efpia

European Federation of Pharmaceutical Industries and Associations

White Paper on Circular Economy







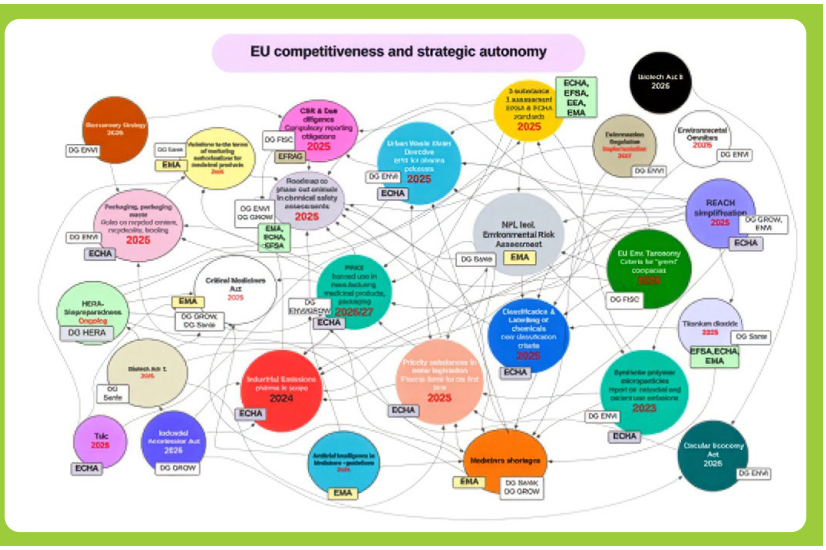




Executive Summary

- The European Commission's Clean Industrial Deal[1], including the proposed Circular Economy Act, sets a clear direction for a sustainable business model based on circularity.
- Transitioning to a more circular economy requires changes across the full value chain, from product design, manufacturing and supply to new business and market models. Key considerations include designing products with lower environmental impact, identifying new ways of turning waste into resources, prolonging the life of products and driving changes to consumer behaviour.
- EFPIA, the research-based pharmaceutical industry body, is supportive of the principles of Circular Economy[2] and sees clear synergies with our aspiration to safeguard the future supply of pharmaceuticals for patients and improve human health and decarbonise across the value chain whilst minimising impact on nature. We welcome the opportunity to contribute constructively by working with EU institutions, policymakers and healthcare stakeholders to shape a coherent framework and by advancing circularity within member companies' own operations and value chains.
- Significant progress is already being made through innovation in product design, packaging, manufacturing processes, waste reduction, material recovery and value-chain collaboration.
- At the same time due care is needed to understand the implications of circular economy measures for extended medicines, vaccines, and therapeutics supply chains both within and beyond the EU. Through continued collaboration between industry, regulators, healthcare stakeholders and policymakers, Europe can establish a circular economy model that strengthens sustainability while protecting patient safety, access to medicines and creating resilient healthcare systems.
- Looking ahead, the success of the Circular Economy Act will depend on its ability to combine environmental ambition with regulatory coherence, industrial competitiveness and public health objectives. A science-based framework that enables innovation while safeguarding product quality, patient safety and continuity of supply.

Circularity does not exist in a regulatory vacuum. The growing interconnection between pharmaceutical, chemicals, packaging, waste and environmental legislation means that circular economy measures need to be designed and implemented with the wider regulatory framework and with the specific requirements of medicines in mind.



1 https://commission.europa.eu/topics/competitiveness/clean-industrial-deal_en

2 https://www.ellenmacarthurfoundation.org/circular-economy-principles



Glossary

Circular Economy	Circular economy refers to models of production and consumption that minimize waste and reduce pollution, promote sustainable uses of natural resources, and help regenerate nature.	The Climate Dictionary[3]
Circularity	Systematic cycling of the provision and use of resources within multiple technical or biological cycles	ISO 59004: 2024 3.1.6 Circular economy — Vocabulary, principles and guidance for implementation[4]
Eco-design principles	Eco-design is a way of creating products or services that have minimal environmental impact throughout their life cycle. Eco-design considers environmental aspects at all stages of the product development process, from conception to recycling.	
Safe and Sustainable by Design (SSbD)	The safe and sustainable by design framework is a voluntary approach to guide the innovation process for chemicals and materials. It aims to steer the innovation towards the green and sustainable industrial transition, while avoiding or minimizing harmful impacts to human health and the environment.	JRC, Safe and sustainable by design Chemicals and Materials[5]
Sustainability	Meeting the needs of the present without compromising the ability of future generations to meet their own needs. Term encompassing human rights, gender equality in a balance of economic, social and environmental concerns.	UN, Department of Economic and Social Affairs Sustainable Development[6]
Product/ Chemical/Material Environmental Sustainability	The ability of a product/chemical/material to deliver its function without exceeding environmental and ecological boundaries along its entire life cycle, while providing welfare, socio-economic benefits and reducing externalities	Lovsin Barle, E., Whitford W.G. (2023), Sustainability Definitions for the Pharmaceutical Industry, Pharmaceutical Engineering[7]
Facility/ Operation/Process Environmental Sustainability	Design of a facility/operation/process to conserve resources, use renewable energy sources and deliver its function without exceeding environmental and ecological boundaries	

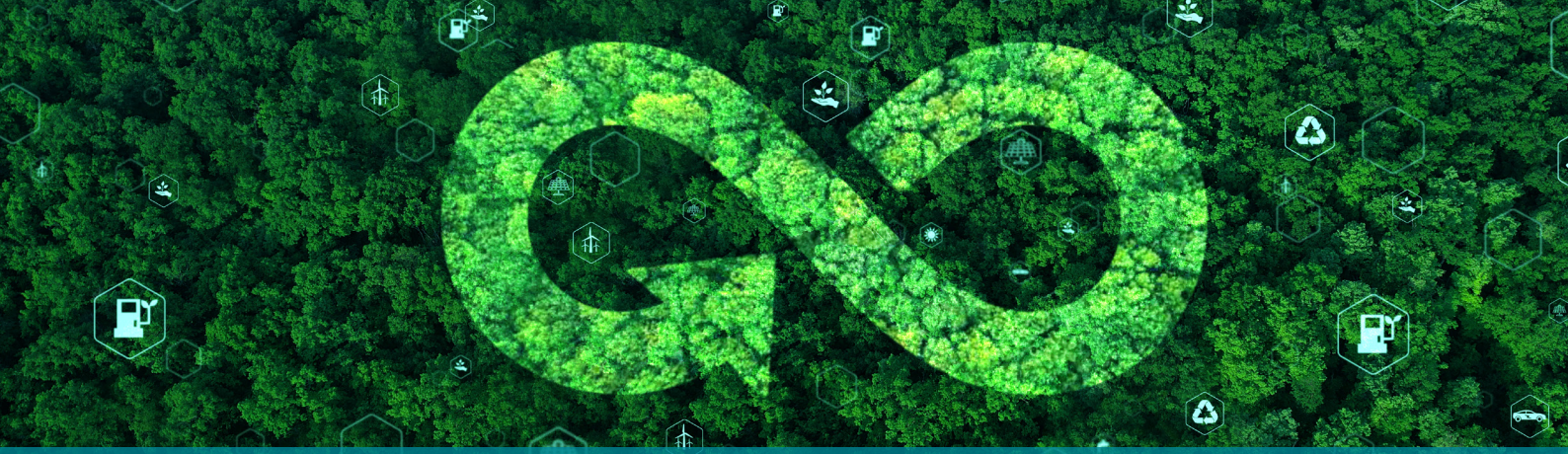
3 https://www.undp.org/publications/climate-dictionary

4 ISO 59004:2024 - Circular economy — Vocabulary, principles and guidance for implementation. https://www.iso.org/standard/80648.html

5 JRC Publications - Safe and Sustainable by Design Chemicals and Materials. Revised framework (2025). https://publications.jrc.ec.europa.eu/repository/handle/JRC143022

6 https://sdgs.un.org/2030agenda

7 https://ispe.org/pharmaceutical-engineering/march-april-2023/sustainability-definitions-pharmaceutical-industry



1. Circular Economy – An overview

The Circular Economy[8] has been a key priority for the European Commission since 2015[9,10] and remains central to the EU's ambition to create a more sustainable, competitive and resource-efficient economy.

This paper sets out EFPIA members' perspective on circular economy principles and confirms members' support for the transition towards circularity, in line with the EU Green Deal[11] and its successor the Clean Industrial Deal[12], the principles of the Ellen MacArthur Foundation[13] and the UN Sustainable Development Goals[14].

This paper focuses specifically on circular economy principles and their relevance for the research-based pharmaceutical industry. Details on EFPIA's approach on Climate Change, Chemicals and Pharmaceuticals in the Environment are discussed in separate papers which can be accessed on the website of EFPIA (Annex 1).

We see circularity as a complementary lever to deliver decarbonisation, improve resource and energy efficiency and minimise impact on nature for the pharmaceutical industry to ensure access to sustainable supplies of raw materials and energy in a resource constrained world, while also providing protection against price volatility and building a more sustainable and resilient business model.

A responsible transition to circularity should be grounded in established circular economy principles and applied in a way that reflects the specific requirements of healthcare. The Ellen MacArthur Foundation principles provide a useful framework to

- Design out waste and pollution (design for circularity)
- Keep products and materials in use (at their highest value)
- Regenerate natural systems

For the pharmaceutical industry, circularity is both a sustainability opportunity and a policy challenge. While innovation can create new opportunities for growth, improve resource security and strengthen competitiveness, these outcomes require cross-industry cooperation, engagement with authorities and international collaboration to establish enabling economic and legislative frameworks and realise synergies across value chains.

