WHITE PAPER

GAPL 2

(Green Air Pharma Logistics)

FOCUS ON PACKAGING

Pharma.Aero
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Executive Summary

The pharmaceutical and Life Science sector is under intensifying pressure to minimize its environmental footprint without compromising on safety and regulatory compliance—particularly in the realm of global air cargo logistics. One frequently underestimated contributor to this impact is the tertiary packaging: the outermost layer that shields temperature-sensitive pharmaceuticals in transit.

In recognition of this overlooked opportunity, Pharma.Aero initiated GAPL 2—the second phase of the Green Air Pharma Logistics initiative—with a targeted emphasis on enhancing the sustainability of tertiary packaging. Building on the groundwork of GAPL 1, which focused on the airport-to-airport segment, and introduced the Lane Sustainability Readiness Index (LSRI), GAPL 2 aims to deliver tangible advances in packaging sustainability standards.

This phase involved active engagement with over 160 stakeholders across workshops, surveys, and value chain analysis to identify sustainable alternatives, assess lifecycle impacts, and develop a comprehensive sustainability assessment framework. This framework empowers logistics actors to evaluate packaging solutions holistically—considering environmental metrics such as carbon footprint, water consumption, reusability, and recyclability.

Seamlessly integratable with the LSRI, the framework serves as a decision-support tool for pharmaceutical manufacturers, freight forwarders, and airport operators. The findings underscore that sustainable packaging is a shared responsibility across the ecosystem. Suppliers must invest in innovative materials, buyers must embed environmental metrics into procurement strategies, and logistics providers must develop scalable reverse logistics systems.

Ultimately, GAPL 2 affirms the industry's ability to meet climate goals, reduce SDG 3 emissions, and co-create a circular future by embedding sustainability into packaging strategies. It highlights that environmental stewardship in pharma logistics is no longer a competitive advantage, but a necessary evolution toward global health and environmental responsibility.

Liew Zhong Yao, Vice-Chair, Pharma.Aero Board of Directors
Frank Van Gelder, Pharma.Aero Secretary General

2 Introduction

The pharmaceutical and Life Science sector, while fundamentally dedicated to improving global health outcomes, faces growing scrutiny for its significant contribution to carbon emissions. Increasing global climate regulations, coupled with resource scarcity, are placing additional pressure on the industry to reevaluate its environmental footprint—particularly within its logistics and supply chains.

In response to this challenge, Pharma.Aero launched the Green Air Pharma Logistics (GAPL), a suite of projects aimed at advancing sustainability in pharmaceutical air cargo. Following the foundational work of GAPL 1—which introduced the concept of a "green air lane" and developed standards for measuring lane's sustainability readiness—GAPL 2 shifts focus to another critical area, the tertiary packaging. This outermost layer, essential for safeguarding product integrity during transport, offers a high-impact opportunity for sustainable improvement.

GAPL 2 explores how the industry can balance packaging performance with measurable environmental benefits. The project emphasizes the importance of cross-functional collaboration, engaging stakeholders across the value chain—including manufacturers, logistics providers, airlines, and airport authorities—to develop assessment criteria that support environmentally responsible packaging decisions without compromising regulatory or operational standards.

This White Paper presents the findings of Pharma.Aero GAPL 2 project, offering actionable insights into sustainability trends, material selection, and integration with the Lane Sustainability Readiness Index (LSRI). It serves as a practical guide for decision-makers across procurement, supply chain, sustainability, and R&D roles, all of whom play a vital role in shaping the future of sustainable pharmaceutical logistics.

Problem Statement:

Enhancing Sustainability in Tertiary Packaging for Pharmaceutical Air Cargo

Tertiary packaging plays a critical role in safeguarding life science products during air transport by ensuring integrity and regulatory compliance. However, this essential layer—used for handling, stacking, and protecting shipments—also carries a significant environmental footprint. With rising regulatory pressures and corporate sustainability goals, the pharmaceutical air cargo industry is increasingly focused on reducing the environmental and operational impacts of tertiary packaging.

This paper sets the stage for understanding the key sustainability challenges, current packaging types, emerging innovations, and systemic value chain impacts of tertiary packaging in the pharmaceutical logistics landscape.

