectively "switched off" during manufacture, distribution, storage and use, but becomes possible under defined end-of-life conditions. Achieving this balance, while simultaneously meeting cost, manufacturing, regulatory and aesthetic requirements, will be central to the wider commercial adoption of biomaterials within the beauty industry.

Section Summary

- *Beauty formulations are chemically complex, requiring packaging materials that resist water, oils, active ingredients, and fragrance without degrading across the products shelf life.*
- *Compatibility testing is a standard test ahead of any packaged product going to market, so testing protocols are already robust to assess alternative bio-based materials for compatibility, chemical resistance and barrier performance appropriate to the formulation and application.*
- *Biomaterials can meet the compatibility requirements for packaging, but selection should be carefully considered to ensure the right material is being used for the right application.*

05 Packaging Challenges

Small Size

Beauty packaging frequently uses small-format components, including lipstick and mascara tubes, caps, travel-sized products, sample containers, applicators and other components. Although some of these materials may technically be recyclable, their physical size can prevent them from being recovered through conventional Material Recovery Facilities (MRFs).

Pact Collective, a beauty-industry initiative focused on hard-to-recycle packaging, identifies packaging smaller than approximately 2x2 inches as unsuitable for conventional kerbside recycling through many existing systems[27]. The problem occurs during sorting. Small components can pass through screening equipment rather than progressing through the intended sorting process. Pact has reported that small components, can fall through MRF sorting systems and consequently enter the residual waste stream[28]. This means that theoretical material recyclability does not necessarily translate into recycling in practice.

[27] Pact's Collection Guidelines — Pact Collective
[28] Q&A with Pact Collective Executive Director Carly Snider | Packaging World

This is particularly relevant to beauty because a single package may generate several small components. A serum bottle, for example, may comprise a bottle, collar, cap, pipette and elastomer bulb, each of which behaves differently once separated within the waste-management system.

Bio-Benefit: Small formats therefore represent a potentially attractive application for biodegradable or compostable biomaterials because improving the intrinsic recyclability of a tiny component does not necessarily solve the fundamental problem of physical capture. Where packaging can be safely and reliably directed into an established organic recycling system, compostability could provide an alternative end-of-life route for formats that are structurally poorly suited to conventional mechanical recycling. However, this opportunity is dependent upon appropriate collection and treatment infrastructure. A compostable lipstick component or sachet placed into a conventional plastics recycling stream could itself become a contaminant, while one placed into residual waste may ultimately be incinerated. Importantly, however, this does not necessarily eliminate the benefit of using bio-based carbon. Even where a bio-based material is sent to energy-from-waste, sustainably sourced virgin biogenic carbon can offer an advantage over virgin fossil carbon by avoiding the introduction of additional fossil carbon into the atmosphere. This distinction is likely to become increasingly commercially relevant as the UK Emissions Trading Scheme (UK ETS) expands to include energy-from-waste and waste incineration from 2028. Under the proposed approach, fossil-derived CO_2 emissions from waste incineration will carry a carbon cost, whereas the biogenic fraction is intended to receive a zero emissions factor, subject to the applicable monitoring and sustainability rules. Packaging producers should therefore consider not only current end-of-life infrastructure, but also the future carbon and tax-cost implications of the feedstocks they select. In this context, replacing virgin fossil carbon with sustainably sourced biogenic carbon may retain a climate and economic benefit even where the optimum composting or recycling pathway is not yet available. However, the strongest opportunity is therefore likely to be in applications where material design, consumer disposal behaviour and organic-waste collection infrastructure can be aligned.

Mixed Materials

High-performance beauty packaging frequently relies on complex multi-material assemblies. Pumps, for example, can contain several grades of plastic alongside metal springs, while serum droppers can combine glass, plastic, silicone or rubber components. Compacts, mascara packs and dispensing systems can similarly contain several materials within a small package.

These combinations provide important functionality but create significant challenges at end of life. Conventional recycling systems depend upon identifying and separating relatively homogeneous material streams. Where several materials are permanently or semi-permanently combined within a small component, automated sorting and reprocessing becomes significantly more difficult.

Pact Collective identifies mixed-material construction as one of the principal reasons beauty packaging is difficult to recycle and recommends mono-material packaging wherever possible[29]. Its specialist recycling system illustrates the extent of the problem: Pact has described manually separating components such as the glass and silicone elements of cosmetic droppers because conventional MRFs are unable to undertake this level of disassembly.

The problem is therefore not simply whether each individual material is theoretically recyclable. A glass bottle, polypropylene collar, silicone bulb and glass pipette may each have potential material value, but the assembled product may not be practically recyclable within the system into which consumers dispose of it.

[29] Guide: Designing better beauty and wellness packaging — Pact Collective

Bio-Benefit: Bio-based materials could help address this challenge where they enable manufacturers to simplify packaging structures. Replacing several incompatible fossil-derived materials with a single bio-based polymer, or a compatible family of materials, could support mono-material design while retaining the functionality required by the product. A second opportunity is the development of fully compostable multi-component systems in which the individual components have been designed to follow the same validated biological end-of-life pathway. In principle, this could remove the need for consumers or recyclers to disassemble complex packs before treatment. However, the benefit arises from system compatibility rather than bio-based content alone. A multi-material pack does not automatically become easier to manage simply because each component is bio-based. The materials must be compatible with one another at end of life and with the infrastructure through which the complete package will actually be collected and treated.

The design opportunity for the beauty industry is therefore to move from multiple materials providing multiple functions, towards compatible materials providing multiple functions, whether through mono-material recyclable systems or appropriately designed compostable systems.

Post-Consumer Recycled Content

Post-consumer recycled (PCR) material is material recovered from products that have been used by consumers, collected as waste, and subsequently processed into a secondary raw material for use in new products. In plastic packaging, this typically involves the collection, sorting, cleaning and reprocessing of used plastic into flakes or pellets that can be incorporated into new packaging. PCR differs from post-industrial or pre-consumer recycled material, which consists of manufacturing scrap or waste that has not reached the consumer.

Increasing PCR content is an important component of the transition towards a circular economy because it keeps existing materials in productive use, reduces demand for virgin raw materials and can reduce the environmental impacts associated with producing new material. In beauty packaging, common examples include bottles and containers manufactured partly or wholly from recycled PET (rPET), polyethylene (rPE) or polypropylene (rPP).

However, beauty packaging presents several challenges for PCR that can limit the percentage of recycled content achievable in particular applications. One challenge is material purity and consistency. Post-consumer plastics originate from heterogeneous waste streams and can contain substances associated with previous uses, other polymers, adhesives, labels, additives and degradation products. Although regulatory requirements differ between cosmetics and food-contact applications, the stringent controls applied to recycled plastics intended for sensitive applications demonstrate the underlying technical issue. The European Food Safety Authority (EFSA), for example, identifies contamination from previous uses and other waste as an important consideration in recycled plastic intended for food-contact materials. Its guidance specifically identifies contaminants arising from non-food PET applications including cosmetics, personal-hygiene products and household cleaners[30].

Tightening restrictions on per- and polyfluoroalkyl substances (PFAS) create an additional challenge for recycled materials. PFAS have historically been used across a wide range of products and industrial applications because of their resistance to water, oils, chemicals and heat. As the UK and EU move towards substantially tighter controls on PFAS, manufacturers will increasingly need to understand not only the performance of recycled feedstocks but also their chemical history and the potential presence of legacy substances.