A true circular economy embraces principles of value retention, technical restoration and nature regeneration by embedding circular principles at the design stage and minimising resource inputs, pollution, and carbon emissions. It creates closed-loop systems through reuse, refurbishment, remanufacturing and recycling, where

8 For more details, see this overview of concepts with the circular economy: https://www.ellenmacarthurfoundation.org/circular

9 European Commission, 2015. Communication from The Commission to The European Parliament, The Council, The European Economic and Social Committee and The Committee of the Regions, Closing the loop - An EU action plan for the Circular Economy. Available at: eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52015DC0614

10 European Commission, 2019. Final Circular Economy Package. Available at: https://ec.europa.eu/environment/circular-economy/

11 European Commission, 2019. Communication on the European Green Deal. Available at: https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF

12 European Commisssion, 2025, https://commission.europa.eu/topics/competitiveness/clean-industrial-deal_en

13 Ellen MacArthur Foundation (launched 2010). Available at: https://www.ellenmacarthurfoundation.org/our-story/mission

14 United Nations, 2015. The Sustainable Development Goals. Available at: https://sustainabledevelopment.un

materials are continuously looped back into different levels of the supply chain and 'waste' from one process becomes the input for another parallel use or within an alternative supply chain.

The prevailing linear economic model of 'take, make, use, dispose' is neither innovative, nor sustainable. Current evidence shows that global resource use continues to exceed planetary limits. In 2025, seven of the nine planetary boundaries were transgressed, reinforcing the need to move towards models that keep products, materials and resources in productive use for longer and reduce avoidable waste.[15]

For EFPIA, circular economy is a value chain model that maximises the lifetime of resources, reduces unnecessary waste and minimises environmental impacts. Moving towards a circular economy can enable new business models, in which products are designed to have longer or multiple lifecycles. Circularity in pharmaceutical value chains can be advanced through supplier partnerships.

Circularity is not limited to recycling products at the end of their life: it starts with designing for circularity. Whilst the sector aims to move towards safe and sustainable closed-loop recycling where feasible, valuable material should also be circulated as secondary raw materials for other sectors where this is appropriate and possible.

Circular economy also aims to create value across all phases of a product life cycle. This requires identifying opportunities early, embedding continuous improvement and ensuring that circularity considerations are integrated into product, process and supply chain decisions.

In healthcare, priority opportunities include eco-design of products, packaging and devices; end of life management; circulation of products and materials to maximise resource value; reduced reliance on single-use and disposable plastics, preservation of finite materials; exploring renewable resources & reusability; and engagement with suppliers, customers and healthcare stakeholders.

At the same time, medicines, vaccines and drug-delivery devices are subject to stringent quality, sterility and performance requirements. Changes to materials, packaging or manufacturing processes often require validation and regulatory approval before implementation, making policy coherence and realistic transition timelines essential.

Reduce, Reuse, Recycle ... Best option remains the "Refuse" principle: paperless use case

Following circular economy hierarchy, which emphasizes avoiding unnecessary materials, Sanofi has implemented a strategic initiative to eliminate paper-based patient information leaflets where regulatory frameworks permit. By removing the physical leaflet entirely, this approach reduces material consumption at source. The transition leverages digital channels to provide patients with access to essential product information.

The implementation of this initiative varies according to local regulatory contexts. In markets such as Canada or Singapore, existing regulations already enable paper leaflet removal, across all products or from specific product categories, allowing for broader-scale deployment. Meanwhile, pilot programs are underway in diverse regulatory environments



including most European Union member states, Brazil or South Korea, where physical leaflet removal remains subject to evolving local regulatory approval.

This initiative represents a practical application of circular economy principles within the pharmaceutical sector, demonstrating how digital innovation can support environmental stewardship while maintaining regulatory compliance and patient safety standards.

15 Fanning, A.L., Raworth, K. Doughnut of social and planetary boundaries monitors a world out of balance. Nature 646, 47–56 (2025).

Indicative circular economy opportunities available to the pharmaceutical industry



	RAW MATERIALS	DRUG PRODUCT	DEVICES	PACKAGING
1. Raw Material	• Non-hazardous materials	• Non-hazardous materials	• Avoid the use of substances within the device that negatively affect the re-use and recycling of the materials • Certified, renewable or recycled materials	• Avoid the use of substances within the packaging that negatively affect the re-use and recycling of the materials • Certified, renewable or recycled materials
2. Design	• Biodegradable • Green chemistry & technology principles • Build LCA/DfE into design process	• Biodegradable • Green chemistry & technology principles • Dosage optimisation • Maximise shelf life • Build LCA/DfE into design process	• Reusable or refillable • Reduce material complexity • Maximise life of the device • Build LCA/DfE into design process	• Optimise packaging size • Reduce material complexity • Design to minimise outer & transport packaging • Design for recyclability
3. Production	• Renewable energy at production facilities • Minimize environmental footprint of production • Maximise mass production efficiency. • Secondary raw materials	• Renewable energy at production facilities • Minimize environmental footprint of production • Maximise API vs raw material efficiency. • Minimise API emissions	• Suppliers to meet sustainability criteria • Minimise environmental footprint of production • Local sourcing of parts	• Suppliers to meet sustainability criteria • Minimize environmental footprint of production • Local sources of packaging materials
4. Distribution	• Apply sustainable logistics • Minimize environmental footprint of distributor(s) • Manufacture at point of use	• Apply sustainable logistics • Minimize environmental footprint of distributor(s) • Manufacture at point of use	• Apply sustainable logistics • Minimize environmental footprint of distributor(s)	• Local sourcing • Apply sustainable logistics • Minimize environmental footprint of distributor(s) • Reduce use of passive shipper boxes for cold chain
5. Consumption, use, reuse, repair	• Recirculation of solvents • Reuse of catalysts	• Dosage & pack size optimization • 'Personalised' medicines • Promote guideline directed medical treatment	• Offer repair options • Minimise waste generated over treatment period • Reusable device/reload device	• Maximise efficiency on packaging lines • Reuse transport packaging
6. Collection	• Incineration of drug product waste • Education of patient	• Incineration of drug product waste • Take back schemes • Education of patient	• Segregate waste at source to optimise recycling • Scale take back schemes across industry	• Segregate waste at source to optimise recycling • Scale take back schemes across industry
7. Recycling	• Solvent reuse • Re-use of water for primary rinses • Re-use of overlap by-products and waste streams for other purposes • Recycling of metals (e.g. PGMs)	• Develop certified unused drug recycling programs	• Recycle device materials	

Petri, S., Porkka, M., Rahmstorf, S., Schaphoff, S.,, Thonicke, K., Tobian, A, Virkki, V., Wang-Erlandsson, L, Weber, L, Rockstrom, J., Earth beyond six of nine planetary boundaries, Science Advances, 9(37), doi: 10.116/sciadv.adh2458

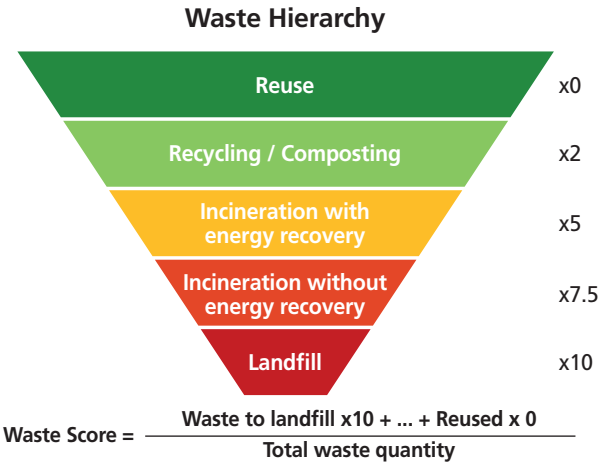


2. Circular Economy is important for the pharmaceutical industry

The driving motivation of the pharmaceutical industry is to improve human health and well-being. Environmental protection and human health are interlinked. Reducing environmental degradation and pollution of air, water and soil, reducing the use of scarce resources, e.g. as water in water scarce areas, and limiting climate change to 1.5°C are all goals that will underpin health in the 21st Century[16]. Continued adoption of circular economy principles into the pharmaceutical sector can reduce materials extraction and operational waste, contribute to a reduction in greenhouse gas emissions and the regeneration of nature[17], and safeguard the future supply of medicines essential for patients.

The pharmaceutical sector can adopt circularity at different levels throughout the value chain, such as product design, production process, product use, and end-of-life management.

A survey in 2026 conducted with EFPIA member companies indicates that the industry is aligned with circular economy principles and already acting. As compared to the survey in 2023, action on circular principles is increasing. In 2023, 60% had targets around circular economy, and most of the member companies were piloting circular economy initiatives. Two years later, 80% of member companies have circularity targets and 75% of them are implementing beyond the pilot stages.

