



**Redefining
pharmaceutical
packaging: From
protective layers to
sustainable supply
chain solutions**

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Acknowledgement:

The pharmaceutical packaging industry is undergoing a period of rapid transition. Increasing regulatory expectations, heightened stakeholder awareness, and the broader push toward climate action are placing greater pressure on manufacturers to adopt sustainable and low-carbon solutions. Beyond ensuring product protection and compliance, companies are now expected to demonstrate environmental accountability across their value chains. This shift has amplified the need for practical strategies and adaptable frameworks that enable the sector to reduce emissions, incorporate eco-efficient materials, and strengthen circularity—while continuing to safeguard patient health and product efficacy.

This whitepaper, *Redefining Pharmaceutical Packaging: From Protective Layers to Sustainable Supply Chain Solutions*, has been developed through a collaborative joint effort between EY-Parthenon and ACG (Associated Capsules Group). We extend our appreciation to all contributors whose insights, technical expertise, and thoughtful inputs shaped the depth and direction of this work. This paper reflects a shared commitment to advancing industry understanding and supporting the transition toward responsible, resilient, and future-ready packaging systems.

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Introduction and background

Evolution of pharmaceutical packaging from protection to performance

Pharmaceutical packaging has moved beyond basic protection and regulatory compliance to become an active enabler of product performance, patient safety and brand differentiation. Innovations – from tamper-evident and dose-accurate delivery systems to smart or connected packaging (QR codes, Near Field Communication (NFC), sensors) now support medication adherence, cold-chain integrity for biologics and real-time traceability across global supply chains. Packaging strategy today blends material science, digital enablement and supply-chain design to preserve product efficacy while improving patient outcomes and operational efficiency.

Current industry context with regulatory environmental and patient-centric demands

- **Regulatory pressures:** The European Union's Packaging and Packaging Waste Regulation (PPWR) mandates that by 2030, all packaging must be recyclable, and the

use of recycled plastics in new packaging is required. Additionally, overpackaging is to be banned, promoting reusable packaging options and clear labeling to enhance recycling efforts¹.

- **Environmental considerations:** The global sustainable pharmaceutical packaging market was valued at approximately US\$87.24 billion in 2023 and is projected to reach US\$220.39 billion by 2030, growing at a compound annual growth rate (CAGR) of 14.2%. This growth reflects the increasing demand for eco-friendly packaging materials such as biodegradable plastics, recycled paper and plant-based alternatives².
- **Patient-centric expectations:** Patients are increasingly prioritizing sustainability, with 67% of consumers in the US stating that they consider a company's environmental impact when making purchasing decisions. In a survey by Packaging Technology's Shorr Packaging³, 86% of consumers said they would be more likely to purchase a brand if its packaging was considered sustainable. This shift is influencing pharmaceutical companies to adopt more sustainable packaging practices to meet patient expectations⁴.

Global pharma and packaging companies driving sustainable packaging initiatives

Company	Sustainability initiative in packaging	Impact / target	Source
Pfizer	Introduced recyclable, paper-based secondary packaging for injectables	Reduces plastic use and overall packaging footprint	Pfizer
Johnson & Johnson (J&J)	Exploring sustainable packaging, circularity solutions and green chemistry principles	Supports circular economy in pharma packaging	J&J Climate Action Plan
Novartis	Environmental sustainability strategy: packaging redesign to use lighter, lower-impact materials	Target: Carbon-neutral supply chain by 2030	Novartis Sustainability
GSK	Use of Forest Stewardship Council (FSC)-certified paperboard packaging; testing bio-based blister packs	Moves away from Polyvinyl Chloride (PVC); reduces virgin plastic use	GSK Sustainability
Ancor (Global supplier)	Launched AmSky™: recyclable blister packs replacing PVC-aluminum with polyethylene	Cuts >60% carbon footprint vs. traditional blisters	Ancor AmSky
Sanofi	Applying eco-design principles; reduced-weight cartons; part of Healthcare Plastics Recycling Council	Minimizes packaging weight, boosts recyclability	Sanofi Sustainability