[30] European Food Safety Authority (EFSA), *Recycled Plastic Materials*, reviewed 20 February 2026.

This creates a particular challenge for circularity. Restrictions on hazardous substances can prevent chemicals that are no longer considered acceptable in virgin materials from being repeatedly recirculated through recycled material streams. The European Chemicals Agency (ECHA) is currently progressing a proposal for a broad restriction covering more than 10,000 PFAS under REACH, while the UK is also developing its regulatory approach to PFAS[31]. As restrictions tighten, demonstrating that PCR meets future chemical requirements could therefore require greater feedstock traceability, testing and quality control, particularly where recycled material originates from heterogeneous or poorly characterised historic waste streams.

This does not mean that PCR inherently contains PFAS, nor that recycled material should be avoided. Rather, it highlights a wider challenge associated with the transition towards a non-toxic circular economy: recycling keeps materials in circulation but can also keep legacy additives and contaminants in circulation unless they can be identified and removed. For beauty brands designing packaging intended to remain compliant for many years, chemical provenance and the ability to demonstrate the absence of substances of concern are therefore likely to become increasingly important considerations when specifying PCR.

For beauty applications, these considerations sit alongside demanding formulation-compatibility and product-quality requirements. Recycled material must provide sufficiently consistent mechanical, barrier and chemical properties while avoiding interactions that could compromise the formulation.

There can also be aesthetic constraints. Mechanical recycling can produce variation in colour, clarity, odour and surface appearance depending upon the polymer, source material and recycling process. These characteristics can conflict with packaging specifications that require high transparency, precise colour matching or a consistent premium finish. Importantly, however, these limitations are not universal: high-quality PCR is already successfully used in a range of personal-care and skincare packaging applications, and packaging should therefore maximise recycled content where technically and environmentally appropriate[32].

Bio-Benefit: Bio-based virgin polymers offer a complementary route to reducing dependence on virgin fossil carbon where PCR cannot meet the purity, compatibility, optical, chemical or performance requirements of a particular beauty application. Because the carbon feedstock originates wholly or partly from renewable biological resources, bio-based materials can provide virgin-material performance without relying exclusively on virgin fossil feedstocks. Virgin bio-based materials may also offer greater control over chemical composition and provenance than heterogeneous post-consumer feedstocks, potentially making it easier to design materials from the outset without PFAS and other legacy substances of concern. This is not to say that bio-based material is inherently superior to PCR. From a circular-resource perspective, retaining existing materials within productive use through recycling can offer significant benefits. Rather, bio-based feedstocks provide an additional source of renewable carbon for applications where virgin-quality or tightly controlled material remains necessary. This creates the potential for a hierarchy in which packaging manufacturers first minimise material use and maximise reuse and recycled content where practicable, while using sustainably sourced bio-based carbon to progressively displace the remaining requirement for virgin fossil feedstock. Bio-based and recycled materials can therefore be viewed as complementary rather than competing approaches to reducing the beauty industry's dependence on virgin fossil resources while supporting the transition towards safer and more traceable material cycles.

[31] ECHA publishes updated PFAS restriction proposal | EU Chemicals Platform
[32] Guide: Designing better beauty and wellness packaging — Pact Collective

Section Summary

- *Biomaterials directly address the format and material limits that recycling infrastructure cannot solve on its own. For example, small components fall through sorting equipment no matter what they're made of, and mixed-material assemblies can't be separated for recycling.*
- *Compostable materials offer a working alternative disposal route and bio-based materials enable products to reduce their fossil footprint.*
- *Recycled content struggles with purity, contamination, and appearance in beauty applications; however, bio-based materials enable contact sensitive material that is both virgin and renewable.*

06 Waste Outcomes for Problematic Packaging

Despite noteworthy progress in packaging design and recycling, a substantial proportion of beauty packaging remains poorly suited to existing UK recycling systems (Table 2). The combination of small formats, complex dispensing mechanisms, mixed materials, specialist coatings and barriers, and demanding aesthetic and performance requirements means that packaging which performs exceptionally well during use can be particularly difficult to manage at end of life. Understanding where these formats ultimately go, and what happens to their carbon (and other constituents) when they get there, is therefore critical when assessing the sustainability of alternative packaging materials.

This section examines how problematic beauty packaging is treated within the UK's emerging recyclability frameworks, the implications of residual waste treatment and incineration, and why the transition from fossil to renewable bio-based carbon could provide environmental and, increasingly, economic benefits even where recycling is not currently viable.

In practice, many of the beauty packaging formats that are most difficult to recycle ultimately enter the residual waste stream. Packaging may be technically recyclable at a material level but still fails to be recycled in practice because it cannot be effectively collected, identified, sorted or reprocessed within existing UK infrastructure. Once packaging enters residual waste, its principal end-of-life routes are incineration, including energy-from-waste (EfW), or landfill. Across England as a whole, 18.9 million tonnes of residual waste were incinerated in 2024, while 37.8 million tonnes were sent to landfill[33].

The UK's Recyclability Assessment Methodology (RAM), introduced as part of Extended Producer Responsibility for packaging (pEPR), seeks to address the distinction between theoretical and practical recyclability. Rather than considering only whether the underlying material is technically recyclable, RAM assesses packaging across the stages required for it to be successfully recycled, including collection, sortation, reprocessing and its ability to be converted into useful secondary material. Packaging is ultimately assigned a green, amber or red rating, with less recyclable packaging attracting higher disposal costs under pEPR[34],[35].

This is particularly relevant to the beauty industry because a number of common beauty packaging characteristics can result in poor RAM performance. For example, for rigid plastic packaging, items must generally measure at least 40 mm in at least two dimensions to achieve a green rating at the sortation stage, unless specified exceptions apply. This creates a challenge for small beauty components such as caps, closures, and miniature packaging. Rigid plastics containing carbon-black pigment are also rated

[33] Estimates of Residual Waste and Municipal Residual Waste in England - GOV.UK
[34] Recyclability assessment methodology: materials and outputs - GOV.UK
[35] Assess packaging recyclability: recyclability assessment methodology (RAM) 2027 - GOV.UK

red at sortation, while particular incompatible materials and components can result in a red rating at reprocessing[36].

Complex packaging structures create further difficulties. RAM requires multi-material components that cannot easily be separated by hand to be assessed together, meaning that the recyclability of a nominally recyclable primary material can be compromised by attached components[37]. For rigid plastics, incompatible caps, seals, inserts, labels and sleeves can lead to red or amber classifications depending on the polymer and component concerned. Flexible packaging also faces significant restrictions: flexible packs must contain at least 80% polyethylene (PE), polypropylene (PP), or a combination of the two to progress through the relevant reprocessing assessment, while materials including PET, PVC, PVDC, paper and aluminium foil can result in a red classification[38].

These criteria have direct implications for common beauty formats. Small components, pumps incorporating incompatible materials, metallised or multilayer sachets, heavily pigmented packs, complex droppers and packaging containing incompatible labels, sleeves or barriers may therefore perform poorly under RAM even where their principal material is theoretically recyclable. The problem is not necessarily the recyclability of the individual polymer, glass or metal, but the ability of the complete packaging system to pass successfully through the collection, sorting and reprocessing infrastructure available in the UK.