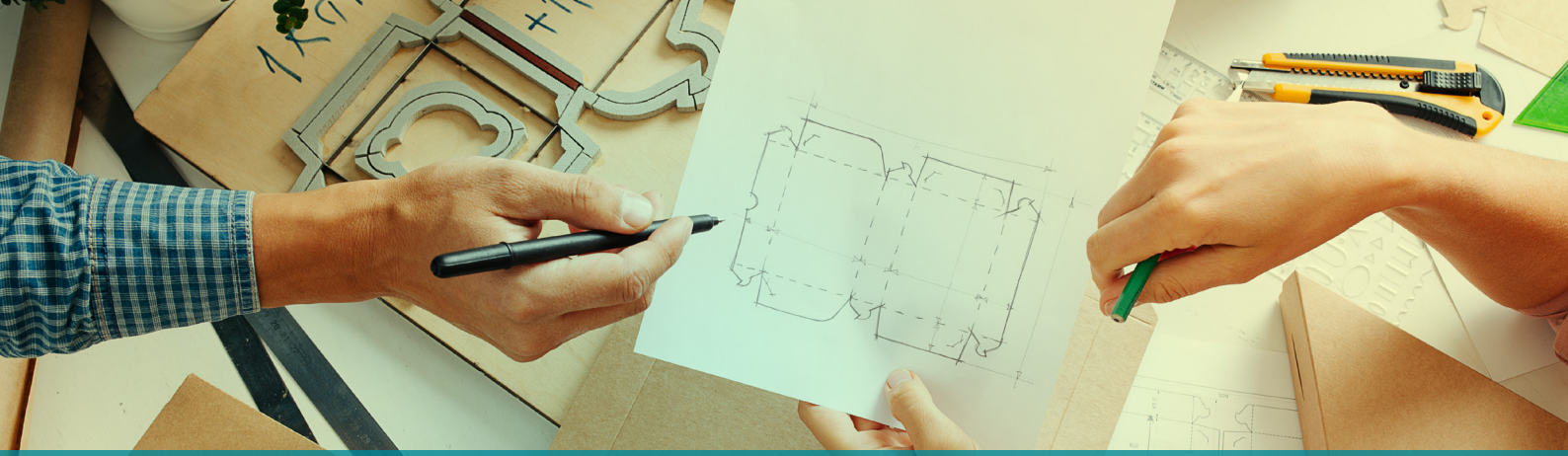


To capture the complexity of the waste hierarchy (reduce, reuse, recycle…), Sanofi uses a single, normalized Waste Impact Index that helps determine whether a site is progressing up the waste hierarchy. The waste quantities associated with each hierarchy layer are weighted using a weighting factor and then summed to calculate the Waste Impact Index. This figure is then divided by the total waste quantity to obtain the Waste Impact Score. The lower the Waste Impact Score, the more effective the waste management, and the lower the impact on the environment (see figure). This enables Sanofi to efficiently track progress and maturity in circularity. In this context, Sanofi targets a 30% reduction by 2030 compared to 2019. As of end-2025, audited data confirm a 27.7% reduction of the Waste Impact Index compared to 2019.

The circular economy approach supports a global, sustainable economy and protects production from increased pressure on resources, but it is important to recognise that there are currently barriers to circularity, such as regulatory requirements and safety and quality concerns. We need to find ways to align the incentives and interests of different stakeholders and sectors, and to ensure a fair and just transition for all. Transitioning to a circular economy should be done in a gradual, flexible, and inclusive way. This will require a systemic change that involves not only technological innovation but also social innovation. It will also require a collaborative effort that engages not only governments and businesses but also civil society as a whole.

16 Ellen MacArthur Foundation, 2019, Completing the Picture https://www.ellenmacarthurfoundation.org/assets/downloads/Completing_The_ Picture_How_The_ Circular_ Economy-_Tackles_Climate_Change_V3_26_September.pdf)

17 European Commission, 2025, https://commission.europa.eu/topics/competitiveness/clean-industrial-deal_en

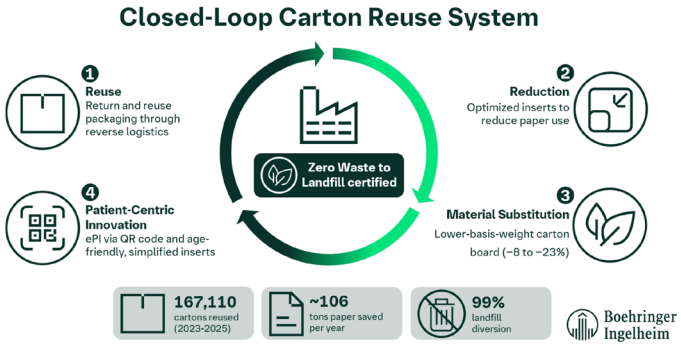


Design of products, processes and packaging

In the design phase, minimising input resources, designing products and manufacturing processes to maximise re-use and recycling, selecting materials with lower environmental impact, such as responsibly sourced renewable or recycled materials to preserve virgin resources and maximising product lifetimes is an integral part of the process. For example, EFPIA members already actively apply the principles of green chemistry to select the least environmentally damaging materials and maximise process efficiency.

Eco-design principles are also fundamental to drive the development of more sustainable formulations, devices and packaging. Building on these design foundations, reuse is a valued circular strategy that complements recycling, keeping products and materials in use at their highest value for longer. Reusable devices, such as cartridge-based injection pens and inhalers could directly replace multiple disposable ones, thereby reducing material consumption and waste generation.

Circular Packaging & Patient-Centric Innovation Enabled by a Closed-Loop System



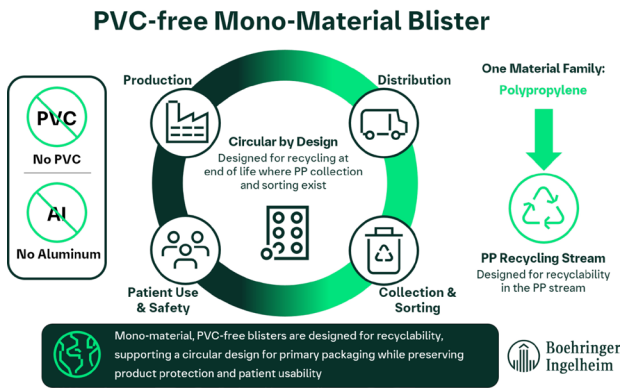
Boehringer Ingelheim Shanghai Pharmaceuticals (BISPL)[18] has moved its packaging from a linear, single-use model toward a circular system built on three pillars (reuse, reduction, and material substitution) underpinned by a certified Zero-Waste-to-Landfill management system. A reverse-logistics system returns and reuses transport cartons to extend their lifecycle and reduce virgin-material demand; package inserts are optimized to lower paper use; and carton board was substituted with lower-basis-weight grades, reducing board material by 8–23% per unit area across 14 SKUs. Cross-stakeholder collaboration across suppliers and distribution partners enables the system to scale. Patient-centric measures, electronic product information (ePI via QR code) and age-friendly, simplified inserts contribute to reduced paper consumption while improving accessibility.

The Zero-Waste-to-Landfill system (certified by TÜV Rheinland to ZWTL MS 2022, three-star level, since 2021) provides foundational capability, supporting closed-loop material management.

Realized benefits to date include 167,110 carton reuses through the return system (2023–2025) and an annual saving of approximately 106 tons of paper from insert optimization. The approach is potentially transferable across product lines and markets, and BISPL has received external recognition (National Green Factory; Zero-Waste Factory; Circular Economy Pioneer Award) and has contributed to Chinese Zero-Waste Factory group standards, helping to codify circular-packaging practices for broader sector adoption.

18 https://www.boehringer-ingelheim.com/about-us/sustainable-development/more-green/driving-environmental-solutions-people-and-planet

PVC-free mono-material blister designed for recyclability

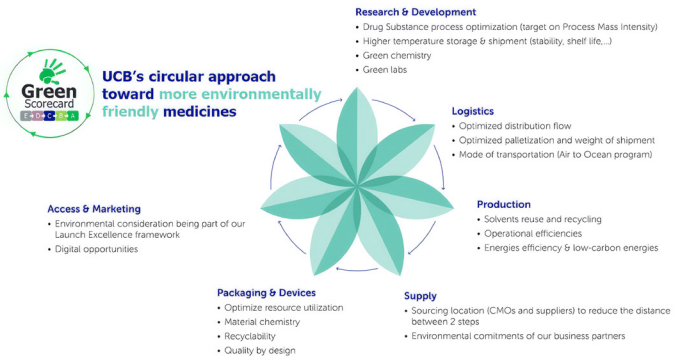


Conventional pharmaceutical thermoform blisters for products with lower requirements on barrier properties combine multiple materials (PVC or PVC/PVDC form foils with aluminum lidding), which are not designed to be recycled at the end of life. Boehringer Ingelheim is developing a PVC-free mono-material blister designed for recyclability, in which both the bottom foil and the lidding foil are made of the same polymer (polypropylene, PP). With this material change, PVC and aluminum are also eliminated for the low-barrier blister pack. Because this blister pack is then a mono-material, the blisters can, in principle, re-enter the recycling stream rather than being landfilled or incinerated, supporting a circular design for primary packaging while preserving product protection and patient usability.

A comparative internal screening Life Cycle Assessment (LCA; PEF methodology, 16 impact categories, weighted) of PP mono-material blister films was performed against six current packaging formats (PVC, PVC/PVDC, aluminum blisters, and HDPE bottles). On a per-capsule basis, the PP mono-material blisters showed a lower weighted environmental footprint than all six reference formats. Main remaining impacts of the mono-material options are fossil-resource use, climate change, and particulate matter.

The project is at a development / feasibility stage: initial mono-material prototypes have progressed from manual trials to blister-line runs and an internal screening LCA was completed. Product/market selection and commercial-scale qualification are currently ongoing; in parallel, the end-of-life recycling pathway is in discussion within different internal and external workstreams. This case illustrates how eco-design principles can be embedded early to enable PVC-free primary packaging designed for recyclability.

UCB Green Product Scorecard leading to packaging redesign



UCB's Green Product Scorecard evaluates the environmental performance of medicines across their full lifecycle—from raw material extraction and manufacturing to distribution, patient use, and end of life management[19].

This cradle to grave LCA approach covers impacts such as carbon emissions, water use, resource efficiency, and waste generation, helping us identify opportunities to optimize each stage of a product's journey. All core UCB medicines are assessed through the Scorecard, with tailored improvement targets set for each one.

In this context, two packaging design initiatives for two different medicines were delivered in 2025:

- The first project reduced the size of the outer box and the patient leaflet, and removed several plastic elements, including trays, cutting the overall secondary packaging weight by 65% while improving recyclability.
- The second project reduced packaging waste by 62% in total weight, including a 48% cut in plastic, and increased the use of recycled materials by replacing a plastic film with one containing 50% recycled content.

19 Sustainable packaging | UCB

Improving circularity across production processes

From the discovery to disposal, AstraZeneca are using the latest technologies and innovation to adopt more circular business approaches to reduce material use, keep resources in circulation for longer, and limit waste to bring our waste circularity rate to 50%.

One major area of focus is API manufacturing, where solvent use and disposal are among the largest contributors to carbon footprint. To address this, AstraZeneca is prioritising solvent reduction in both R&D and manufacturing. In 2025, this delivered a more than 50% reduction in solvent-related carbon footprint across two new drug substances. The company is now scaling this work through solvent reuse and recycling, together with a shift towards renewable alternatives, as part of a systematic reduce-reuse-recycle approach being applied across all APIs in development.

