HORIZON-CL6-2021-CIRCBIO-01
Innovative solutions to over-packaging and single-use plastics, and related microplastic pollution (IA)

BUDDIE-PACK

Business-driven systemic solutions for sustainable plastic packaging reuse schemes in mass market applications

Starting date of the project: 01/09/2022
Duration: 42 months

= Deliverable: D8.5 =

Buddie-Pack input on market watch information

Due date of deliverable: 31/08/2025
Actual submission date: 10/09/2025

Responsible WP: Gemma Cornuau, WP8, ACTIA
Responsible TL: Wilfried Paget, ACTIA
Revision: V3.1

Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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DOCUMENT HISTORY

Document version	Date	Change
V1	25.06.2025	Partner info template
V2	21.07.2025	First draft
V3.0	21.08.2025	Second draft, based on IPC review
V3.1	09/09/2025	Final version for review, integrating ASEVI, IPC, Searious Business and Dawn meats comments

DOCUMENT APPROVAL

Reviewers		Validation date
Work Package Leader	Gemma Cornuau	09/09/2025
Coordinator	Florence Isnard	10/09/2025

DOCUMENT DATA

Keywords	Reusable plastic packaging, Logistics, Traceability, Regulatory framework, Economic viability, Market trends
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Delivery date	09/09/2025

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Acronym description

GA	Grant Agreement
WP	Work Package
BiB	Bag-in-Box
B2B	Business-to-Business
B2C	Business-to-Consumers
EPR	Extended Producer Responsibility
LCA	Life Cycle Analysis
LCCA	Life Cycle Cost Analysis
NFC	Near-Field- Communication
PPWR	Packaging and Packaging Waste Regulation
QR	Quick Response
RFID	Radio Frequency Identification
RVM	Reverse Vending Machine
SUP	Single-use plastic

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Executive Summary

This deliverable summarises market conditions, key actors and trends relevant to reusable plastic packaging (RPP) systems in Europe, drawing on inputs from BUDDIE-PACK pilot partners and complementary deliverables. It maps the main stakeholders across the reuse value chain, manufacturers, food and non-food producers, retailers, logistics operators, washers and digital traceability providers and analyses their roles, interdependencies and infrastructure needs. Although policy momentum is increasing, packaging reuse still represents less than 3 % of packaging flows in the EU, constrained by high upfront investments, lack of interoperable infrastructure and consumer behaviour challenges that reduce return rates.

The BUDDIE-PACK pilots show that innovative approaches—durable packaging formats, advanced decontamination and washing systems and digital traceability platforms—can provide viable alternatives to single-use packaging, especially in closed-loop or institutional settings such as catering, schools and elderly homes. Wider uptake in more fragmented sectors will depend on harmonised standards, clear regulatory frameworks and financial incentives, combined with user engagement and collaboration across the value chain. By addressing these barriers and demonstrating practical use cases, BUDDIE-PACK helps pave the way for mass-market deployment of reusable packaging systems and strengthens the transition towards a circular, resource-efficient economy.

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1. Introduction

This deliverable has been prepared using a combination of sources. It is primarily based on feedback collected through questionnaires completed by the pilot partners Dawn Meats, Asevi, Ausolan, and Vytal. Their inputs provided practical insights into market conditions, challenges, and opportunities for reuse systems. In addition, relevant extracts from Deliverable 4.2 (section 4.8 *Scalability of Buddie-Pack use cases*) and Deliverable 1.1 (*Regulatory update*) were incorporated to complement the analysis with perspectives on scalability and the evolving regulatory framework.
The document is structured into four main sections. The first part identifies the key economic stakeholders involved in packaging reuse systems and their respective roles along the value chain. The second part analyses the competition context and assesses the economic viability of reuse models in comparison with single-use alternatives. The third section highlights market trends and innovations, including consumer demand, stakeholder feedback, and technological solutions identified during the project. Finally, the report concludes with an overview of the main findings and their implications for scaling reuse systems in mass-market applications.

2. Reuse economic stakeholders

2.1. Reuse stakeholders

The **reuse packaging economy** relies on a diverse and interdependent network of economic stakeholders, each contributing specific functions and competences. These stakeholders can be grouped into the following key categories:

1. **Scientific community:** Research institutions that provide expertise on materials, hygiene, consumer behaviour, and environmental impacts, supporting the safe and scalable deployment of reuse systems. As an example in BUDDIE-PACK's consortium: IPC, LNE, CTCPA and AIMPLAS are considered being part of the scientific community.
2. **Packaging manufacturers:** companies that design and produce reusable packaging such as trays, bottles, and Bag-in-Box formats, ensuring durability, regulatory compliance, and reusability, such as:
   - **SMURFIT WESTROCK BAG-IN-BOX:** provider of Bag-in-Box containers for refillable detergent solutions
   - **Knauf Industries:** producer of reusable food packaging formats (e.g., trays and rigid containers)
3. **Food and non-food manufacturers:** producers that fill reusable packaging with food products and adapt processes to ensure hygiene, freshness, and supply chain compatibility. They are represented by **DAWN MEATS**, meat processor piloting semi-rigid reusable skin packaging case study, **AUSOLAN,** private caterer using reusable trays in schools and elderly homes and **ASEVI,** manufacturer of home and personal care detergents, testing Bag-in-Box formats combined with in-store dispensing systems.
4. **Retailers :** businesses that offer reusable packaging to consumers through supermarkets, refill stations, or takeaway counters, and facilitate return and collection. This type of stakeholder is not directly part of BUDDIE-PACK, but is contracted with for the sake of the demonstration phase, as Hyper U – La Chapelle sur Erdre (France).
5. **Reuse operators:** they are versatile, they can provide reverse vending machines, take care of the packaging traceability and overall logistics of the reuse loop, such as **Vytal,** operator of a digital reuse platform with QR-code tracking and deposit systems and **Uzaje**, reuse-as-a-service provider managing return logistics and washing for B2B and B2C

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6. **Washers:** facilities or service providers responsible for cleaning and sanitizing reusable packaging in compliance with food safety or hygiene requirements. **Uzaje and ETERNITY SYSTEMS** operate centralized washing hubs for both B2B and B2C applications.
7. **Waste management service providers :** actors who collect and manage packaging waste, including the recovery or disposal of reusable containers that are damaged or not returned. Their activities will vary from country to country depending on the existing sorting and recycling infrastructures. They are not beneficiaries of BUDDIE-PACK, but partners interact with local waste management services for container recovery and end-of-life processes and CITEO in France.
8. **Logistics operators:** organizations that transport full and empty reusable packaging between stakeholders, including return flows, warehousing, and consolidation. This stakeholder is not part of BUDDIE-PACK's consortium.