Where these formats are not captured for recycling, they enter residual waste. An increasing quantity of England's residual waste is treated through incineration: government statistics show that residual waste sent to incineration, including EfW, increased by 16.9% between 2019 and 2024, reaching 18.9 million tonnes in 2024[39]. EfW facilities combust waste to reduce its volume and, in many cases, recover energy as electricity or heat.

This has an important consequence for the choice of packaging feedstock. When fossil-derived plastics are incinerated, their carbon content is converted principally into fossil CO_2, transferring carbon that was previously stored in geological reserves into the active carbon cycle. By contrast, the carbon contained within sustainably sourced bio-based materials originates from atmospheric CO_2 that has relatively recently been captured through biological growth. Its combustion returns this biogenic carbon to the atmosphere rather than introducing additional fossil carbon into the active carbon cycle.

For problematic beauty packaging that is likely to remain within the residual waste stream, the relevant environmental comparison may consequently be broader than simply “recyclable versus non-recyclable.” Where recycling cannot realistically occur, replacing virgin fossil carbon with sustainably sourced renewable biogenic carbon can still provide an important benefit by reducing the amount of additional fossil carbon entering the atmosphere at end of life. As carbon pricing increasingly reaches the waste sector, beauty brands should therefore consider not only whether packaging is recyclable today, but the carbon origin of materials that are likely to be incinerated and the potential future carbon-cost implications of those choices.

This creates a potentially vital role for bio-based materials in difficult-to-recycle beauty formats. The optimum outcome remains prevention, reuse or effective recycling where these are technically and environmentally appropriate. However, for packaging that cannot currently be captured and recycled at scale, substituting sustainably sourced bio-based carbon for virgin fossil carbon can reduce dependence on finite fossil resources and potentially reduce exposure to the future carbon costs associated with fossil carbon at end of life.

[36] Recyclability assessment methodology: stages of recyclability and definitions - GOV.UK
[37] Recyclability assessment methodology: stages of recyclability and definitions - GOV.UK
[38] Recyclability assessment methodology: stages of recyclability and definitions - GOV.UK
[39] Estimates of Residual Waste and Municipal Residual Waste in England - GOV.UK

Table 2. Examples of Problematic Beauty Packaging that Cannot Be Recycled.

Problematic Packaging Format	Reason Not Recyclable
Bottles smaller than 40mm	Too small
Plastic tubes smaller than 40mm	Too small
Deodorant	Mixed material and generally too small
Lip products (lip balm, lip gloss, lipstick) and other twist up applicator products	Too small, mixed materials
Aluminum tubes	Can't be picked up for sorting by eddy current with more than 2% (by weight) contamination
Multi-layer pouches	mixed materials
Plastic Refill pods	Too small
Eyeliner and eyeliner caps	Too small
Compacts	Often too small, often made with non-recyclable materials (ABS), often mixed material (mirror insert, metal pan, etc.)
Perfume Caps	Too small, often made with not recyclable materials
Refill spout pouches	Mixed material, often made with not recyclable materials
Plastic caps (even on metal and glass containers)	Too small, often with mixed material gasket insert
Pump dispensers	Mixed material and/or too small
Spray caps	Mixed material and/or too small
Pipette Droppers	mixed material and/or too small
Sample Sachets	Too small

Section Summary

- *Packaging that cannot be recycled is typically incinerated or landfilled. England incinerated 18.9 million tonnes of residual waste in 2024.*
- *The UK's Recyclability Assessment Methodology excludes many beauty formats from a green rating due to size, pigment, or material combination, independent of the underlying polymer.*
- *The 2028 expansion of the UK Emissions Trading Scheme to waste incineration will introduce a direct carbon cost for fossil-derived packaging. Substituting biogenic carbon for fossil carbon reduces net fossil emissions even when recycling is not viable.*

07 Moving Beyond Reduce, Reuse, Recycle

The principles of Reduce, Reuse, and Recycle remain fundamental to sustainable packaging. However, they do not provide a complete solution for every beauty packaging format. The technical requirements of beauty products, combined with the limitations of existing collection, sorting and recycling infrastructure, mean that some packaging will continue to require virgin material and some formats will remain difficult or uneconomic to recycle.

The opportunity for biomaterials is therefore not to replace the waste hierarchy, but to address the gaps within it. Alongside reducing material use, expanding reuse and maximising effective recycling, a transition from fossil to renewable carbon and the development of alternative end-of-life pathways can provide additional tools for reducing the environmental impact of beauty packaging.

Reduce, Reuse, Recycle

Reduce: use less material

Packaging should first be eliminated or lightweighted wherever possible. However, reduction has practical limits. Beauty packaging performs essential functions, including containing and dispensing formulations and protecting them against oxygen, moisture, light, contamination, and physical damage. Reducing packaging beyond the point at which these functions can be maintained risks product deterioration or waste, potentially shifting rather than reducing the overall environmental impact.

Reuse: keep packaging in circulation

Reuse and refill systems can significantly reduce demand for single-use packaging when containers achieve sufficient numbers of reuse cycles. The beauty industry is already developing refillable fragrance, skincare and personal-care formats, but these systems must overcome practical challenges including reverse logistics, consumer participation, cleaning and hygiene, refill infrastructure and the additional durability required of reusable packaging. Their environmental benefit is therefore dependent not simply on whether a pack is designed for reuse, but whether reuse occurs consistently and at sufficient scale.

Recycle: keep materials in circulation

Where reuse is not practical, effective recycling can retain valuable materials within the economy and reduce demand for virgin resources. However, as discussed previously, many characteristic beauty packaging formats remain poorly suited to conventional recycling infrastructure. Small components, pumps, droppers, applicators, multilayer sachets and mixed-material assemblies can fail at collection, sorting or reprocessing even where their constituent materials are theoretically recyclable. For these applications, repeatedly designing around a recycling pathway that does not function in practice risks creating the appearance of circularity without actually achieving it.

Extending the Hierarchy: Replace, Renew, Replenish

Biomaterials provide an opportunity to extend the conventional hierarchy by considering not only how much packaging is used and what happens to it after use, but also where its carbon comes from and what happens if it escapes conventional recycling systems.

Replace: Design for the End-of-Life Route That Can Actually Work

Where conventional mechanical recycling is demonstrably impractical, alternative material and end-of-life strategies should be considered rather than assuming recyclability must always be the preferred design objective.

For selected formats, this could mean replacing fossil-based, difficult-to-recycle structures with bio-based materials designed for an appropriate biological end-of-life pathway. Small-format and highly complex applications such as lipstick components, mascara components and sachets may represent particularly interesting opportunities because their physical format can prevent effective capture by conventional Material Recovery Facilities regardless of the theoretical recyclability of the underlying polymer.

This does not mean that compostability should displace recycling where recycling works effectively. Rather, packaging should be designed around the most credible end-of-life pathway for the particular product and material, supported by the collection and treatment infrastructure required to make that pathway work in practice.

Renew: Replace Fossil Carbon with Renewable Carbon

Circularity should consider the source of carbon as well as its circulation. Even a perfectly recyclable fossil-derived plastic ultimately originates from carbon extracted from finite geological reserves. Bio-based materials offer an opportunity to progressively replace this virgin fossil carbon with renewable carbon derived from biomass, residues, wastes, or other sustainable biological feedstocks.