AstraZeneca is also using biocatalysis in active pharmaceutical ingredient manufacturing. In some cases, biological catalysts called enzymes can replace multi-step synthetic routes with a single-step pathway, lowering material demand, reducing waste and improving overall resource efficiency.

To improve circularity of our product packaging, AstraZeneca have developed mono-polypropylene (PP) blister packaging materials and technology to manufacture PP blister packaging at scale, with launch of products in PP blisters from 2027.[20] Mono-PP blisters avoid the use of materials, such as polyvinyl chloride (PVC) and Aluminium, that are challenging to recycle through conventional waste streams, whilst preserving the quality, safety, and usability of our medicines.

Circularity is also being applied within R&D operations. At AstraZeneca's Cambridge, UK, and Gothenburg, Sweden, sites, liquid helium used in superconducting magnets is recycled and reused—with 85–90% achieved in Gothenburg and Cambridge progressing towards this level—helping to conserve a scarce, non-renewable and business-critical resource.[21]

Polystyrene elimination in neonatological Product Packaging

In 2023, Chiesi introduced an updated packaging solution for a key neonatology product, which replaced the polystyrene anti-crush box with a cardboard anti-crush packaging system made with Forest Stewardship Council (FSC) certified paper.[22]

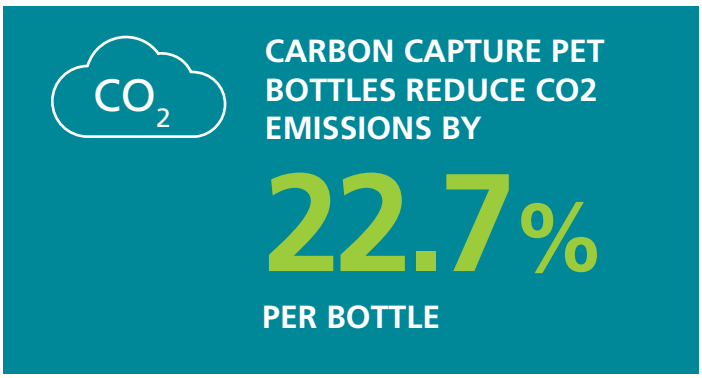
The change has been fully implemented worldwide in all countries where the product is commercialised. The aim of this project was to reduce the use of plastic material in order to increase packaging recyclability. This allows us to make greater use of materials that are easier to recycle at their end of life and that are sourced from sustainable supply chains, all the while keeping same safety and functionality characteristics of the packaging system.

Introduction of alternative material from renewable sources

In 2025 Chiesi introduced a sustainable version of the bottle used as primary packaging of a nasal spray indicated for the prophylaxis and treatment of seasonal and perennial allergic rhinitis, as well as vasomotor rhinitis.[23]

The new bottle is manufactured with Carbon Capture PET, a material obtained through a biofermentation process that captures carbon emissions and results in a product chemically equivalent to fossil based PET. This marked the first application of Carbon Capture PET for primary packaging of pharmaceutical products in liquid form, offering both environmental benefits and high safety levels for patients at the same time.

Carbon Capture PET bottles reduce CO2 emissions by 22.7% per bottle if compared to traditional PET, while maintaining the same extractables profile and the same mechanical and physical performance as traditional PET.



20 https://www.astrazeneca.com/media-centre/articles/2026/sustainable-blister-packaging.html

21 https://www.astrazeneca.com/sustainability/nature/waste-circularity.html

22 Chiesi Sustainability Report 2024: chiesi.com/img/annual_report/documenti/8_2025-chiesi-sustainability-report-2024.pdf (p. 80)

23 Bormioli partners with Chiesi to supply Carbon Capture PET packaging - European Pharmaceutical Manufacturer

Merck's L.I.F.E. Project: Innovating for a Sustainable Future - A Model of Efficiency and Responsibility

The L.I.F.E. (Leaflets Improvements for the Future and the Environment) project exemplifies Merck's commitment to sustainability by transitioning documents with a complex, high-grammage booklet accompanying its medicines to a single, streamlined leaflet that combines the instructions for use and the patient information leaflet. This innovative approach is projected to reduce raw material usage by an average of 18%. By minimizing resource consumption, the L.I.F.E. project not only enhances operational efficiency but also significantly contributes to reducing product carbon footprint. Furthermore, this initiative is expected to decrease greenhouse gas emissions, underscoring Merck's dedication to environmental stewardship and responsible healthcare practices.

Circular Digital Display Labels



Digital Display Labels (DDLs) are smart, e-paper labels that replace paper labels on investigational medicines used in clinical trials[24]. Updated wirelessly via near-field communication (NFC), they remove the need for manual relabelling when language, expiry dates, or other label details change. As part of the Digital Health in a Circular Economy project[25], circular prototypes were developed and Johnson & Johnson partnered with a key supplier to bring the solution to market and establish the reverse logistics needed for refurbishment.

After the medicine is used or returned, the DDL is removed and collected. Specialised service providers test, clean, and refurbish units that pass quality checks so they can be reused in new packaging; units that are damaged or at end-of-life are sent for proper electronic waste (WEEE) disposal. Refurbished DDLs re-enter normal manufacturing and distribution for clinical supplies, and the cycle can be repeated multiple times while the electronics remain functional. The result is a future-ready system that streamlines operations, lowers costs, reduces waste, and brings digital flexibility to the clinical supply chain without sacrificing safety or quality.

24 https://youtu.be/d1lawPvXPUg

25 DiCE - Digital Health in the Circular Economy | European Circular Economy Stakeholder Platform (europa.eu). https://circulareconomy.europa.eu/platform/en/good-practices/dice-digital-health-circular-economy



Production process

Optimizing resource efficiency and waste management can be achieved using renewable or recycled energy and water, implementing industrial symbiosis. Turning waste into secondary raw materials for other industries is an option for the pharmaceutical industry to minimize the environmental impact of its activities across the entire value chain while also reducing costs in the long run. This approach is already widely adopted across the industry, especially for solvents, water and packaging materials. However, due to the high quality and purity requirements for medicines, use of secondary raw materials within the sector presents more of a challenge.

Development of a market for secondary raw materials ensuring materials of adequate and consistent quality and availability is a key area for future industry collaborations. Investment in recycling infrastructure by EU member states and engagement with the EMA is necessary to facilitate this.

Moving to a more sustainable waste management also leads to a reduction of greenhouse gas emissions and negative externalities, by focusing foremost on preventing and reducing waste; promoting recycling of materials; and as a last step, minimising landfill waste or incineration without energy recovery.

Closing the loop

Lundbeck applies green chemistry principles and advanced technologies to minimise waste and optimize resource use in chemical production. A key part of this effort is solvent recycling. Currently, approximately 60% of the solvents most frequently used in their processes are recycled. This is primarily achieved through internal recycling units at their chemical factory in Denmark, which have been in operation for several years[26].

Looking ahead, the internal recycling capacity will be expanded through the installation of an additional recycling unit, thereby enhancing operational efficiency. This measure affirms Lundbeck's dedication to responsible production and ongoing improvement.

26 Lundbeck_Annual_Report_2024.pdf.coredownload.pdf. https://www.lundbeck.com/content/dam/lundbeck-com/masters/global-site/annual-reporting/2024/Lundbeck_Annual_Report_2024.pdf.coredownload.pdf

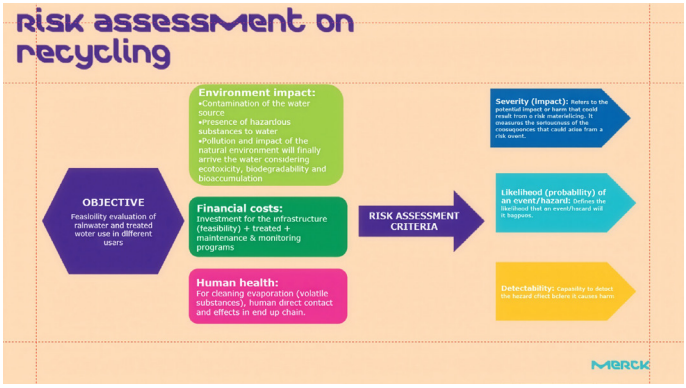
Enabling Sustainable Oligonucleotide Production Through Safe Solvent Recovery

Solvent synthesis and waste disposal comprise a major part of the overall carbon footprint of active pharmaceutical ingredients (APIs). Effective recovery techniques and the reuse of solvents can lead to a significant reduction in the environmental impact of API manufacture. Despite these potential sustainability benefits, companies seeking to implement solvent recycling and reuse face technical and regulatory challenges in doing so.

Much of the concern about the use of recovered solvents stems from the potential for nitrosamine contamination in recovered materials. Nitrosamines are unwanted potentially genotoxic chemical impurities that are strictly regulated to extremely low levels to ensure patient safety. A cross-company collaboration recently developed a framework for assessing the nitrosamine risk in industrial solvent recovery based on the physicochemical principles underlying the distillation process. In silico calculations based on calculated vapor-liquid equilibria (VLE) for nitrosamine/solvent combinations can provide conservative estimates of a process's nitrosamine depletion capacity.

Oligonucleotide therapeutics an innovative class of drugs made from short strands of genetic material that can precisely switch genes on or off to treat diseases at their source. Acetonitrile is the preferred solvent for the manufacture of oligonucleotides and is used at an estimated 2.7 L per gram of product. The in-silico modeling approach described above was used to demonstrate that a distillation-based process for regenerating acetonitrile from oligonucleotide waste streams is highly effective at reducing the nitrosamine contamination risk. These in silico results provide a solid science-based, process-specific risk assessment strategy to support acetonitrile recovery. This work lays the foundation for significant improvements in the sustainability of oligonucleotide manufacture by addressing concerns about contamination.