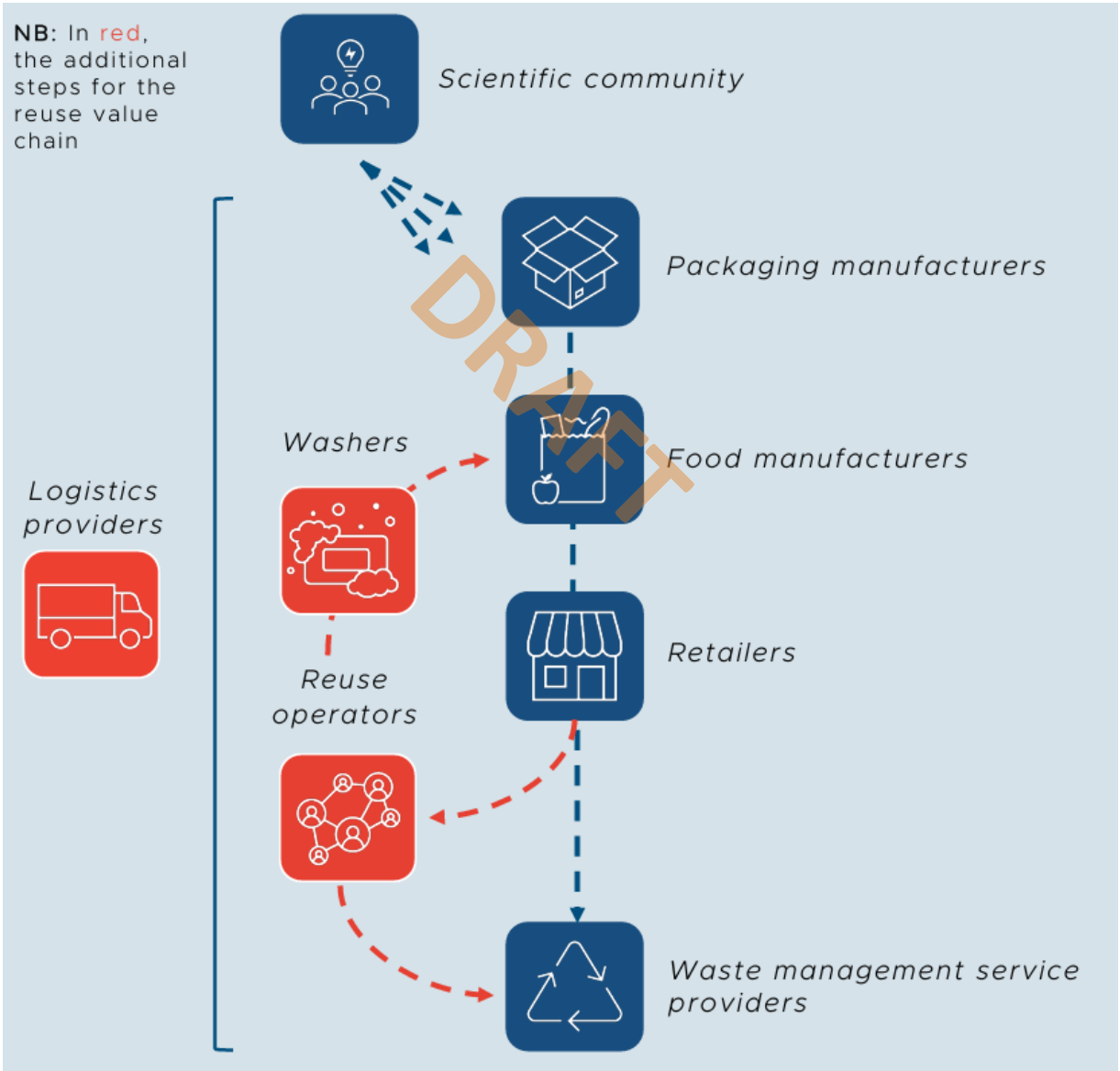

Figure 1: Reuse value chain (Source: R3PACK, D7.2 Business plan)

2.2. Infrastructure and operations

Infrastructure remains a central enabling factor for the successful deployment of reuse systems. Across all five BUDDIE-PACK use cases, the availability, cost/benefit and configuration of logistics, cleaning, return mechanisms, and digital tracking determine whether a reuse model is operationally viable.

In institutional catering, much of the necessary infrastructure is already in place. Many providers, such as AUSOLAN, operate professional cleaning lines on-site, which allows them to sanitize reusable containers without needing external partners. This closed-loop environment—where meals are prepared, served, and returned within a single facility—offers a stable foundation that could be further developed and adapted to accommodate other materials, such as reusable plastic packaging and to implement a traceability system. Buddie-Pack D4.2 depicts Ausolan case as the most promising early adoption market due to closed-loop control.
In contrast, sectors like takeaway food, meat distribution, and detergent sales face more fragmented infrastructure landscapes. In urban takeaway scenarios, the introduction of smart return bins and reverse vending machines (RVMs) in supermarkets and public spaces has shown promise, particularly in cities where deposit systems are already familiar which is the case in Germany. VYTAL and UZAJE have tested public return points and are exploring partnerships with retailers to facilitate container recovery. For supermarkets, such machines are typically offered on a rental basis, which represents an additional but manageable operating cost compared to outright purchase.
Digital traceability systems are emerging as another key component. Platforms that allow containers to be scanned and tracked—either via QR codes or RFID tags—can support **better return rate monitoring,** cleaning compliance, and inventory management. The adoption of standards aligned with the Global Alliance to Advance Reuse (PR3), as well as internationally recognized GS1[1] standards for product identification and data sharing, is seen as a way to improve interoperability and cost efficiency. However, setting up these systems comes at a cost, and stakeholders note that they are only financially viable at scale. Smaller operators often lack the resources to invest in traceability tools. Indeed, the cost of implementing traceability systems varies widely depending on the technology and scale (see Table 1 below). A detailed analysis of the different solutions has been already done in deliverable 4.1.

Barcode scanner	20 - 30 €
QR code scanner	30 - 60 €
RFID tag	0.08 - 0.15 €
RFID scanner	20 -200+ €
NFC tag	0.1 - 1 €
NFC Scanner	40 – 50+ €

Table 1: Approximate costs of different technologies (Source: Buddie-Pack, Deliverable 4.1)

[1] GS1 is a global, non-profit organization that develops and maintains internationally recognized standards for product identification, data capture, and information sharing across supply chains. These standards, including barcodes, QR codes, and RFID tags, enable businesses to uniquely identify products, track their movement, and share critical information efficiently and accurately.

3. Competition and economic viability

3.1. Reuse market share

Despite growing policy momentum and environmental awareness, the **actual rate of packaging reuse in the EU remains under 3%**, with estimates like **2.2% in France** (ADEME, 2023) and **1.1%** for consumer packaging, highlighting the **persistent gap** between ambition and implementation. The slow adoption of reuse systems in the packaging sector can be attributed to a combination of **structural, economic, behavioral, and regulatory factors**, outlined below.

For decades, packaging systems have been designed for **linear, disposable use**, optimized for efficiency and low upfront costs. Industrial ecosystems, machinery, and distribution channels are deeply embedded in the single-use logic. This legacy makes it difficult and costly for companies to pivot toward reuse without **fundamental changes to business models.** Setting up reuse systems requires **investment in return logistics, cleaning facilities, digital traceability, and packaging durability**. These components often lack scale and standardization, especially across borders. The **absence of shared or pooled infrastructure** makes unit costs for reusable packaging challenging to compete when compared to disposables, particularly in low-margin sectors such as food retail or take-away (Zero Waste Europe, 2022).