1 Vogue Business, Dec 2022, What to know about the EU's crackdown on plastic packaging

2 Grand View Research, 2023, Sustainable Pharmaceutical Packaging Market (2024 - 2030)

3 Shorr, Jan 2025, The 2025 Sustainable Packaging Consumer Report

4 Packaging Digest, March 2023, Sustainability is Top Trend for Pharmaceutical Packaging in 2023

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Key challenges in pharmaceutical packaging



Balancing product safety, compliance and sustainability

Packaging must ensure patient safety by protecting products from contamination, counterfeiting and degradation. The pharma industry is highly regulated (e.g., US Food and Drug Administration (FDA), European Medicines Agency (EMA), Central Drugs Standard Control Organization (CDSCO) in India) and any material changes to packaging often requires lengthy validation and regulatory approvals. This slows down the adoption of innovative, sustainable materials despite growing demand.



Escalating packaging costs driven by breakage risks, stability demands and research and development (R&D) complexity

- Globally, injectable medicines are packaged in fragile glass vials, leading to high breakage risks in transport. Alternative formats like rotomolded cases, foam inserts and polymer-coated vials are emerging but add to costs.
- Biologics lose stability if exposed to improper temperatures or humidity. Specialized barrier films insulated shipping boxes and Internet of Things (IoT)-enabled temperature trackers are now essential but increase packaging complexity.
- New biologics interact with traditional glass/silicone packaging. For instance, protein aggregation in silicone lubricated syringes is driving demand for silicone-free technologies. R&D for such next gen polymer vials and nano coatings is capital-intensive and slow to scale.



High reliance on plastics and aluminum with recyclability concerns

Pharma packaging relies heavily on single-use plastics such as polyvinyl chloride (PVC), polyethylene terephthalate (PET) and polypropylene (PP), as well as aluminum foils used in blister packs and pouches. According to industry reports, blister

packs account for nearly 80% of solid oral dosage packaging globally⁵, yet PVC and aluminum combinations are difficult to recycle. Limited recycling infrastructure leads to high waste volumes.



Supply chain complexities in sourcing cost and carbon footprint

Pharmaceutical packaging contributes significantly to Scope 3 emissions, driven by raw material extraction, manufacturing and logistics. Volatile oil and aluminum prices directly affect packaging costs. For instance, aluminum prices surged 60% between 2020 and 2022, putting cost pressures on blister foil packaging. Sourcing sustainable alternatives (bio-based plastics and recycled content) often means higher costs and fragmented supplier networks that create risk for consistent supply.



Counterfeiting risks and regulatory burden on brands

- Medicines in low- and middle-income countries often face quality and authenticity challenges. Advanced packaging solutions such as holograms, QR or Radio Frequency Identification (RFID) codes and tamper-evident seals are essential safeguards, though evolving counterfeiting methods continue to pose risks.
- The EU Falsified Medicines Directive (FMD) mandates serialization and anti-tampering by 2025 for Italy and Greece, while the U.S. Drug Supply Chain Security Act (DSCSA) law requires full supply chain traceability by 2027. For companies producing drugs across geographies, harmonizing labeling and compliance is a major operational challenge.
- Under India's Plastic Waste Management (PWM) Rules and Extended Producer Responsibility (EPR) framework, Plastic Waste credit exchange markets (where companies purchase recycling credits from registered processors) face challenges of verification, inflated credit pricing and lack of standardization across states. This complicates compliance for packaging-intensive pharma players.