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3.1

Environmental & Operational Challenges

Environmental Impacts

Tertiary packaging generates emissions and waste at multiple lifecycle stages:

PRODUCTION

Virgin materials such as plastic, cardboard, and wood demand energy- and water-intensive manufacturing processes, contributing to high carbon footprints.

TRANSPORT

Heavier packaging materials like wooden crates significantly increase air cargo emissions, while lighter options such as corrugated cardboard offer lower-impact alternatives. However, cold chain logistics necessitate multiple protective layers, further increasing weight and complexity.

END OF LIFE

Many tertiary materials, especially plastics, pose long-term waste management challenges due to poor recyclability and lack of recovery infrastructure. Shrink wrap, insulation panels, and certain foams often end up in landfills.

3.1

Environmental & Operational Challenges

Operational Barriers

Pharmaceutical companies must juggle cost-efficiency, regulatory compliance, and performance standards, particularly in temperature-controlled logistics:

- High initial investment in sustainable alternatives and complex validation protocols slow down adoption.
- Strict distribution and packaging regulations demand validated temperature control, traceability, and real-time data monitoring (e.g., using ISTA standards).
- Regulatory frameworks such as the EU's Packaging and Packaging Waste Regulation (PPWR) are introducing binding targets for recyclability and waste reduction, creating compliance pressure.

3.2
Landscape of Tertiary Packaging Solutions

Traditional Packaging Types

Cardboard Boxes: Recyclable but prone to contamination and energy-heavy to produce.

Shrink Wraps & Films: Lightweight but rarely recycled.

Wooden Pallets: Reusable but contribute to deforestation and increase emissions due to bulk.

Temperature-Controlled Solutions

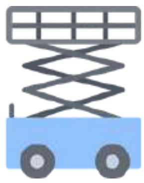
Active Systems: Electrically powered containers with precise cooling; high energy use.

Passive Systems: Insulated boxes with gels, dry ice, or PCM; lower emissions but energy-intensive pre-conditioning.

Airfreight Consumables

Cargo nets, straps, corner protectorsand thermal blankets ensure shipment safety and insulation. While some items are single-use, many can be reused via closed-loop systems if effectively managed by airlines.

Unit Load Devices (ULDs)



ULDs are aircraft-standard containers designed for repeat use and optimized air cargo efficiency. Constructed from durable materials like aluminum or composites, they reduce packaging waste but require logistical oversight and repair infrastructure.

3.3 Innovations Driving Sustainability in Pharmaceutical Logistics

Smart Technologies

- Sensors embedded in packaging help monitor temperature, humidity, and shock, improving compliance and reducing the need for excess insulation.
- AI-powered optimization tools improve packing density, material efficiency, and route planning—minimizing emissions and waste.

Material Innovations

- Bio-based & biodegradable options (e.g., mycelium, seaweed, plant polymers) reduce dependence on fossil fuels and enable compostable packaging.
- Advanced lightweight composites and aerogels enhance insulation while lowering shipping weights.
- Smart materials support product tracking and protection through embedded technology.

Reusable and Recyclable Consumables

Developments in biodegradable plastics, recycled content, and reusable airfreight accessories (e.g., thermal blankets) are gaining traction, offering scalable paths to circular packaging systems.

3.4 Systemic Impacts and Value Chain Considerations

Sustainability in tertiary packaging cannot be addressed in isolation. Each lifecycle phase presents unique challenges and trade-offs.

Phase	Key Considerations
Design	Tailored solutions enable functionality but complicate standardization and compliance.
Material Selection	Lightweight and recyclable materials are preferred but may be costly or hard to source.
Production	Localized, efficient production helps, but inconsistent global regulations pose barriers.
Distribution	Centralized reuse hubs aid logistics but return cycles remain costly and inefficient.
Repair & Reconditioning	Modular containers can be refurbished, but managing returns across global routes is challenging.
Waste Recovery	Collection systems exist but are inconsistent; small-unit recovery is often unviable.
Recycling & Next Use	Reintegrating recovered materials supports circularity but is constrained by regulations.