Water Circularity Initiative



The pharmaceutical industry is increasingly adopting sustainable practices to enhance water efficiency and promote circularity. One notable effort is Merck's Water Circularity Initiative, which focuses on site-specific projects aimed at improving water management and reuse across its operational units.

In 2025, Merck's Healthcare production sites in Brazil, Italy, Mexico, and Switzerland implemented various water conservation projects, with significant advancements already reported in Mexico and Rio. These two sites have successfully utilized recycled water in their utility systems, demonstrating a commitment to reducing water withdrawal and enhancing resource efficiency. This effective utilization of recycled water not only conserves valuable water resources but also contributes to the organization's overall sustainability goals.

To minimize any risk, a comprehensive risk assessment is conducted to identify potential users for recycled water use. This assessment ensures that the recycled water complies with safety and environmental standards. It aligns with the predicted no-effect concentration (PNEC) values, which are established to protect aquatic life and human health by ensuring that wastewater discharges do not exceed harmful levels[27].

Among the innovative technologies employed, reverse osmosis has been a key method for treating water to be recycled, enabling its reuse in utility systems. This approach not only conserves water but also reduces the environmental impact of wastewater discharge. Additionally, infrastructure upgrades at these sites have significantly improved overall water efficiency.

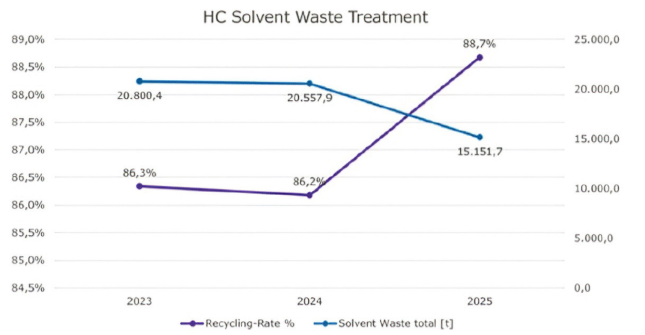
27 environment-merck-sr21.pdf. https://www.merckgroup.com/it-it/environment-merck-sr21.pdf and Water and Marine Resources (E3) - Merck Annual Report 2024. https://www.reports.merckgroup.com/en/annualreport/2024/management-report/sustainability-statement/environment/water-and-marine-resources-e3.html

The Importance of Internal Solvent Recycling

As the Healthcare business sector of Merck strives to contribute to the ambitious sustainability goal of achieving a circularity rate of 80% by 2030, internal solvent recycling at sites producing active pharmaceutical ingredients plays a crucial role.

Data from our solvent waste treatment indicates a steady improvement in recycling rates, with projections showing an increase from 86% in 2023 to 89% by 2025. This upward trend highlights the effectiveness of our internal recycling initiatives, which not only reduce waste but also minimize the environmental impact associated with solvent disposal. Current figures reveal that internal recycling efforts successfully processed significant volumes of solvent waste, with 20,558 tons recycled internally in 2024 alone.

Treatment of Solvent Waste (HC)
Recycling Rate [%] and Total Solvent Waste [t]



Elimination of PVC from secondary and tertiary packaging

As part of Novartis' commitment to waste reduction and the use of recycled materials, they improved process efficiencies and used more recycled plastics and reusable shipping boxes.

By the end of 2024, they had eliminated 100% of PVC (poly-vinyl chloride), a long-lasting plastic, in secondary and tertiary product packaging from their sites. The 2025 target is applicable for own manufacturing sites handling final product packaging, all of which have eliminated PVC in secondary and tertiary product packaging.[28]



28 Novartis in Society Integrated Report 2024. https://www.novartis.com/sites/novartis_com/files/novartis-integrated-report-2024.pdf



Value chain collaboration

In the circular economy, opportunities are considered to create greater value by building on collaboration along the value chain. EFPIA members operate global manufacturing, supply and distribution chains and the circular economy will have limited impact if not implemented in collaboration with global partners and stakeholders in the healthcare sector including the point of care. By working together across the sector and within our manufacturing and supply chain, we believe we can advance human health and ensure our use of natural resources is efficient, sustainable and affordable.

Hospitals, medical staff, public health bodies, patients and supply chains have an important role to play.

Digitalisation can become a key enabler of circularity. Digital Product Passports, electronic product information (ePI), harmonised reporting systems and digital compliance tools can improve traceability, facilitate recycling and drive efficiency across the supply chain. For further downstream reporting, in the pharmaceutical sector, digital solutions should be designed to complement existing regulatory systems (e.g. Falsified Medicines Directive) while maintaining patient safety and product integrity.

Novo Suppliers for Zero programme

Environmental challenges have never been more critical or urgent. As Novo grows to reach more patients, its responsibility to reduce emissions, transform plastic use and protect nature grows too. More than 95% of the company's environmental impact lies in its supply chain, so working with suppliers and contract manufacturing organisations (CMOs) is essential to deliver real progress.

Building on the company's Circular for Zero strategy and environmental roadmaps, Novo has launched Suppliers for Zero[29]— an environmental supplier programme that sets out how the company and its partners will collaborate to meet shared targets across Climate, Plastic and Nature. The programme recognises that suppliers differ in size, capability and readiness; it is not a one-size-fits-all mandate. Instead, Suppliers for Zero invites suppliers and CMOs who share Novo's commitment to action to work together on practical, measurable steps — from scaling renewable electricity use to reducing plastic waste and protecting biodiversity.

This collaborative approach leverages existing momentum — more than 3,000 suppliers have already committed to sourcing renewable electricity for Novo — and raises the ambition to embed circular thinking across the value chain. By aligning priorities, sharing knowledge and enabling innovation, Suppliers for Zero aims to build a resilient, future-proof supply chain that supports sustainable products and the health of future generations.

29 Suppliers for zero. https://www.novonordisk.com/sustainable-business/zero-environmental-impact/suppliers-for-zero.html

Industrial Scale Biomethane Supporting Sustainable Manufacturing



In 2025, AstraZeneca UK announced the start of operations of the first unsubsidised industrial-scale supply of biomethane in partnership with Future Biogas. Their partnership with Future Biogas produced 69.4 GWh by year-end and supplies clean heat to all UK R&D and manufacturing sites. Clean heat has enabled a first for Macclesfield, the second-largest manufacturing site globally, achieving 100% renewable energy use in 2025. The Moor Bioenergy biomethane plant features innovative carbon capture technology which collects carbon dioxide produced during biomethane generation. Additionally, feedstock supplied to Moor Bioenergy biomethane plant is sourced from crops sourced close to the plant, with local farmers supported to drive circular farming practices, by returning leftover digestate to local farms for use as an organic fertilizer.[30]

Reuse of temperature dataloggers

Temperature dataloggers are essential for monitoring conditions during the storage and transport of medicines, recording temperature data throughout supply chain operations.

The take-back scheme for temperature data loggers is operated by Sensitech and Sanofi is working with them since 2016. The program is running in 13 countries in APAC, EMEA and North America with increasing take-back rates whereas LATAM is starting in Q4 2025[31].

The refurbished devices can be reused in the Food and Industrial verticals but also in the Life Sciences industry. In 2022 and 2023, Sanofi returned around 6% of the dataloggers bought worldwide and in 2024 a 23% return rate was reached. In the first half of 2025, the return rate was increased again to almost 100%. The 104% shown in the graphics below is a statistical artefact as dataloggers are usually not returned directly after buying them.



30 2026 sustainability impact report. https://www.futurebiogas.com/our-projects/moor-bioenergy-ltd/
31 Device Takeback Program | Sensitech. https://www.sensitech.com/en/sustainability/Takeback/



End-of-life management

In the circular economy, no resources end up as "waste", and a number of EFPIA members are actively working with collecting or retrieving products or materials, recycling or recovering value from products or materials, regenerating or repurposing products or materials, preventing or reducing environmental pollution. One of the successful examples is the pilot scheme of industry-wide take-back scheme for medical devices.

Biomedical plastic waste processing facilities

As global demand for plasma-derived therapies rises, Takeda is demonstrating that growth in healthcare does not have to come at the expense of the environment. Since 2025, Takeda has been operating state-of-the-art biomedical plastic-waste-processing facilities at its manufacturing site and BioLife testing lab in Covington, Georgia, and its BioLife testing lab in Hoover, Alabama, U.S. This initiative directly addresses one of healthcare's toughest challenges: the high volume of single-use plastics required to ensure patient safety.[32]

The 8,000-square-foot facility in Covington is equipped with technology that sterilizes and shreds the millions of plastic bottles and test tubes required to collect plasma, test it, and manufacture plasma-derived therapies each year. Instead of being sent to landfills, this material is processed in order to be recycled by regional partners, which is then transformed into new products such as lumber and used in the sustainable manufacture of concrete. The projection is to divert up to 2.6 million pounds of plastic from landfill annually by 2030 across both sites combined.

This initiative is a powerful example of the circular economy in action. Rather than following a linear "use and dispose" model, Takeda keeps materials in circulation, reduces reliance on virgin plastics, and lowers environmental impact while maintaining strict biomedical safety standards. Onsite processing also cuts transportation costs and emissions, improving operational efficiency.

By aligning patient care, environmental responsibility, and economic value, Takeda's investment demonstrates how material loops can work—even in the most complex industries. This initiative supports Takeda's goal of achieving zero-waste to landfill by fiscal year 2030.

32 https://www.takeda.com/en-us/our-stories/tackling-biomedical-plastic-waste/

7 pharmaceutical companies - Novo, Eli Lilly, Sanofi, Merck, GSK, Novartis and UCB – collaborate on solving end-of life product challenge in returpen™ Denmark



Each year millions of injection pens are produced worldwide. After use many end up as waste. In September 2021 discussions were initiated in the EFPIA Circular Economy Network (EFPIA CEN) on how to collaborate on "solving end-of-life product challenge". Earlier take-back efforts had been discontinued due to lack of partnerships and funding, hence collaboration across the industry is pivotal to succeed.