⁵ Market.us, Jan 2025, Healthcare Blister Packaging Market Size, Share - CAGR of 7.9%

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Opportunities for transformation

Green materials such as biodegradable recyclable and low-carbon options

In pharmaceuticals, the biodegradable pharma packaging market is expected to grow at a CAGR of 12.6%⁶. Implications of green material usage:

- Pharma companies can reduce their reliance on traditional plastics and aluminum by using biopolymers such as Polylactic Acid (PLA), Polybutylene Adipate Terephthalate (PBAT), Polyhydroxyalkanoates (PHA), and biodegradable laminates and recyclable multi-material substitutes.
- The EU Packaging and Packaging Waste Regulation (PPWR), 2025, requires 30% recycled content in plastic packaging by 2030, accelerating the shift towards circular packaging solutions. However, these requirements currently exclude “contact-sensitive” packaging—materials in direct contact with medicines and medical devices, owing to stringent safety and sterility considerations. Several environmental groups and policy stakeholders continue to advocate for the gradual inclusion of primary pharmaceutical packaging within the PPWR framework.
- Lower-carbon feedstocks and recycled materials help reduce embodied carbon and improve Environmental, Social and Governance (ESG) ratings.

Digital packaging and smart labeling for traceability and waste reduction

Smart packaging tools (QR codes, NFC, serialization and sensors) are increasingly adopted to improve supply-chain traceability, anti-counterfeiting and patient safety.

Lightweight designs such as reduced wall thickness and minimal secondary packaging can reduce material usage by up to ~25% in pilot cases (e.g., Merck’s packaging redesigns)⁷.

Implications of digital packaging are as follows:

- By adopting smart labeling and digital serialization, brands can reduce losses from counterfeit/damaged products, enable real-time monitoring (cold chain) and improve recalls, while also enhancing patient safety through features such as dosage reminders, authenticity checks and user guidance.
- By reducing secondary packaging, companies can aid logistics efficiency and lower transport emissions.

Circular economy models for collection reuse and recycling

Amcors & Kolon Industries are developing flexible packaging using chemically recycled PET and polyethylene furanoate (PEF), targeting ~30% post-consumer recycled content⁸. SCHOTT has launched pilot recycling initiatives for specialty pharmaceutical glass packaging, aiming for climate-neutral glass by 2030⁹.

Implications of circular economy approaches include:

- Pharma companies can implement take-back programs for primary or secondary packaging, work with third parties to recycle glass vials and aluminum foils, or design for modular reuse.
- By increasing the share of recyclable plastics in packaging, pharma companies can generate surplus EPR credits. These credits can be sold in the compliance market, creating an additional revenue stream while meeting regulatory obligations and strengthening sustainability positioning.
- Using higher recycled content and improving recycling recovery rates reduces material costs and carbon footprint, enabling pharma companies to meet sustainability targets while enhancing long-term supply chain resilience and resource efficiency.

6 Dataintel, 2021, Biodegradable Pharmaceutical Packaging Market Report

7 Greenworksbio, Sustainable Pharmaceutical Packaging: Ready to Lead?

8 Asiana Network, May 2025, Circular Economy in Pharma Packaging Market Growth Accelerated by Green Packaging Trends and Increasing Adoption of Bio-Based and Recyclable Materials

9 Newstrail, July 2025, Circular Economy in Pharma Packaging Market Driven by Demand for Sustainable Materials

Benefits to pharma and R&D functions through sustainable packaging adoption

- **Lower formulation risks and fewer stability failures:** Bio-based, halogen-free films reduce drug-package interactions (leachables, extractables, protein aggregation), increasingly seen in biologics and high-potency Active Pharmaceutical Ingredients (APIs). This helps avoid reformulation, failed batches and accelerates time-to-market.
- **Faster regulatory approvals through cleaner, compliant materials:** Recyclable mono-materials and low-carbon aluminum reduce additives, contamination and heavy-metal traces, easing stability testing and dossier approvals with EMA, USFDA and PPWR. They also align with EPR and low-carbon sourcing rules, supporting global market access.
- **R&D cost savings from lower material intensity:** Lightweighting and eco-design remove unnecessary layers, simplify formats and cut material use, reducing material costs, transport load and packaging validation cycles.
- **Better patient-centric design and health outcomes:** Sustainable formats often allow easier-to-use packs, such as recyclable easy-peel blisters, clearer labels, tactile cues and larger fonts, improving adherence, a major hidden cost for pharma.
- **Biodegradation options for clinical trial waste:** Biotech R&D teams are testing enzyme-based breakdown (e.g., PlasticIQ and Carbios PET enzymes) for trial blister and secondary-pack waste, enabling on-site safe disposal and reducing hazardous waste logistics.
- **Carbon-scored packaging integrated into R&D workflows:** Pharma companies increasingly use Product Carbon Footprint (PCF)-based tools to rank packaging options by barrier performance, cost, carbon footprint and recyclability, guiding R&D toward the lowest-footprint viable choice early in development.