4 Analysis and Research Findings

4.1 Methodology Overview: A Three-Phase Approach

01. Baseline Phase

- **Qualitative Research & Desk Study**: Reviewed global best practices and challenges in sustainable packaging from academic, industry, and regulatory sources
- **Stakeholder Survey**: Targeted questionnaire collected insights from Pharma.Aero members on sustainability maturity across the packaging lifecycle.
- **Value Chain Workshop**: 75 participants mapped key sustainability touchpoints and challenges in packaging.

02. Exploration Phase

- **PLMC 2024 Workshop (Dallas Fort Worth)**: 163 air cargo stakeholders participated in structured, rotating group discussions to explore key "How Might We?" challenges, understand the current value chain opportunities and identify actionable sustainable strategies.

03. Deployment and Verification Phase

- **Best Practices & Life Cycle Insights:** Sector-wide Life Cycle Assessments (LCA) informed the development of a sustainability assessment framework.
- **Industry Interviews:** Insights from leading packaging providers helped shape criteria and evaluation questions for decision-makers.
- **Final Workshop:** Decision-makers from across the value chain validated key sustainability indicators for procurement, contributing to a unified evaluation grid.

4.2

Key Outcomes: Toward a Practical Framework

SUSTAINABILITY CRITERIA FRAMEWORK:

A data-driven evaluation tool was developed, integrating economic, ecological, and operational metrics such as material impact, carbon footprint, water usage, and end-of-life viability.

INTEGRATION INTO LSRI:

The refined criteria were designed for inclusion in the Lane Sustainability Readiness Index (LSRI), enabling air cargo stakeholders to assess and benchmark route-level packaging sustainability.

DISSEMINATION STRATEGY:

Findings were consolidated into a Technical Report for Pharma.Aero members, with a publicly available White Paper to encourage broader industry engagement.

GAPL 2 Assessment Framework:

Leading indicators and sub-indicators for sustainability assessment of tertiary packaging

01
- Corporate Sustainability Strategy
- Circular Economy Initiatives
- Corporate Sustainability Governance & Management

02
- ESGrelated Certifications
- ESG Assessment scores
- Waste Commitment
- UN Global Compact

03
- Emissions and Climate
- Circular Inflow
- Energy Consumption
- Water consumption

04
- Material Efficiency
- Reusability

05
- Emissions and Climate
- Circular Inflow
- Energy Consumption
- Water consumption

06
- Traceability rate of returned product
- Recovery rate of returned product

The complete framework is detailed in the GAPL 2 Technical Report, which is available exclusively to Pharma.Aero members.

5 Conclusion and Path Forward

Sustainable tertiary packaging for pharmaceutical air cargo sits at the intersection of environmental responsibility, operational feasibility, and strict regulatory compliance. While current systems remain highly reliant on virgin and single-use materials, innovations in smart packaging, AI, and eco-friendly materials offer a promising future.

To drive meaningful change, stakeholders must:

- Collaborate to develop standardized, reusable packaging systems.
- Invest in reverse logistics and recovery infrastructure.
- Align material and process choices with upcoming regulatory frameworks.
- Benchmark practices across other industries to scale innovation.

With clear visibility across the value chain and alignment on long-term goals, the industry can transition toward packaging solutions that are not only compliant and cost-effective but also significantly more sustainable.

5 Conclusion and Path Forward

Enabling a Sustainable Future for Pharmaceutical Air Cargo Through Circular Packaging Innovation

The GAPL 2 project marks a significant milestone in the journey toward more sustainable pharmaceutical logistics, with a focused lens on tertiary packaging. Recognizing the environmental, operational, and regulatory challenges associated with conventional packaging practices, this initiative underscores the urgent need to embed sustainability into every aspect of the life sciences supply chain.

A key advancement from GAPL 2 is the development of a Tertiary Packaging Sustainability Assessment Framework, which can stand alone or integrate seamlessly into the Lane Sustainability Readiness Index (LSRI) established in GAPL 1. This integration empowers logistics stakeholders—including manufacturers, forwarders, and airlines—to assess the environmental impact of packaging choices more holistically. It adds a critical dimension to lane risk assessments by factoring in packaging sustainability, which can vary depending on the airline or the sustainability rating of a transit hub.

By incorporating packaging considerations into the LSRI, stakeholders are equipped with a robust tool that supports greener decision-making and aligns with Scope 3 emissions reduction goals. This is particularly crucial as the pharmaceutical industry faces increasing regulatory pressure and a growing mandate to uphold environmental responsibility alongside product integrity.