This distinction becomes particularly important for packaging that cannot currently be recycled and is ultimately incinerated. Combustion of fossil-derived plastics introduces fossil carbon into the active carbon cycle, whereas sustainably sourced bio-based materials return recently captured biogenic carbon. Moving from virgin fossil carbon to renewable biogenic carbon can therefore provide a benefit even where the ideal recycling or composting pathway is not ultimately achieved.

This could also become increasingly economically significant as the UK Emissions Trading Scheme expands to waste incineration and energy-from-waste from 2028. The carbon origin of materials entering residual waste may consequently become not only an environmental consideration, but a potential future carbon-cost consideration for the packaging value chain.

Replenish: Design Materials to Safely Return to Biological Systems

The final opportunity is to rethink what happens when material can no longer be kept within a technical cycle. For appropriately selected applications, biodegradable and compostable materials can be designed to return their constituent carbon and nutrients to biological systems rather than persist as long-lived plastic pollution.

This is particularly relevant where packaging or small components have a high probability of escaping conventional recycling systems. Materials capable of biodegrading under defined environmental or managed composting conditions may reduce the risk of persistent plastic fragments and microplastics accumulating in soils and aquatic environments.

Some emerging biomaterials may also offer multiple credible end-of-life pathways, for example being mechanically or organically recyclable while retaining intrinsic biodegradability under specified conditions. Rather than designing a material around a single idealised disposal scenario, this creates the possibility of packaging that remains compatible with more than one material cycle.

The objective should therefore be to move towards materials that are stable when stability is required, circular where circularity is achievable, and capable of safely returning to biological systems where appropriate.

From a Waste Hierarchy to a Carbon and Materials Hierarchy

Reduce, Reuse and Recycle should remain the foundation of sustainable packaging - but they need not represent the limits of it. For the beauty industry, a more complete approach is to minimise packaging first, reuse it where systems can support genuine, repeated use, and recycle materials wherever recycling works effectively. Where those routes reach their technical or practical limits, the next question should be: Can we replace the problematic format? Can we renew its carbon source? And can we design its eventual return to the biosphere without persistent pollution?

Together, Reduce, Reuse, Recycle, Replace, Renew and Replenish provide a broader framework for moving beauty packaging away from a linear model based on virgin fossil resources and persistent waste, towards one based on resource efficiency, renewable carbon and genuinely circular material flows.

Section Summary

- *Reduce, Reuse, and Recycle remain necessary but are structurally limited for many beauty formats due to hygiene, logistics, and infrastructure constraints.*
- *The report proposes extending the hierarchy with Replace, Renew, and Replenish, addressing material choice, carbon source, and end of life. This reframes circularity around carbon origin and material design, to expand opportunities for brands to adopt more sustainable packaging using biomaterials.*

08 Priority Opportunities for Bio-Based and Compostable Beauty Packaging

Bio-based and compostable materials are unlikely to be the optimum solution for every beauty packaging application. Where packaging can be eliminated, reused effectively or recycled at scale, these routes should generally remain the priority. However, there are specific beauty formats for which conventional mechanical recycling performs poorly because of the physical size, material complexity, contamination, or construction of the pack.

Specific Beauty Formats

These applications represent some of the strongest opportunities for biomaterials. Rather than attempting to make an inherently difficult format marginally more recyclable, material innovation can address the problem at source: replacing fossil carbon with renewable carbon, simplifying material combinations and, where appropriate collection and treatment systems exist, designing packaging for a biological rather than mechanical end-of-life pathway.

Small-Format Plastic Items

Small-format packaging is a particular challenge for the beauty industry. Examples include minis, eyeliner and brow-pencil components, lipstick and mascara components, travel-sized products, pipettes, applicators, caps and closures.

The problem is not necessarily the polymer from which these items are manufactured, but their physical size. Small items can fall through screens during mechanical sorting and consequently fail to reach the appropriate polymer recycling stream. Pact Collective, which specialises in difficult-to-recycle beauty packaging, identifies bottles and jars below approximately 2 × 2 inches, alongside caps, pumps, droppers, applicators, lipstick tubes and mascara components, as formats requiring specialist collection rather than conventional kerbside recycling[40]. The Ellen MacArthur Foundation has similarly reported that L'Oréal estimated approximately 20% of its products were too small to be captured by recycling sorting infrastructure[41].

This creates a fundamental limitation to conventional design-for-recycling. Changing a small item from one recyclable polymer to another does little to improve circularity if sorting infrastructure cannot physically capture it. The proliferation of packaging that is unrecyclable by design has been identified as a challenge by the British Beauty Council, whose initiative *The Great British Beauty Clean Up* encourages consumers to return their hard to recycle packaging to a take back scheme for disposal.[42] This is a sector-

[40] Pact's Collection Guidelines — Pact Collective
[41] Global Commitment 2020 Progress Report published | Ellen MacArthur Foundation
[42] The Great British Beauty Clean Up 2026 is live and makes an industry call to recycle, reduce and refill - British Beauty Council

led initiative to provide an interim solution while packaging materials and infrastructure evolve to address the packaging waste issue at the source.

Bio-based materials offer two potential benefits. First, replacing virgin fossil polymers with sustainably sourced bio-based materials reduces reliance on fossil carbon even if the item ultimately enters residual waste. Second, where the application and waste-management system are appropriate, certified home- or industrially compostable materials could provide an alternative biological end-of-life pathway. Intrinsically biodegradable materials may also offer an additional safeguard against long-term persistence where small items inadvertently escape formal waste-management systems, although environmental biodegradation must be demonstrated for the specific material and receiving environment rather than assumed from compostability certification.

Mixed-Material Components

Beauty packaging frequently achieves its required functionality by combining multiple materials within a single component. Pumps and spray mechanisms can combine several polymers with metal springs; droppers may incorporate glass, plastic and elastomers; while compacts, palettes and applicator systems can contain numerous permanently or semi-permanently connected components.

Individually, some of these materials may be recyclable. The difficulty arises when they are assembled into a format that cannot readily be separated by either consumers or recycling infrastructure. The Ellen MacArthur Foundation has identified complex fixtures such as pumps and sprays as disruptors to cosmetics recycling. L'Oréal, for example, reported a project specifically aimed at removing metallic springs from pumps used with PET packaging[43].

This makes mixed-material components an important target for redesign. One approach is to develop mono-material bio-based systems, allowing several functional components to be manufactured from compatible materials. Another is to design complete multi-component systems from materials that can follow the same validated end-of-life pathway, including composting where appropriate.

The important principle is not simply to replace several fossil materials with several bio-based materials. The objective should be to design compatibility into the complete packaging system, so that the whole component can follow a credible end-of-life pathway without requiring unrealistic levels of consumer disassembly.

2M & Xampla: plant waste converted into ELEMIS sample sachets

British skincare company ELEMIS has partnered with Xampla and 2M to develop plastic-free sample sachets using ELEMIS's own leftover plant waste.[1]

This waste was converted into heat-sealable film used for the sachets, turning a manufacturing byproduct directly into packaging material. This collaboration shows how waste in unrecyclable plastic formats can be replaced with biomaterials, and how a brand's own waste stream can supply the feedstock for developing circular packaging.