Collaboration with suppliers and stakeholders across the value chain

Theme or initiative	What companies are doing	Key benefits / outcomes
Low-carbon material procurement and supplier workshops	<ul style="list-style-type: none"> ▪ GSK's Sustainable Procurement Programme: From 2023, GSK requires suppliers to act on carbon, power, heat, transport, waste, water and biodiversity. The program includes education, emissions disclosures, target-setting aligned to Science Based Targets Initiative (SBTi), renewable power adoption.¹⁰ 	<ul style="list-style-type: none"> ▪ Improved data quality and supplier capacity for emissions reporting ▪ Shared innovation on lower-carbon materials and energy use ▪ Mitigation of Scope 3 emissions by moving upstream in the supply chain and influencing material choices
Collaboration with value-chain participants (VCPs) on source segregation, recyclable and lightweight materials, smart labeling and regulatory alignment	<ul style="list-style-type: none"> ▪ Energize Program: Launched in 2021 by 10 major pharma companies (including AstraZeneca, GSK, Pfizer and Sanofi) to enable suppliers to adopt renewable energy and encourage green power purchasing.¹¹ ▪ Neuland Laboratories: Conducts supplier audits and hosts supplier conferences to share sustainability learning, set improvement goals and promote recyclable or lightweight packaging and separation at source¹² 	<ul style="list-style-type: none"> ▪ Enhanced traceability and transparency across packaging inputs (what materials are used and how they are disposed) ▪ Reduction of packaging waste via lightweight design and source segregation for reduced contamination and improved recycling ▪ Better alignment with regulation (EPR, labeling rules) and avoidance of compliance risk ▪ Strengthened stakeholder relationships and shared risk or costs with better-prepared suppliers

¹⁰ GSK, Sept 2022, Sustainable Procurement Programme for suppliers

¹¹ Healthcare Packaging, Feb 2022, 10 Global Pharmaceutical Companies Launched First-of-its-Kind Supplier Program to Advance Climate Action

¹² Contract Pharma, Oct 2024, Securing Sustainability Throughout the Pharmaceutical Supply Chain

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Case study: The sustainable packaging journey of the Associated Capsules Group (ACG)

ACG' s Vision

ACG aims to become a global frontrunner in sustainable pharmaceutical packaging, ensuring that protective layers for medicines also contribute to a greener planet. The company aims to embed sustainability at the core of its packaging portfolio while balancing product safety, regulatory compliance and environmental responsibility. It also supports pharma clients in meeting their decarbonization goals. The main objective is to ensure compliance across geographies while building long-term competitiveness.

- **European mandates:** Alignment with the EU Carbon Border Adjustment Mechanism (CBAM) and packaging waste directives
- **Indian regulatory landscape:** Adherence to India's EPR for plastics and pharma packaging rules
- **Customer expectations:** Increasing demand from global and domestic pharma companies for low-carbon, recyclable and traceable packaging solutions

Leadership inputs (vision and positioning):

Mr. Karan Singh, Managing Director at ACG noted that the firm sees material innovation and circularity as twin pillars of its vision; he emphasized that leadership requires both scientifically validated materials and deep collaboration with regulators, pharma brands and recyclers to build credible, scalable solutions. He also stated that while the food sector has moved faster, pharma's safety and regulatory complexities require a cautious, evidence-based transition. Mr. Karan observed that investments in lab infrastructure to enable real-world stability trials are central to accelerating customer acceptance. He underscored that sustainability is also a competitive advantage.