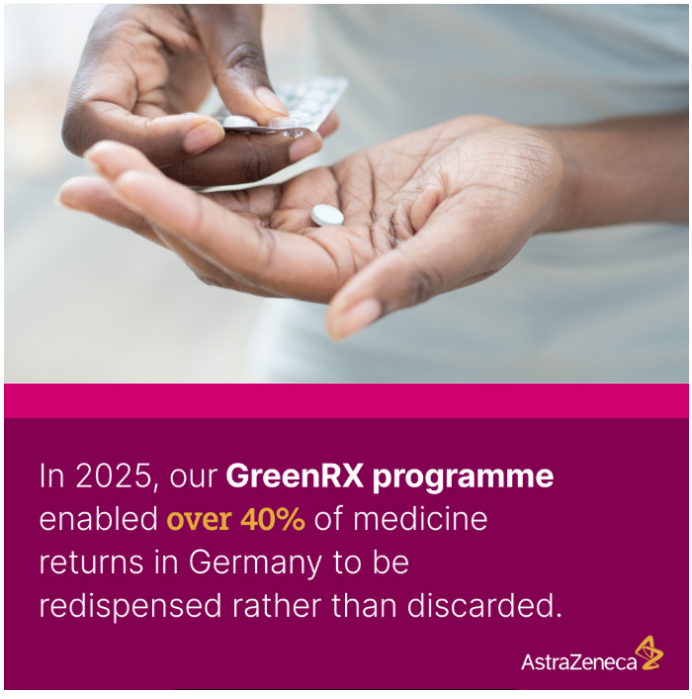
Based on the take-back pilot returpen™[33] launched by Novo in Denmark, December 2020, discussions were initiated to expand this pilot project into an industry pilot. EFPIA CEN was used as a platform to convene the industry, and transparency was important, while keeping in mind that some of the partners were direct competitors in the market. Hence, legal considerations needed to be in place to ensure compliance. After careful preparations and analysis across Novo, Eli Lilly, Sanofi and Merck the partners signed a cooperation agreement leading to the world's first pharmaceutical take-back industry pilot, which was launched 1 May 2023.

Per January 2025 GSK, Novartis and UCB have joined the partnership, and as result of that, returpen™ is now covering almost 90% of the injection pen market in Denmark. With the expansion of the three new partners, the project is also expanding into the hospital sector.

Overall, this case has demonstrated that EFPIA CEN is a strong platform to convene the industry, and that we can perceive the sustainability agenda as precompetitive across the industry.

Partnership with ATIV GmbH to reuse unwanted medicines

At the end-of-life stage, AstraZeneca's GreenRX programme in Germany demonstrates how circular models can also be applied to medicines after distribution. Delivered in partnership with ATIV GmbH, the programme enables the return, assessment and reuse of medicines that remain suitable for use. By the end of 2025, 47% of returned packs were approved for re-dispensing, while 43% of inspected packs were resold instead of destroyed. Once fully implemented, the programme could prevent approximately 20,000 packs from being discarded.[34]



33 Returpen™. https://returpen.dk/
34 2026 sustainability impact report. https://www.astrazeneca.com/sustainability/resources/our-impact.html

Reusable devices industry collaboration

The transition to a circular economy in healthcare requires moving beyond end-of-life management towards fundamentally rethinking how medical devices are designed, used and valued. Reusable devices represent a significant opportunity in this regard: by replacing single-use products with devices designed for multiple use cycles, the pharmaceutical industry can meaningfully reduce plastic waste, lower carbon footprint and keep materials in productive use for longer - in direct alignment with circular economy principles. In the field of insulin pens for instance, precedents have demonstrated that one reusable device has the potential to replace 30-45 disposable devices.

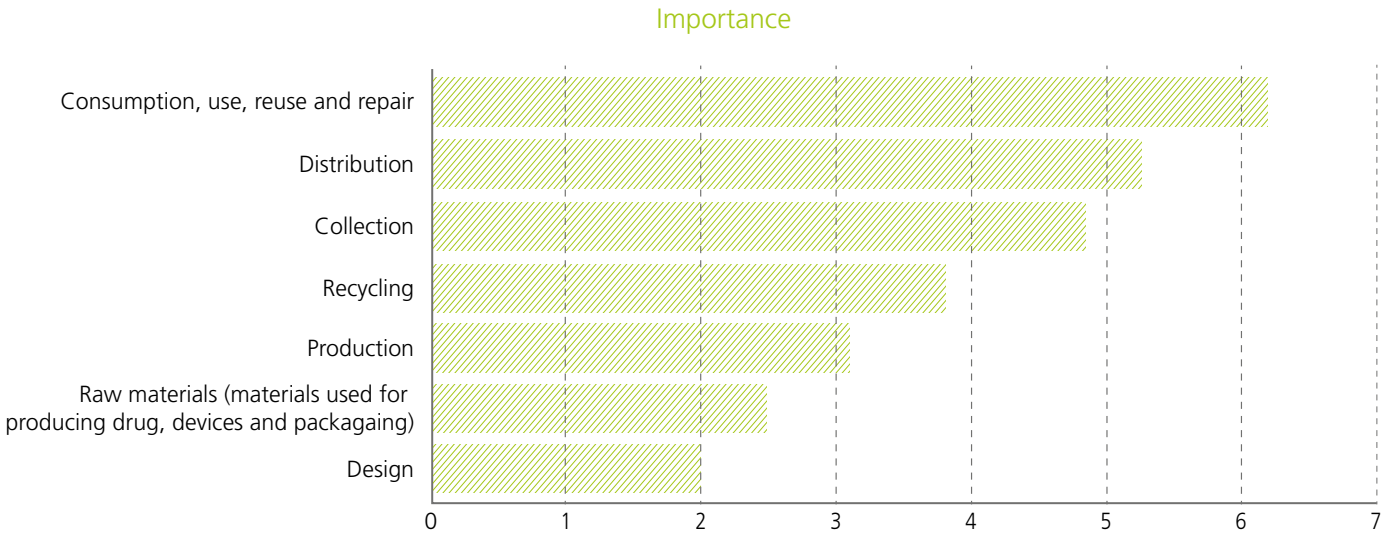
Launched mid-2026 under the EFPIA Circular Economy Working Group, the EFPIA Reusable Devices Task Force is a cross-industry initiative co-led by Sanofi and Novo, bringing together Takeda, Chiesi, Eli Lilly, GSK, Johnson & Johnson, Amgen, AstraZeneca, Boehringer Ingelheim, MSD, Novartis, Teva and ABPI. The Task Force aims collectively to understand and remove barriers to the sustainable, at-scale adoption of reusable devices across European markets and issue recommendations to shape a favourable ecosystem to accelerate this transition to more sustainable medical devices. A position paper is expected for end of 2026.

Pre-requisites for this acceleration may include:

- Developing awareness of patients / healthcare professionals/stakeholders on the current negative environmental impact of disposable medical devices;
- Converge to regulatory, market access and reimbursement pathways that are compatible with such an acceleration;
- Develop sustainability criterias for tenders that would further encourage the introduction and ramp-up of reusable medical devices;
- Adaptation or co-construction of distribution circuits and processes compatible with the constraints of reusable devices, in partnership with pharmacists (e.g. initial distribution of devices to patients and end-of-life take-back mechanisms);
- In parallel, the Taskforce also aims at developing a standardised methodology for comparing the environmental impact of reusable versus disposable devices across their full lifecycle, using PAS 2090 as a reference standard.

Through this initiative, EFPIA members are demonstrating that the pharmaceutical industry can act collectively and proactively to advance circular economy principles in healthcare - combining scientific rigour, regulatory engagement, and cross-industry collaboration to accelerate the transition to more sustainable medical devices.

The EFPIA Survey in 2026 revealed that the most important life cycle in a company's circular economy strategy is the patient stage, followed by distribution.



Device disassembly for self-injectable devices

Johnson & Johnson's Safe Returns program lets patients mail back used self-injectable devices in safe and convenient prepaid paper envelopes. The program now operates in nine European countries and the United States.

To support the recovery of selected plastic and steel materials from disassembled devices, J&J invested internally to design, build, and operate a disassembly machine at a hub in Switzerland. This disassembly machine is used to carefully separate returned devices through Safe Returns in Europe allowing selected materials to be recovered for recycling where feasible.

Cross border transport procedures were also established to enable returned devices to be transferred safely to the Swiss disassembly facility. These procedures include appropriate packaging, transportation arrangements, and compliance with regulatory and safety requirements for international shipments.

After initial disassembly of devices collected in Switzerland earlier in the year, the first batch from Ireland was processed mid 2025. Selected plastic and steel materials recovered through the disassembly process were then sent on to recycling partners. Any material that is not recyclable such as mixed material components as well as syringes made from borosilicate glass will be managed in accordance with applicable local regulations.



3. Regulatory Landscape

As a provider of life-saving medicines to the EU market, the pharmaceutical industry is subject to unique, and often strict regulation which may challenge circular economy initiatives.

The European Union is entering a new phase of circular economy implementation. The Circular Economy Act[35] announced by the European Commission is expected to complement an expanding body of legislation including the Packaging and Packaging Waste Regulation (PPWR)[36], the Ecodesign for Sustainable Products Regulation (ESPR)[37], revisions to the Waste Framework Directive[38], the Industrial Emissions Directive[39] and chemicals legislation such as REACH[40] and Classification, Labelling and Packaging of chemicals (CLP Regulation)[41].

Together, these frameworks can accelerate circularity across sectors. However, they also create increasing complexity for highly regulated sectors such as healthcare. For the pharmaceutical industry, changes to materials, packaging systems, manufacturing processes or devices often require extensive testing, validation and regulatory approval before implementation. Therefore, secondary legislation needs to be delivered as soon as possible to give clarity and time for implementation.

Regulatory coherence across environmental and pharmaceutical legislation will therefore be essential. Circular economy requirements should support sustainability objectives, while safeguarding patient safety, product quality, efficacy and continuity of supply.