[43] Global Commitment 2020 Progress Report published | Ellen MacArthur Foundation

Sachets and Flexible Films

Sachets, sample packs, pouches, and other flexible formats represent another significant opportunity. These packs use little material and provide excellent product protection, but the high barrier performance required for cosmetics has traditionally been achieved using multilayer structures combining different plastics, aluminium foil, paper, adhesives and coatings.

Such structures can be extremely difficult to separate and mechanically recycle. Their small size and low material value can compound the problem. Pact consequently includes pouches and sachets among the specialist beauty packaging formats it collects[44].

Compostable flexible films are one of the more commercially developed biomaterial alternatives for these applications. Cellulose-based films can provide transparency and barriers to aroma, gases, and moisture while being derived from renewable feedstocks. They can also be combined with compatible bio-based films, coatings, inks, and adhesives to create complete certified compostable structures[45].

Futamura: Natureflex film's evolution from food to beauty sachets

Conserving Beauty, an Australian skincare company, now uses a NatureFlex-based laminate (barrier film plus a second biofilm for sealing) for its cleansing wipe sachets, which are certified home and industrial compostable under EN 13432.

Futamura's NatureFlex cellulose film was originally used in the food sector, and is market leading for biobased and biodegradable confectionery wrap, snack pouches, tea bags, and other food packaging. Beauty faces the same core problem as the food sector: small, single-use formats needing a barrier film that holds up against moisture and oxygen loss. Futamura carried their biobased film technology over into cosmetics, showcasing how learnings from successful biobased and biodegradable solutions from other sectors can be translated into other applications.

Product-Contaminated Packaging

A final challenge is packaging that remains contaminated with cosmetic formulation after use. Tubes, pumps, compacts, applicators and containers for viscous products can retain significant residues that consumers cannot easily remove. This matters because recycling systems generally require packaging to be sufficiently empty and clean for processing. Pact, for example, requires beauty packaging entering its specialist collection programmes to be clean and empty and states that packaging containing residual product may be considered contaminated and unsuitable for its recyclers to process[46].

This creates an important distinction between technical recyclability and real-world recyclability. A polymer may be highly recyclable in isolation, but the actual package placed into the waste system may still fail if it cannot readily be emptied or cleaned. Compostable packaging could offer an alternative for selected applications where both the packaging material and its residual contents are compatible with the intended organic recycling process. Unlike mechanical plastics recycling, biological treatment is

[44] Pact's Collection Guidelines — Pact Collective
[45] NatureFlex™ - Futamura
[46] Ulta Beauty - The Beauty Dropoff — Pact Collective

capable of processing biodegradable organic matter alongside certified compostable materials. This could make packaging that predictably remains associated with compatible organic residues an interesting target for future material development.

However, this opportunity requires careful qualification for cosmetics. Not every cosmetic formulation is suitable for introduction into composting systems, and compostability of the package does not automatically mean that the combined package-and-product residue is acceptable for organic recycling. Formulation ingredients, ecotoxicity, certification requirements and local acceptance criteria therefore need to be considered alongside packaging biodegradation.

Shellworks: The world's first home compostable pipette droppers

Shellworks has developed a fully home-compostable pipette dropper made from Vivomer, a biobased material made by microorganisms that is entirely home compostable.[1] This innovative dropper is already used by brands such as Hair by Sam McKnight and Clara's Corner.

Pipette droppers are normally built from fused glass, rubber, and plastic, making the ubiquitous format unable to be recycled because it is both mixed-material and too small. By creating the whole dropper in Vivomer, the entire pipette and bottle biodegrade down together at end of life instead of becoming unrecyclable waste. Shellworks has replaced over 9 million pieces of plastic packaging with its compostable packaging to date, demonstrating that even highly technical, multi-component beauty formats can be redesigned with biobased and biodegradable materials.

Where Biomaterials Can Add Most Value

Taken together, these examples suggest that the greatest near-term opportunity for biomaterials may not be replacing packaging that already performs well within existing recycling systems. Instead, innovation should initially focus on the problem formats for which circularity is currently weakest: packaging that is too small to sort, too complex to separate, too flexible to reprocess economically, or difficult to clean sufficiently for conventional recycling.

In these applications, bio-based materials can address the source of the carbon, while biodegradable and compostable materials can potentially address its destination. The strongest opportunities will be those that achieve both: replacing virgin fossil feedstocks with sustainably sourced renewable carbon while designing a credible end-of-life pathway that reflects what actually happens to the package after the consumer has finished with it.

Opportunity areas for safer beauty packaging

Safety is an increasingly important dimension of packaging sustainability. A material that is renewable, recyclable, or biodegradable cannot be considered genuinely sustainable if it introduces substances of concern into products, recycling streams or the wider environment. This is particularly important in beauty, where packaging can remain in direct contact with complex formulations for several years and where chemical migration, formulation compatibility, and consumer safety are critical performance requirements.

Bio-based materials therefore present an opportunity that extends beyond renewable carbon. Where they are developed according to safe-and-sustainable-by-design principles, they can provide brands with greater control over feedstock, additives and material composition from the outset. This could become increasingly valuable as regulation tightens around PFAS and other persistent substances and brands seek packaging systems that combine performance, renewable carbon and demonstrably safer chemistry.

Reducing Contact-Sensitivity and Purity Constraints Associated with PCR

Post-consumer recycled (PCR) content plays an important role in reducing demand for virgin resources and should be maximised where it can safely and effectively meet the requirements of the application. However, its use can become more challenging in packaging that requires particularly high levels of purity, consistency, formulation compatibility, or aesthetic performance.

The opportunity is therefore not to replace PCR indiscriminately. Rather, beauty brands could maximise recycled content where it is technically and environmentally appropriate while using sustainably sourced bio-based carbon for the proportion of packaging that continues to require virgin-quality material. This creates a pathway towards reducing both virgin resource consumption and dependence on virgin fossil carbon.

Designing Out PFAS and Other Substances of Concern

A second opportunity lies in the chemistry used to achieve packaging performance. Conventional packaging can depend on additives, coatings, processing aids, inks, adhesives and barrier treatments to provide properties such as water, oil, grease, and chemical resistance. Some substances historically used to provide these functions are now receiving increased regulatory scrutiny because of their environmental persistence and potential impacts on human health.

PFAS — per- and polyfluoroalkyl substances — are a particularly important example. PFAS comprises a large family of highly persistent fluorinated chemicals that have been used across numerous applications because of their resistance to water, oil, heat, and chemical degradation. Their extreme environmental persistence has resulted in them becoming widely known as “forever chemicals.”

The issue is also increasingly relevant to the beauty industry itself. In 2024, the European Chemicals Agency identified cosmetics as one of the sectors in which PFAS alternatives were being considered as part of its evaluation of the universal restriction proposal[47]. This creates a wider strategic question for beauty brands: as PFAS and other persistent substances are progressively restricted, what chemistries will provide the barrier and functional properties currently demanded from packaging?

[47] ECHA and five European countries issue progress update on PFAS restriction | Burgmann Packings

Bio-based material innovation could help provide part of the answer. Cellulose, chitosan, alginate, natural waxes, proteins and other biologically derived materials are being investigated or commercialised as coatings and barriers capable of providing moisture, oxygen, grease or other functional properties without relying on particular persistent synthetic chemistries.