ACG Pharmapack has taken initiatives to reduce carbon footprint across the value chain

a) CBAM impact assessment and compliance reporting

- ACG Pharmapack conducted carbon intensity benchmarking of aluminum foils and films used in blister packaging
- The company developed compliance reporting templates for EU customers to ensure smooth cross-border trade under CBAM

Leadership inputs (CBAM and commercial response):

Mr. Nitin Desai, Chief Commercial Officer, indicated that ACG has proactively sourced raw materials for export products from low-carbon European suppliers to eliminate CBAM exposure rather than pass costs to customers.





b) Science Based Targets initiative (SBTi) commitment and decarbonization strategy

- ACG Pharmapack has publicly committed to the SBTi and has near-term emission reduction targets to achieve 54.6% reduction in Scope 1 and 2 emissions (by FY33 from FY23 as base year) and a roadmap to achieve net zero by 2050.
- The company has also defined targets to reduce scope 3 GHG emissions from purchased goods and services, fuel- and energy-related activities, and upstream transportation and distribution by 61.1% and 97% per ton of products produced by 2033 and 2050, respectively.

c) Opting for alternative clean fuels (Scope 1)

- The company is transitioning from conventional fossil fuels to cleaner alternatives such as biodiesel in manufacturing sites.

d) Renewable energy adoption (Scope 2)

- ACG Pharmapack has installed onsite solar capacity in manufacturing facility at Shirwal and is in line to achieve 100% renewable energy by FY30 in their operations.
- The company is further exploring opportunities with renewable energy developers for long-term power purchase agreements (PPAs), aligning with SBTi RE100 principles.

Leadership inputs (Scope 2 and factory digitization):

Dr. Akbar Ali, General Manager and Head of Development and Technology at ACG, highlighted that ~60% of electricity is already sourced from renewables (primarily solar) at certain sites, and that ongoing smart-factory digitization enables better energy monitoring and overall equipment effectiveness (OEE) improvements. Mr. Karan added that digital and Industry 4.0 investments (real-time energy monitoring, planning optimization) reduce energy use and support replication across facilities.

e) Low-carbon material procurement (Scope 3)

- The company is exploring opportunities to collaborate with low-carbon aluminum producers (using hydro / recycled inputs) for green aluminum, with a potential to cut product carbon footprint (PCF) by 40% to 60% versus conventional aluminum.
- ACG Pharmapack is currently in advanced stages of developing a portfolio of sustainable packaging solutions, including fully recyclable materials, compostable, biodegradable and halogen-free alternatives. A compostable paper-based product is also set for imminent launch.

f) Digital transformation and operational efficiency

- Packaging operations are fully cloud-connected, enabling real-time monitoring and resource optimization.
- Robotic automation and vertical stacking have collectively improved production efficiency and reduced waste.



Outcomes

in emissions reduction cost optimization and compliance readiness

- **SBTi commitment:** The company validated near-term targets and long-term net zero pathway for reducing greenhouse gas (GHG) emissions from 2023 base year.
- **EU market compliance:** CBAM-ready reporting is enabling uninterrupted exports to Europe.
- **RE100 alignment:** Scaled renewable energy use to cut Scope 2 emissions.
- **Customer value:** The company has enhanced trust among pharma clients by ensuring cost optimization, emissions reduction and compliance readiness.
- **Lower product carbon footprint:** Further, the company is aiming for significant PCF reduction in aluminum and PVC products via green sourcing.

To complement these outcomes, ACG's leadership shared valuable on-ground perspectives on how the market is responding to these initiatives, the commercial implications and the emerging risks that accompany this transition.

Mr. Karan reiterated that beyond product innovation, building a circular ecosystem is equally critical; he proposed pharma co-investment models (e.g., small per-kg contributions to fund collection and recycling, with traceable certifications) to ensure that material volumes produced are matched by recovery efforts.

Beyond specific initiatives, several cross-cutting insights emerged consistently across leadership interviews, highlighting ACG's broader approach to sustainable transformation:



Safety comes first: Patient safety and regulatory compliance remain non-negotiable foundations. Sustainable materials or formats are adopted only when they meet uncompromised safety and barrier performance requirements.