Global pharmaceutical supply chains also depend on highly specialised materials, suppliers and regulatory pathways. Regulatory requirements introduced in one region can therefore have implications across global healthcare systems. Early, structured engagement between policymakers, regulators, industry and healthcare stakeholders is critical to ensure circular economy objectives can be implemented effectively and proportionately.

Legislation that underpins product quality is critical to the pharmaceutical industry. Ongoing dialogues with the authorities, including EMA and FDA, will have to continue to support the responsible use of secondary raw materials where appropriate risk assessment, quality standards and regulatory oversight are in place. This is illustrated by the lack of consensus between industry and regulators about the minimum quality requirements limiting the use of recovered solvents, recycled packaging materials and other resources, creating barriers for EFPIA members seeking to integrate these materials into manufacturing processes.

If well designed and embedded within a coherent policy approach, the circular economy principles can benefit both the economy and environment. They can support a resource-efficient, competitive, and resilient pharmaceutical industry while enabling continued delivery of innovative medicines to patients. Any regulatory change should be evidence-based, proportionate and informed by full product life cycles to avoid unintended consequences.

In response to the EFPIA circular economy survey in 2025, respondents scored GMP and other regulatory requirements as the greatest barriers to implement circular economy principles into product development and operations. For example, regulatory barriers with

35 https://environment.ec.europa.eu/strategy/circular-economy_en
36 https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste_en
37 Implementing the Ecodesign for Sustainable Products Regulation - Green Forum. https://green-forum.ec.europa.eu/implementing-ecodesign-sustainable-products-regulation_en
38 https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en
39 https://environment.ec.europa.eu/topics/industrial-emissions-and-safety/industrial-and-livestock-rearing-emissions-directive-ied-20_en
40 https://environment.ec.europa.eu/topics/chemicals/reach-regulation_en
41 https://environment.ec.europa.eu/topics/chemicals/classification-labelling-and-packaging-chemicals_en

regards to nitrosamines limits solvent recovery during API manufacture, although solvent recovery has been identified as a key decarbonisation opportunity.

Circular economy measures affecting medicines, medical devices and healthcare products must preserve patient safety, product quality and efficacy. The use of recycled materials, alternative substances or circular business models should be enabled through science-based approaches and appropriate regulatory oversight. Because pharmaceutical products often require years of development, qualification and regulatory approval, circular economy requirements should include sector-specific transition periods that reflect healthcare product life cycles and regulatory obligations. Environmental, pharmaceutical and medical technology legislation should also be reviewed for interactions to avoid contradictory requirements and reduce cumulative burden. Harmonisation across Member States will be important to avoid fragmented implementation and protect competitiveness.

Investment in high-quality infrastructure, the promotion of availability of suitable recycled materials and facilitation of standards relevant to healthcare applications are needed to enable the uptake. Innovation should be further incentivised through supportive policies, streamlined regulatory pathways and support for collaborative innovation projects.



4. How Pharma has contributed to the transition to Circular Economy

EFPIA members are constantly working towards cost-effective and resource-efficient innovations and a shift to a circular economy will see an expansion and acceleration of innovations already taking place across the industry. It is up to the members of EFPIA to find an innovative circular economy approach based on business model options, current legislation and the circular economy principles outlined by the Ellen MacArthur Foundation.

The EFPIA 2026 survey shows that the circular economy is widely prioritized by the industry: 80% of the member companies have set internal or external targets

The survey also indicates that partnerships are very important in all stages: by developing guidelines and driving innovation, looking for scalable end of life solutions, and setting standards.

In addition, 10 out of 17 companies responding to the survey had circular economy case studies to share, in contrast to only 4 companies in 2020, which implies that many EFPIA members have been actively working on circular economy initiatives in the last few years.

Providing a clear vision of a circular pharmaceutical industry and sharing best practices of the circular economy between our member companies will help harness the innovation expertise in our sector, facilitating the design of circular principles into products and supply chains at an early stage. The opportunities available to the pharmaceutical industry are illustrated by the activities listed in this paper which will also showcase to our stakeholders how the pharmaceutical industry addresses the circular economy.

Circular Economy opportunities and activities undertaken by the pharmaceutical industry

A. Disease Prevention

The pharmaceutical industry is investing in innovation to prevent, manage and cure diseases. Public-private partnerships in screening and early intervention, including lifestyle and dietary changes, can help prevent Type 2 diabetes and obesity. This supports health and wellbeing, reduces the need for treatment and helps save healthcare resources.

B. Create awareness

It is vital to engage key stakeholders in the pharmaceutical industry to raise awareness and seek opportunities for circular innovation.

Patient behaviours in the use and disposal of prescribed medicines will further enable opportunities.

C. Product design

The Circular Economy Action Plan has identified that up to 80%[42] of products' environmental impacts are determined at the design phase and this highlights the importance of circularity in pharmaceutical research and development. Given the long development cycles in the pharmaceutical industry, the design stage is even more critical than for fast-moving consumer goods. On average, it takes around 10 to 15 years for a new medicine to go from initial discovery to market launch[43].

42 https://www.mckinsey.com/industries/life-sciences/our-insights/fast-to-first-in-human-getting-new-medicines-to-patients-more-quickly
43 https://peghub.org/lca

D. Dosage
The pharma industry is increasing its focus to prevent disease and provide cures rather than long-term treatment of symptoms with the associated resources usage. Successful development of vaccines, for example to prevent the virus that causes cervical cancer, not only support health and wellbeing but prevent the need for treatment of the condition and thus saves resources.

E. Product Lifetime
The stability of the product is key to ensuring that patients receive the optimum dose to support their recovery. The pharma industry has performed extensive research into packaging, to extend the shelf life of a product and minimize waste generation. In general, extending the lifetime of products will lower the environmental impact by reducing in product loss but this must be evidenced for example by the Life Cycle Assessment (LCA).

G. Life Cycle Assessment (LCA)
LCA is a scientifically robust approach to quantifying the environmental impact of a product or process across its full or partial life cycle. LCA is an existing, well-established, methodology that can help identify where the pharmaceutical industry should invest and innovate to improve the environmental performance of the manufacturing and distribution of medicines. It prevents a narrow view of environmental sustainability and allows the opportunity for product principles like the 4Rs (reduction, reuse, recycling and recovery), green chemistry and eco-design to be applied and understand the environmental impacts of new products at all the stages of their product lifecycles.

Both the data collected as input to LCA, and the assessment results, can help identify the life cycle stages with the largest improvement potential, and also ensure that a circular economy initiative, such as recycling or recovery, is not working against decarbonization and efforts to mitigate climate change.

EFPIA member companies published a report in 2025 highlighting the need to advance environmental sustainability assessments of pharmaceuticals through standardisation and harmonisation. PAS2090, published on November 30 2025, is the first publicly available specification to establish harmonised product category rules for pharmaceuticals.

F. Logistics
Transportation and distribution are a crucial part of the pharmaceutical industry. For example, thermal shipping systems are commonly used within pharmaceutical distribution to provide a safe transportation of temperature-sensitive products to patients around the world. The thermal shipping system is composed of insulation material e.g., expanded polystyrene (EPS) and vacuum insulation panel (VIP) and cooling elements to provide adequate thermal and mechanical protection for the product. These shipping systems are qualified to withstand temperature challenges that occur during supply chain processes. However, many of these systems have been single-use, members of EFPIA have been working to transition from single-use practices in logistics to a reusable system model, as seen in the example below.

H. Secondary or renewable raw materials

Certain elements that are critical in the manufacture of medicines (e.g. Platinum group metals) are being consumed at such a fast rate that there is a tangible risk to future supply. These elements are not destroyed but they become widely dispersed and therefore difficult to harvest in meaningful volumes. The pharma industry recognizes that the growing demand for critical elements represents a material risk for the future supply of medicines and that recycling, and reuse are fundamental to expanding the lifetime of raw materials in the value chain.

The periodic table below is comprised of 90 elements that make everything on Earth. The areas correspond to the number of atoms (on a logarithmic scale) of each element in the earth's crust and atmosphere. The area for some of the elements has been exaggerated otherwise they would not be visible.

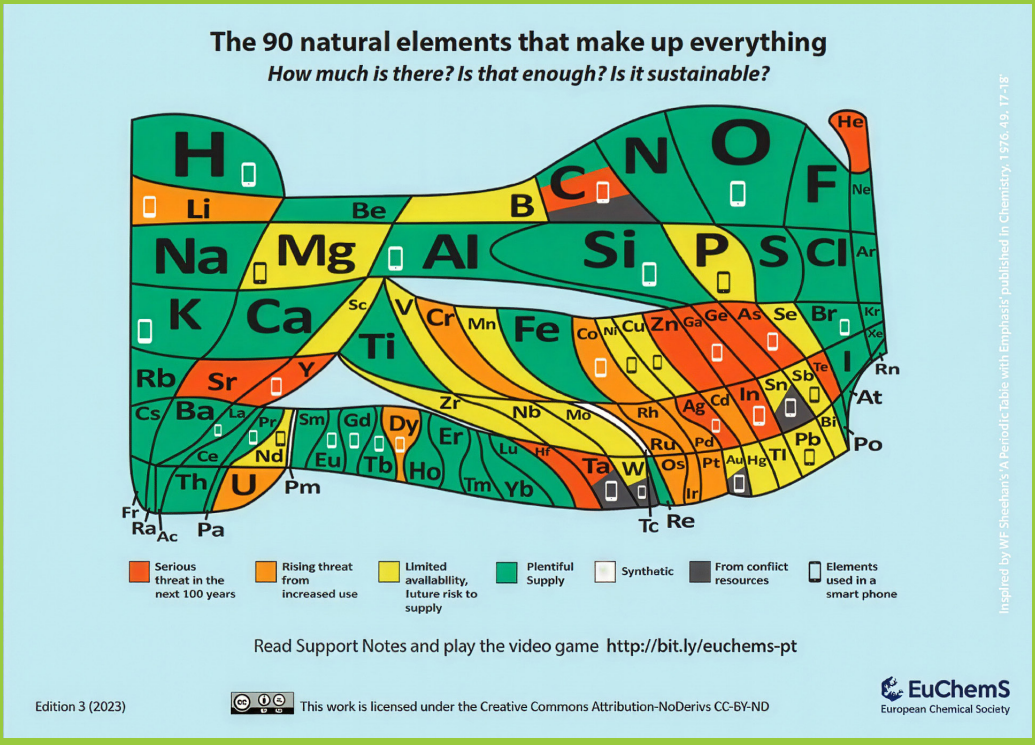
The use of secondary raw materials or the re-use of materials directly back into pharmaceutical manufacture can present significant challenges due to the regulatory and safety requirements associated with our products and the technical performance needed from these materials.