The key message emerging from this work is that sustainability must be a shared responsibility. Packaging solution providers have already demonstrated leadership through innovations such as lightweight materials, reusable systems, and closed-loop logistics. However, scaling these efforts requires a coordinated, ecosystem-wide approach. Manufacturers must integrate sustainability into procurement decisions, logistics service providers must optimize reverse logistics, and airports must support infrastructure for returns and reuse. Regulatory bodies, in turn, play a pivotal role in incentivizing sustainable practices.

To further drive transformation, several spin-off opportunities have been proposed:

- A data-driven mutualized platform for packaging optimization, traceability, inventory management, and emissions tracking.
- A repository of industry best practices, serving as a knowledge hub to foster collaboration and accelerate innovation.
- Adoption of international circularity standards such as the ISO 59040 Product Circularity Data Sheet (PCDS), offering structured, reliable data sharing.
- A Food & Farm for Health initiative, linking the life sciences and perishable goods sectors to optimize trade lanes with dual-purpose logistics flows.
- Reverse logistics for unused medicines, integrating it with reusable packaging systems to minimize waste and maximize efficiency.

Together, these efforts form the foundation for a circular and resilient pharmaceutical logistics ecosystem. As the industry continues to evolve, Pharma.Aero remains committed to refining the LSRI, ensuring its relevance and effectiveness in driving impactful, measurable, and collaborative sustainability practices.

In summary, the GAPL 2 project not only highlights the importance of sustainable tertiary packaging but also lays out a practical, forward-looking roadmap. Through collective action, shared innovation, and continuous improvement, the pharmaceutical air cargo industry can significantly reduce its environmental footprint while ensuring the reliable, safe, and efficient delivery of life-saving therapies around the world.

6 Call to Action: Making Sustainable Tertiary Packaging the New Standard in Pharma Logistics

To achieve meaningful sustainability in pharmaceutical air cargo, all stakeholders must take coordinated action—starting with how tertiary packaging is selected and assessed. This initiative calls for cross-functional collaboration between procurement, logistics, and CSR teams to move beyond price-driven decisions. Instead, packaging choices must balance cost, performance, and environmental responsibility.

We urge procurement and operations teams to:

- Adopt a structured assessment framework based on lifecycle principles—considering climate impact, resource efficiency, reuse potential, and end-of-life circularity.
- Integrate sustainability metrics into procurement decisions with a balanced weight (e.g., 40/40/20 for quality, cost, and CSR), enabling long-term gains in emissions reductions and packaging innovation.
- Engage with suppliers transparently, using a standardized indicator grid to evaluate each packaging solution—not just the provider—on key environmental and operational metrics.
- Prioritize 'must-have' sustainability indicators for harmonized evaluations, while also exploring 'nice-to-have' criteria for more advanced assessments tailored to specific supply chain needs.
- Align on operational inputs—from volumetric weight to transport modes and lane risks—to ensure solutions are both effective and sustainable in real-world conditions.

We also call on packaging providers and industry partners to:

- Provide clear, data-backed sustainability profiles for each packaging solution, including lifecycle assessments, ESG certifications, and commitments to circularity.
- Support reverse logistics and end-of-life optimization, ensuring reuse and recycling are practical, scalable, and measurable.

6 Call to Action:
Making Sustainable Tertiary Packaging the New Standard in Pharma Logistics

Finally, we encourage all participants in the pharma air cargo ecosystem to:

Use the GAPL Tertiary Packaging Sustainability Assessment Framework to compare, benchmark, and improve their packaging strategies.

Contribute to and benefit from shared industry best practices, standards, and tools that advance collective progress toward climate goals.

The time for incremental change has passed. Let's drive bold, measurable action—together—to make sustainable tertiary packaging the new norm in pharmaceutical logistics. The health of our planet and the resilience of our supply chains depend on it.

6 Acknowledgements: Contributors and Participating Companies

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This White Paper is based on the more comprehensive and detailed technical report on GAPL 2 Tertiary Packaging project, which presents the findings of in-depth research supported by a wide range of scientific literature and industry sources. The technical report offers a deeper exploration of the subject and is available exclusively to Pharma.Aero members.

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