Customer willingness to pay varies sharply by market: Multinational and highly regulated markets show greater readiness to pay a premium for sustainable packaging, while domestic and price-sensitive markets move slower unless supported by regulation or fiscal incentives.



High costs and an immature ecosystem slow adoption: Sustainable alternatives often require significant investment and current supply chain, and recycling ecosystems are still developing, making scale-up challenging.



Digital and operational tools are becoming key enablers: Smart factory initiatives, real-time monitoring, digitized audits, traceability systems and product-level PCF visibility help accelerate customer qualification, strengthen logistics resilience and validate sustainability claims.



Localization and supplier collaboration help de-risk operations: Onshoring, regional warehousing and deeper supplier collaboration are emerging as strategic moves to ensure continuity amid geopolitical uncertainty and support sustainable sourcing.



Sustainability is now a commercial priority: Faster adoption of credible sustainable formats by competitors could lead to lost business, putting pressure on companies to move beyond symbolic commitments and move toward accelerated implementation.

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Recommendations and roadmap for the pharma-packaging industry

The pharmaceutical packaging sector is at an inflection point. What began as a compliance-driven challenge is now a transformative opportunity to reimagine packaging systems as sustainable, smart and patient-focused. The roadmap ahead requires coordinated short-term innovation, medium-term circular collaborations and a long-term vision of net zero packaging.

Short-term priorities in material innovation and design for recyclability

a) Material innovation and design-for-recyclability

- Introduce recyclable mono-material films, bio-based laminates and low-carbon aluminum foils.

b) Regulatory alignment

- Comply with EU CBAM and Indian EPR mandates, ensuring packaging materials meet recyclability thresholds.

Medium-term strategies for supply chain decarbonization and circular partnerships

a) Supply chain decarbonization

- Collaborate with suppliers to procure green aluminum and recyclable plastics; roll out supplier-focused decarbonization workshops.
- Transition to renewable energy (RE100 commitments) across packaging operations.

b) Circular economy collaborations

- Collaborate with VCPs to enable source segregation, take-back schemes and recycling models.

c) Smart packaging and digital labels

- Integrate QR-based traceability to cut down on leaflet waste and improve compliance.

Long-term vision for fully sustainable smart and patient-centric packaging systems

a) Next-gen sustainable materials

- Scale compostable, biodegradable and halogen-free packaging at global levels.

b) Smart and patient-centric systems

- Packaging embedded with sensors, e-labels and connected health data to minimize waste and maximize adherence.

c) Global standards and policy alignment

- Adopt harmonized frameworks such as International Organization for Standardization (ISO), World Health Organization (WHO) and the EU Green Deal for sustainable pharma packaging worldwide.

6

Conclusion

Packaging as a lever for sustainable growth in pharma

Packaging is no longer just a protective layer; it has become a strategic lever for sustainable growth in the pharmaceutical industry. With increasing regulatory pressures, rising consumer expectations, and the urgent need to decarbonize value chains, the sector must reimagine packaging as a driver of both environmental and business resilience.

Industry-wide call to action for collaboration

The road forward cannot be pursued in isolation. It demands deeper collaboration across the ecosystem:

- Suppliers who can bring innovation in materials and processes
- Regulators who can enable progressive, supportive policies
- Technology providers who can advance scalable solutions
- Value chain partners who can integrate circular models seamlessly

Positioning ACG as a leader in redefining pharmaceutical packaging

ACG Pharmapack and other leading pharmaceutical packaging companies are positioning themselves as a frontrunner in redefining pharmaceutical packaging for a net zero future. Their initiatives clearly show that sustainability, compliance and profitability can go hand in hand—offering a blueprint for the wider industry. For instance, ACG Pharmapack's initiatives are:

- SBTi commitment (near term and net zero)
- Green aluminum and recyclable films adoption
- Bio-based solutions and renewable energy adoption

The call to action is clear: it is time for the pharmaceutical ecosystem to move beyond incremental change and embrace a bold, collaborative transformation in packaging. In doing so, the industry will not only safeguard the planet but also strengthen trust, resilience and long-term growth.

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