However, bio-based should not itself be treated as a safety claim. A bio-based polymer can still contain problematic additives, coatings or processing aids, just as a fossil-derived polymer can be manufactured without PFAS. The opportunity is instead to combine renewable feedstocks with safe-and-sustainable-by-design chemistry, explicitly excluding PFAS and other substances of concern and demonstrating safety through appropriate chemical characterisation, migration and ecotoxicity testing.

Section Summary

- *Bio-based and compostable materials directly solve beauty's hardest formats: small items, mixed-material components, sachets, and product-contaminated packaging.*
- *Developing bio-based materials for sensitive applications means brands can eliminate the risk of PFAS and other concerning substances from their supply chain. This enables brands to leverage renewable materials where PCR is not suitable.*

09 Policy Challenges & Opportunities

The UK beauty and personal care sector operates within a packaging policy landscape designed to reduce plastic waste and increase recycling. Unfortunately, these policies are not aligned with the realities of beauty packaging which struggle to meet basic recyclability requirements due to fundamental format design. As a result, UK packaging and packaging waste policies fail to support the most waste reduction in beauty packaging and should focus efforts on transitioning to lower-impact materials in the beauty sector.

The global cosmetics industry produces an estimated 120 billion units of packaging annually, much of it in formats that are difficult or impossible to recycle[48]. In 2021, UK plastic packaging waste exceeded 2.5 million tonnes per year, and current estimates from WRAP suggest that just 51% of this packaging is effectively recycled.[49] [50] Within this system, beauty packaging performs particularly poorly: up to 95% is discarded, largely due to its small size, mixed materials, and contamination from product residue.[51]

Policy Challenges for Biomaterials in Beauty

The development of bio-based and biodegradable packaging is advancing faster than the policy and waste-management systems within which these materials must operate. Current UK packaging policy has largely been designed around a mechanical-recycling model of circularity, with strong incentives to increase recyclability and recycled content. These are important objectives, but they can create unintended consequences for beauty packaging, where many formats are inherently difficult to capture and recycle and where virgin-quality material may remain necessary for technical, safety or aesthetic reasons.

The result is a potential policy mismatch: a bio-based material may reduce dependence on fossil carbon, avoid persistent plastic pollution or provide a credible biological end-of-life pathway, yet receive little or

[48]Kaleigh Moore, 'New Ways the Beauty Industry is Testing Sustainable Practices', *Forbes*, 11 June 2019.
[49] Department for Environment, Food & Rural Affairs, *UK Statistics on Waste* (London: DEFRA, updated July 2025).
[50]WRAP, *UK Plastics Pact Annual Report 2024–25* (Banbury: WRAP, November 2025).
[51]British Beauty Council, 'Packaging', *Planet Positive Beauty Guide* (London: British Beauty Council, 2023).

no recognition for those attributes within current packaging taxes and producer-responsibility mechanisms.

Recycling Is Prioritised Without Equivalent Solutions for Non-Recyclable Formats

The UK's Extended Producer Responsibility for packaging (pEPR) system places recyclability at the centre of packaging assessment. Large producers are required to use the Recyclability Assessment Methodology (RAM) to assess household packaging against its ability to move through collection, sortation, reprocessing and end-use stages within existing UK infrastructure. Packaging receives a green, amber or red rating, with red-rated materials ultimately attracting higher waste-disposal fees[52].

This provides a strong incentive to improve the recyclability of mainstream packaging but presents a challenge for sectors such as beauty where the functionality and physical design of the package can itself prevent effective recycling. Pumps, applicators, small caps and closures, travel-sized formats, sachets and multilayer structures may fail RAM criteria because of their size, construction or incompatibility with existing sorting and reprocessing systems.

Importantly, RAM 2027 defines recycling at scale in terms of packaging moving through existing, proven infrastructure rather than pilot or experimental systems, with sufficient capacity to handle the quantity of packaging placed on the market[53]. This creates a potential innovation problem: new materials and alternative end-of-life technologies cannot readily benefit from policy recognition until infrastructure exists at scale, while investment in that infrastructure is more difficult to justify without sufficient volumes of material.

The current system therefore risks asking, “Can this package be recycled within today's system?” without giving equivalent weight to questions such as “What resources were used to manufacture it?”, “Where did its carbon originate?”, “Will it persist if it escapes collection?” and “What is its environmental impact when it becomes waste?”

Bio-Based and Compostable Materials Can Face Higher Fees and Taxes

This policy challenge becomes particularly clear for biodegradable and compostable plastics. Under the current RAM, oxo-degradable, biodegradable and compostable rigid plastics are classified red at the reprocessing stage[54]. Consequently, a certified compostable package designed around a biological end-of-life pathway can receive the same red recyclability classification as a conventional fossil-derived package that is simply incompatible with recycling.

There is a rationale for this treatment: compostable plastics entering conventional plastics recycling streams can interfere with reprocessing. However, the outcome is that the assessment does not distinguish between materials according to their performance through alternative end-of-life routes. A certified compostable material with demonstrated biodegradation and ecotoxicity performance may therefore receive no additional recognition within RAM for those characteristics.

A similar issue exists within the Plastic Packaging Tax (PPT). The tax applies to finished plastic packaging components containing less than 30% recycled plastic. As of 2026, the rate is £228.82 per tonne[55]. Bio-based plastics are not generally exempt simply because their carbon is renewable. A virgin bio-based plastic package can therefore incur PPT in essentially the same way as virgin fossil-derived plastic packaging if it contains insufficient recycled content.

[52] Recyclability assessment methodology: how to assess your packaging waste - GOV.UK
[53] RAM 2027: overview - GOV.UK
[54] Recyclability Assessment Methodology (RAM) v1.1 - GOV.UK
[55] Plastic Packaging Tax - GOV.UK

This creates an important policy asymmetry. A packaging producer replacing virgin fossil plastic with a virgin polymer derived from renewable biological carbon may reduce its dependence on fossil feedstock, but the tax system does not currently recognise that substitution. In applications where recycled content cannot meet formulation-contact, purity or performance requirements, manufacturers can therefore face a choice between paying PPT on renewable virgin material or returning to virgin fossil material and paying the same tax.

The issue is not that bio-based material should automatically be considered sustainable. Feedstock sourcing, land use, production emissions and end-of-life impacts all matter. Rather, policy currently provides strong incentives for one environmental attribute - recycled content - while providing considerably less recognition for another potentially important transition: replacing virgin fossil carbon with sustainably sourced renewable carbon.

Waste Infrastructure Has Not Kept Pace with Material Innovation

A second barrier is the mismatch between material innovation and waste-management infrastructure. The UK has increasingly focused packaging policy on improving collection and mechanical recycling. Equivalent systems for identifying, collecting and treating compostable packaging remain considerably less developed.

This creates a circular dependency. Compostable packaging needs appropriate collection and treatment infrastructure to deliver its intended end-of-life benefit, but infrastructure operators require sufficient and predictable volumes of suitable material to justify investment. Brands, meanwhile, have limited incentive to adopt compostable materials if consumers cannot dispose of them through a recognised collection route.

The consequence is that even certified compostable packaging may enter residual waste and be incinerated rather than organically recycled. This does not necessarily eliminate all of the advantages of using renewable feedstocks, but it means the full potential benefit of the material is not being realised.