Solvent recovery and reuse, as key principles of green chemistry, are considered acceptable, provided that approved procedures exist and the recovered materials meet specifications suitable for their intended use. Waste materials from the pharmaceutical industry which do not comply with pharmaceutical quality requirements are still often of high quality and these valuable raw materials can be used by other industrial sectors facilitated by strong circular economy partnerships. In certain areas, there are also growing opportunities for the pharmaceutical industry to use secondary raw materials from other sectors, for example, the use of food and farming waste to produce clean heat at some manufacturing sites.

The pharmaceutical industry is committed to maximising opportunities to re-use and recycle materials and to keeping these materials at the highest possible value for use for as long as possible. Collaboration across the industry and with other industrial sectors and, where appropriate, engagement with the EMA and FDA are essential to realise the full potential of this approach. Suitable metrics which focus efforts on re-use and recycling at the top of the waste hierarchy will also help drive improvements.

When choosing raw materials and chemicals it is also relevant to explore whether secondary raw material sources (e.g biobased, carbon capture utilisation), for these materials can be used.

Materials of natural origin, especially those on the Science Based Targets Network (SBTN) High Impact Commodity List[44] should be carefully selected and sourced responsibly from practices that regenerate nature to avoid any unintended environmental consequences, for example, on biodiversity, deforestation, water use or pollution due to fertiliser use.



44 https://sciencebasedtargetsnetwork.org/how-it-works/assess/

Regenerative Glucose Sourcing Programme



Novo's regenerative glucose sourcing programme is a cornerstone of their Climate and Nature strategies, designed to reduce environmental pressures across the value chain. Glucose, as a high-volume critical raw material to produce medicine, exerts significant impacts on climate, land use, water quality, and biodiversity. By transitioning to regenerative agriculture (Regen Ag) practices, we aim to restore ecosystems while securing resilient supply chains[45].

Regenerative agriculture focuses on soil health through techniques such as cover cropping, reduced tillage, and precision input management. These practices minimise fertiliser and pesticide losses, enhance carbon sequestration, and improve biodiversity on farms. UCB's suppliers are engaged through outcome-based schemes, incentivising measurable improvements in greenhouse gas (GHG) emissions and soil health. Early pilots have demonstrated a 13% reduction in gross GHG emissions, from reductions in fertiliser and fuel usage.

Supply chain integration is critical. Contracts with suppliers include phased targets: with ~10% sourced in 2025, scaling to 100% by 2033. These agreements incorporate green premiums and cost-sharing models to support farmers' transition, ensuring financial viability alongside environmental benefits.

The environmental benefits are substantial: improved soil structure and water retention, reduced nutrient runoff, enhanced biodiversity, and a projected up to 24% reduction in glucose-related GHG emissions contributing to their SBTi-approved 33% scope 3 reduction target by 2033 and Net Zero 2045 target. Beyond climate gains, regenerative sourcing strengthens supply resilience and helps to achieve their Nature Ambition of Halting the Loss of Nature by 2033.

45 Regen Ag LinkedIn explainer. https://www.linkedin.com/posts/elin-j%C3%A4ger-5b318314_to-make-our-medicines-we-need-glucose-from-activity-7393936590051368960--OI8?utm_source=share&utm_medium=member_desktop&rcm=ACoAADf3nooBU9_L4CDM-Rxb8RI4BzSo-mP5oRM



5. A Circular Economy Future in Pharmaceutical industry

EFPIA members are already advancing circular economy initiatives, as reflected through this white paper. To unlock the full potential of circularity within the pharmaceutical sector, continued collaboration with policy makers, regulators, healthcare stakeholders and value chain partners will be essential.

It is therefore important to accelerate the development of an enabling healthcare ecosystem, ensuring that the full value chain is equipped and prepared to support the transition. While the pathway remains complex, lessons from electronics and consumer packaging and other sectors can help inform scalable circular economy approaches for pharmaceuticals. The sector will continue to apply these learnings, advance collaboration and support a systemic transition towards circularity that safeguards patient safety, product quality and access to medicines.

Project ENKORE[46] (Eco Healthcare)

ENKORE
ECO HEALTHCARE

Is a cross-industry initiative aimed at advancing circularity within the healthcare sector by building the foundations for a functional, scalable ecosystem for materials reuse and recycling. Its core goal is to move beyond isolated pilots and enable system-level change by aligning stakeholders across the value chain; pharma companies, suppliers, waste handlers, and recyclers; around common standards, processes, and infrastructure. The project focuses on redefining waste as a resource, improving value retention of materials, and establishing practical pathways for technical and regulatory feasibility. Key outputs include a structured assessment of current-state barriers, identification of high-impact circular use cases, development of harmonized guidelines or frameworks for implementation, and concrete recommendations to accelerate adoption across the industry, ultimately strengthening supply resilience and reducing environmental impact.

46 https://enkoreecohealthcare.eu/

Project DiCE (Digital Health in a Circular Economy)[47,48]

Digital Health in the Circular Economy

DICE is a Horizon funded project bringing all value chain actors together to address small digital waste within healthcare. DiCE developed and demonstrated novel, circular and environmentally sound solutions to design, collect, directly reuse, refurbish, remanufacture and recycle digital health devices (digital paper label, smart wearable sensor, smart pill box, endo-cutter), which will contribute to enabling a circular transition. Solutions were implemented, tested and demonstrated in five healthcare ecosystems reflecting the geographical spread within Europe through community-engaged pilots in Norway, Belgium, Slovenia, Spain and Germany. DICE contributes to mitigating the globally expanding health waste problem covering three material streams – electronics, plastics, metal- and alleviate shortage of critical and valuable raw materials, while protecting the health and safety of those involved in realising the circular economy. Exploitation of key outputs will be ensured by all partners throughout and after the project and will be further extended to adjacent sectors through existing networks and platforms within which the partners are represented.

PharmEco: Advancing safe and sustainable by design practices in pharmaceutical manufacturing[49]

PHARMECO

The health sector has a significant impact on the environment; in OECD (Organisation for Economic Co-operation and Development) countries, it is responsible for between 3 and 8% of CO2 emissions. It also uses large quantities of water, energy, solvents and fossil-based raw materials, and generates a lot of waste.

The aim of PHARMECO is to trigger a green revolution in the manufacture of medicines.

As a first step, the project will enhance the early stages of pharmaceutical development by integrating 'safe and sustainable by design' (SSbD) principles. Promising innovative technologies and process optimisations will be selected based on their potential to significantly reduce the use of solvents, substances of very high concern, energy, and water in pharmaceutical production practices covering chemical synthesis, biomanufacturing and decontamination. Additionally, considerations of scalability and alignment with the corporate strategies of PHARMECO's industrial partners will be considered, paving the way for the implementation of more efficient and sustainable manufacturing processes for various pharmaceutical products.

In the next phase, the project will test how the SSbD-driven technologies and processes perform at a larger scale, such as that needed for clinical trials and transfer to standard manufacture settings.

One major deliverable of the project focuses on digital tools to support environmentally-sound decision-making when developing new (bio)manufacturing processes. The modular tools will allow users to assess sustainability from multiple perspectives covering all stages of the product's life cycle.

Finally, the project plans to harmonise the way environmental sustainability assessments of pharmaceuticals are carried out by delivering guidelines that are scientifically-robust, practical, and accepted by stakeholders.

Together, the project outputs will form a comprehensive toolkit to support the development and manufacture of more sustainable pharmaceuticals and to evaluate their environmental impact along the whole life cycle.

47 Homepage - Digital Health in the Circular Economy. https://circulardigitalhealth.eu/
48 DIgital health in Circular Economy | DICE | Project | Fact Sheet | HORIZON | CORDIS | European Commission. https://cordis.europa.eu/project/id/101060184
49 Home - Pharmeco, PHARMECO | IHI Innovative Health Initiative. https://pharmeco.eu/



ANNEX 1

Need to know more?

Climate change

With respect to circularity as regards CO2 emissions and climate changes the approach of EFPIA can be accessed here[50], (2026)

Chemicals

Likewise, the view of the pharma industry on chemicals, especially hazardous substances in the manufacturing process, can be seen under the heading Chemicals here.

Pharmaceuticals in the Environment

Controlling and eliminating pollution of pharmaceutical active ingredients in the environment has been discussed and analysed thoroughly within the pharmaceutical industry and its stakeholders in recent years. The approach of EFPIA on residues of pharmaceutical products in the environment in general and on antimicrobials specifically can be found here[51].

Take back of unused medicine

In continuation of the discussion on pharmaceuticals in the environment, take-back of medicine is likewise an important issue. Through many years the pharmaceutical industry has participated in unused medicines take- back programs to ensure safety during disposal of unused drugs.

To boost the return of unused medicines, collaboration between medical professionals, pharmaceutical companies and patients is needed to drive behaviour change.

Read more about disposal of unused drugs here[52].

50 https://www.efpia.eu/media/jlejk0kc/2026-white-paper-on-climate-change.pdf

51 https://efpia.eu/media/636524/efpia-eps-brochure_care-for-people-our-environment.pdf

52 http://www.medsdisposal.eu/



Disclaimer: This document has been developed under the leadership of the EFPIA Environment, Health and Safety group. The examples included are a non-exhaustive selection which do not represent the full level of activities on climate change being undertaken across our industry.

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