Policy therefore needs to consider material and infrastructure development together. Supporting innovative materials without creating viable end-of-life pathways risks stranded innovation; building infrastructure without creating demand for compatible materials risks underutilised capacity.

Waste Policy Does Not Yet Fully Reflect the Origin of Packaging Carbon

For packaging that cannot be recycled, carbon origin becomes particularly important. When fossil-derived plastic is incinerated, carbon extracted from geological reserves is released into the atmosphere as fossil CO_2. By contrast, sustainably sourced bio-based materials contain biogenic carbon that has been relatively recently captured from the atmosphere through biological growth.

This distinction is increasingly recognised within UK climate policy. The UK Government intends to extend the UK Emissions Trading Scheme (UK ETS) to waste incineration and energy-from-waste from 2028[56]. Government work supporting the expansion explicitly distinguishes fossil from biogenic CO_2: under the proposed approach, waste operators would face a carbon cost for fossil CO_2 emitted through incineration, but not for the biogenic CO_2 fraction[57].

This could have important consequences for packaging economics. A fossil-plastic package and a bio-based package may both be classified as residual waste and sent to the same energy-from-waste facility, but their carbon consequences - and potentially their future carbon costs -are not the same.

[56] UK Emissions Trading Scheme (UK ETS): a policy overview - GOV.UK
[57] Science supporting cleaner waste incineration - Case study - GOV.UK

Current packaging policy does not consistently reflect this distinction upstream. RAM is principally concerned with recyclability, while PPT rewards recycled content rather than renewable carbon. From 2028, the waste system could therefore begin placing an explicit price on fossil carbon at incineration while packaging policy continues to provide limited recognition for replacing that fossil carbon at the material-design stage.

For beauty brands developing packaging intended to remain on the market for many years, this is an important strategic consideration. Material selection decisions made today may increasingly determine exposure to carbon costs elsewhere in the value chain as the UK ETS expands.

Biomaterials Face a Complex Standards and Regulatory Landscape

Novel bio-based and biodegradable packaging must also navigate a complex combination of regulatory and technical requirements. Depending on the material and application, manufacturers may need to demonstrate chemical safety and REACH compliance, formulation compatibility, migration performance, biodegradation or compostability, ecotoxicity, bio-based carbon content and compliance with packaging and environmental legislation.

Many of these requirements are entirely appropriate. A claim that a material biodegrades, for example, should be supported by robust evidence demonstrating where, under what conditions and over what period degradation occurs. Likewise, biological origin should never be assumed to mean that a material is inherently safe.

The challenge is that emerging materials must often demonstrate characteristics that incumbent fossil plastics have historically not been required to demonstrate to the same extent. A biodegradable polymer may be expected to provide detailed evidence of its degradation products, biodegradation rate and ecotoxicity, whereas a persistent conventional polymer can remain compliant without demonstrating what happens if it escapes into the natural environment.

Certification can add another layer of complexity. Terms such as bio-based, biodegradable, industrially compostable and home compostable describe different material attributes and require different evidence. A material can be bio-based without being biodegradable, biodegradable without being bio-based, or compostable only under specific controlled conditions. Navigating these distinctions increases testing, certification and communication requirements for innovators and brands.

The policy objective should therefore not be to lower safety or performance standards for biomaterials. Instead, it should be to develop clear, consistent and technology-neutral standards that assess comparable environmental outcomes across all materials, including fossil-derived incumbents.

Moving Towards Outcome-Based Packaging Policy

The central policy challenge is therefore broader than whether the UK should favour recycling or biomaterials. Recycling, reuse, renewable feedstocks and biological end-of-life pathways can all contribute to more sustainable packaging, but their suitability varies between applications.

For beauty packaging in particular, policy needs to recognise that recyclability is one environmental attribute, not a complete measure of environmental sustainability. A more comprehensive approach would assess whether packaging is actually reused or recycled in practice, its greenhouse-gas emissions, use of virgin fossil and renewable resources, persistence and microplastic generation, substances of concern, and its environmental impacts at end of life.

Such an approach could retain strong incentives to reduce, reuse and recycle, while creating appropriate recognition for renewable carbon, safe biodegradation and organic recycling where these provide demonstrably better outcomes. This would shift the policy question from *“Is this packaging recyclable?”*

towards the more important question: “What is the lowest-impact material and end-of-life system for this particular application?”

Policy Recommendations

To enable the transition towards more sustainable beauty packaging, UK policy should move beyond a predominantly recycling-centric model towards an outcome-based approach that considers the full lifecycle of packaging. Recycling should remain a priority where it delivers effective material circularity, but policy should also recognise renewable feedstocks, alternative end-of-life pathways, carbon impacts, material persistence and chemical safety.

The objective should not be to favour biomaterials simply because they are bio-based or biodegradable. Instead, the regulatory framework should create a level playing field in which materials are rewarded according to demonstrated environmental performance and the most appropriate solution can be selected for each packaging application.

1. Evolve EPR beyond Recycling, introduce a Broader Sustainability Assessment Methodology

The current Recyclability Assessment Methodology (RAM) provides an important mechanism for improving conventional recyclability, but it should not become the sole proxy for environmental sustainability. For formats that cannot realistically be captured and mechanically recycled at scale (e.g. small components, multi materials, flexible formats.) policy should provide a mechanism for assessing alternative materials and end-of-life pathways. Certified compostable packaging, for example, should be assessed according to its performance within an appropriate organic recycling system, rather than automatically being judged against its compatibility with conventional plastics recycling.

As Extended Producer Responsibility develops, the UK should expand RAM into a broader Sustainability Assessment Methodology (SAM) that retains recyclability as an important criterion but weighs it alongside other environmental impacts, such as actual reuse, lifecycle greenhouse-gas emissions, virgin fossil-resource displacement, use of sustainably sourced renewable feedstocks, substances of concern, and environmental performance at end of life.

With a SAM methodology, EPR fees would reflect environmental impact beyond recyclability. This would let fee modulation distinguish between packaging that has different lifecycle impacts even if they have similar recyclability scores and would support brands to invest in the packaging system with the lowest overall impact for their products.

2. Reform the Plastic Packaging Tax to Recognise Renewable Carbon

The Plastic Packaging Tax should be reviewed to recognise the displacement of virgin fossil carbon with sustainably sourced renewable carbon, particularly where technical, safety or regulatory requirements prevent high levels of recycled content.

The existing recycled-content incentive should be retained, but sustainably sourced bio-based content could receive proportionate recognition where its renewable carbon content is independently verified and appropriate sustainability criteria are met.

This would avoid a situation in which virgin fossil and virgin bio-based plastics receive effectively identical tax treatment despite fundamentally different feedstock origins. It would also encourage brands to adopt a hierarchy of recycled carbon first where technically appropriate, sustainably sourced renewable carbon for the remaining virgin requirement, and progressively less virgin fossil carbon.

3. Align Packaging Policy with the Expansion of the UK ETS

Packaging policy should be aligned with the expansion of the UK Emissions Trading Scheme to waste incineration and energy-from-waste from 2028.

If fossil CO_2 from waste incineration attracts a carbon cost while qualifying biogenic CO_2 is treated differently, the carbon origin of packaging entering residual waste will increasingly have an economic consequence. EPR, PPT and packaging-design policy should recognise this changing context rather than considering fossil and renewable carbon equivalent upstream.

Government should therefore assess the interaction between EPR fees, Plastic Packaging Tax and UK ETS costs to ensure that the combined policy framework encourages reduction in virgin fossil carbon rather than producing contradictory incentives.

4. Target EPR Investment at End-of-Life Infrastructure Gaps

Revenue generated through Extended Producer Responsibility should help address the infrastructure barriers preventing alternative packaging systems from operating effectively.

This should include investment in organic waste collection, sorting and industrial composting infrastructure capable of accepting certified compostable packaging, alongside appropriate identification and contamination-management systems.

Infrastructure development should initially focus on applications where there is a clear environmental rationale for an alternative pathway, particularly packaging that is demonstrably unsuitable for conventional mechanical recycling.

Rather than attempting to create an alternative system for all packaging, the UK could initially target high-value problem formats, allowing infrastructure and material volumes to develop together.

5. Create a Defined Pathway for Compostable Packaging in Organic Waste Collections

Government should establish clear national rules determining which certified compostable packaging formats can be accepted within food and garden-waste collection and treatment systems.

Where evidence demonstrates that a packaging format meets appropriate compostability, disintegration and ecotoxicity standards and does not adversely affect compost quality or treatment operations, it should be possible to approve that format for collection alongside organic waste.

This could provide an alternative pathway for selected beauty formats that are structurally poorly suited to mechanical recycling. However, acceptance should be evidence-based and coordinated with composters and local authorities to avoid contamination or consumer confusion.

Clear labelling would also be essential so that consumers can readily distinguish between recyclable, industrially compostable, home-compostable and residual-waste packaging.

6. Prioritise Biomaterials Where Recycling Is Structurally Unlikely to Work

Government and industry should identify a defined group of packaging formats for which conventional recycling is structurally constrained rather than simply underdeveloped.

For beauty, this could include small-format components that cannot reliably be captured by sorting equipment, complex dispensing systems, certain multilayer sachets and other formats where repeated design-for-recycling interventions have limited ability to overcome the underlying physical constraint.

These applications could become priority demonstrator markets for bio-based, biodegradable and compostable materials, allowing government, brands, material innovators, waste operators and recyclers to test alternative systems at meaningful scale.

This would focus biomaterial innovation where it can add the greatest value rather than encouraging unnecessary substitution of packaging that already functions effectively within existing recycling systems.

7. Develop Consistent Standards for Bio-Based and Biodegradable Packaging

Government should work with standards bodies, industry, waste operators and material developers to establish a clearer and more consistent regulatory framework for bio-based and biodegradable packaging.

Requirements should distinguish clearly between bio-based content, biodegradability, industrial compostability and home compostability, recognising that these are different material attributes.

Claims should be supported by recognised testing and certification, including evidence on degradation conditions, timescale, ecotoxicity and the fate of additives and degradation products. At the same time, unnecessary duplication between certification, regulatory and procurement requirements should be reduced.

The objective should not be to weaken requirements for emerging biomaterials, but to create clear, proportionate and predictable routes to market.

8. Embed Safe-and-Sustainable-by-Design Principles

Future packaging policy should assess not only where packaging goes at end of life, but what it contains.

Criteria covering PFAS and other substances of concern, persistent degradation products and microplastic formation should increasingly be incorporated into packaging sustainability assessment. This would help prevent a circular economy in which problematic legacy chemicals are simply recycled repeatedly through successive generations of material.

Bio-based materials should be held to the same principles. Renewable origin should not automatically confer environmental preference; materials should demonstrate both sustainable sourcing and safe chemistry.

09 Conclusion

Beauty packaging demonstrates why the transition to sustainable materials cannot be reduced to a single question of recyclability. Packaging exists first to protect the product, and in beauty this requires materials capable of containing complex formulations, maintaining stability for extended periods and delivering demanding functional, safety and aesthetic performance. These requirements have created formats - from pumps and droppers to lipstick components, minis and multilayer sachets - that often perform extremely well as packaging but poorly within conventional recycling systems.

Reduce, Reuse and Recycle must remain the starting point. Unnecessary packaging should be eliminated, reuse should be expanded where repeated use can genuinely be achieved, and materials should be recycled wherever effective collection, sorting and reprocessing systems exist. However, sustainability policy must also acknowledge where these approaches reach their limits. Continuing to describe packaging as circular because its constituent material is theoretically recyclable does not support sustainability goals if the complete package is too small to sort, too complex to separate or otherwise unable to pass through the recycling system in practice.

This is where the bioeconomy can make a significant contribution: through to advancement of materials with characteristics that support sustainability goals. Bio-based materials provide an opportunity to replace virgin fossil carbon with renewable carbon, while biodegradable and compostable materials can, in appropriate applications, create alternative pathways for materials that cannot realistically remain within conventional technical cycles. Commercial developments across sachets, barriers and complex components demonstrate that these technologies are moving beyond laboratory concepts into real beauty applications.

The opportunity is not, however, to replace every conventional material with a biomaterial. The right material should be used for the right application and the right end-of-life system, and PCR and conventional recycling should be prioritised where it works. On the other hand, compostability should be used where a credible biological collection and treatment pathway can be established, and bio-based virgin material should increasingly displace virgin fossil material where virgin-quality performance remains necessary.

Solving packaging sustainability challenges with biomaterials requires a corresponding evolution in policy. Current UK packaging policy strongly rewards recyclability and recycled content but gives considerably less recognition to renewable carbon, persistence, safe biodegradation, chemical composition or alternative end-of-life pathways. As the report identifies, this can result in certified biodegradable and compostable materials receiving the same RAM outcome as difficult-to-recycle fossil plastics, while the Plastic Packaging Tax does not generally recognise the substitution of virgin fossil carbon with virgin renewable carbon.

At the same time, the expansion of the UK ETS to waste incineration and energy-from-waste from 2028 means the distinction between fossil and biogenic carbon is becoming increasingly economically relevant. Packaging, waste and climate policy therefore need to become more closely aligned.

The next stage of UK packaging policy should consequently move from a predominantly recyclability-based assessment towards an outcome-based assessment of sustainability. A Sustainability Assessment Methodology (SAM) could retain strong incentives for recycling while also recognising lifecycle carbon emissions, renewable and recycled feedstocks, resource use, persistence, microplastics, substances of concern and environmental impacts at end of life. The objective should not be to advantage biomaterials because of their origin, but to ensure that all materials compete on their demonstrated environmental performance.

For beauty, this creates an opportunity to lead rather than follow the materials transition. The very characteristics that make beauty packaging difficult to recycle - its small formats, complex components, demanding barriers and high-performance requirements - also make the sector an ideal proving ground for the next generation of biomaterials.

The future of sustainable beauty packaging should therefore move beyond Reduce, Reuse and Recycle to embrace Replace, Renew and Replenish: replace problematic formats with better material systems; renew the carbon they contain by moving from fossil to sustainable renewable sources; and, where appropriate, replenish biological systems through materials designed to return safely to them.

The goal is not to make every package recyclable. It is to ensure that every package has been designed around the lowest-impact material, carbon source and end-of-life pathway available. Achieving that shift would move beauty packaging from a system focused primarily on managing waste towards one designed from the outset to conserve resources, eliminate unnecessary fossil carbon and prevent persistent pollution.