B2C reuse models depend heavily on **consumer behavior**: remembering to return packaging, understanding deposit systems, and accepting new routines. Surveys (e.g., Rethink Plastic Alliance, 2022) show that while public support for reuse is high in theory, actual return rates in trials are **highly variable and often below the 90% threshold** needed to ensure environmental and financial viability. Barriers include **inconvenience, lack of clarity, or return points being too dispersed**.

Until the adoption of the **Packaging and Packaging Waste Regulation (PPWR) in 2024**, most EU-level legislation offered only **soft encouragement** for reuse, without binding targets or harmonized standards. National laws (e.g., France's AGEC - aiming to increase the proportion of reused packaging compared to single-use packaging, setting new targets to be achieved: 5% of reused packaging placed on the market in France in 2023; 10% in 2027 -, Spain's Law 7/2022) have taken early steps, but uneven implementation across Member States has left many businesses unsure of which investments are future-proof. Furthermore, **extended producer responsibility (EPR) schemes** still largely reward recycling over reuse.

Reusable packaging must often be tracked, washed, and reused across multiple partners or regions. However, the sector lacks **harmonized designs, sizes, materials, and tracking systems**. Without such interoperability, reuse systems remain **fragmented and inefficient**, making it difficult to scale across retailers or product categories (R3PACK, 2023).

Even when technically reusable, packaging formats face strong price competition from cheap, recyclable single-use alternatives—particularly plastics. These lighter formats are cheaper to transport and conceal their true cost by shifting waste management and environmental impacts onto society. Recycling still dominates as the "default circularity model," leading many brands to favour recyclability over reuse despite the latter's higher environmental benefits (Ellen MacArthur Foundation, 2021). A study[2] by the Joint Research Centre of the European Commission and the Technical University of Denmark estimates that the societal cost of the EU waste management system—including both direct costs and monetised environmental externalities—amounts to about **68€ per tonne of waste**, or roughly **136€ billion annually (304€ per citizen)**.

3.2. Present competitors

The competition landscape for reuse stakeholders remains highly challenging. Despite regulatory momentum, packaging reuse represents less than 3% of the EU market, with disposable formats still dominating due to their lower unit costs and established infrastructure. Reuse operators, washers, and logistics providers must compete

[2] Comprehensive assessment of environmental and economic impacts of the entire EU waste management system (2025)

against single-use packaging manufacturers that benefit from decades of optimization and economies of scale. Fragmentation of reuse systems—caused by the lack of harmonized designs, materials, and traceability tools—further limits interoperability and scalability, raising costs for both businesses and consumers. Moreover, for companies, recyclable single-use plastics are often perceived as a cheaper "circular" alternative, diverting investment away from reuse. In this context, reuse stakeholders face not only cost competition from single-use models but also behavioural competition, as high consumer return rates are essential for viability yet difficult to achieve consistently.

Please find below the competition context by sector for reuse stakeholders in the different use cases:

- *Use cases 1 and 2 : Institutional catering (Ausolan, reusable trays)*

Competitors: single-use food trays (aluminium, cardboard, plastic) widely available and cheap; disposable systems are already embedded in public procurement and logistics. Reuse trays face competition on price and convenience, despite offering environmental benefits.

- *Use cases 3 and 5: Take-away food (Vytal, Uzaje)*

Competitors: Low-cost disposable cups, boxes, and cutlery—often recyclable or marketed as compostable—dominate the market. Although compostable cups are typically **30more expensive** than conventional plastic versions, their convenience and ubiquity still create strong behavioural and economic competition for reuse systems. In addition, major delivery platforms (e.g. Deliveroo, Uber Eats) are piloting their own reuse schemes, adding direct competitive pressure on independent reuse operators.

- *Use case 4: Meat distribution (Dawn Meats, reusable semi-rigid skin packs)*

Competitors: vacuum-sealed and plastic-wrapped formats optimized for shelf-life and logistics. These single-use solutions are cost-efficient, standardized, and backed by strong supply chains. Reuse formats struggle to reach price parity without scale.

- *Use case 6: Detergent / homecare (Asevi, Bag-in-Box refills)*

Competitors: conventional single-use plastic bottles, optimized for automated filling and large-scale distribution. Reuse/refill solutions compete with "eco-labelled" single-use packaging (e.g., recycled PET) promoted by big brands, which are cheaper to deploy and align with current consumer habits.

- *Reuse logistics and washing services (Uzaje, Eternity Systems)*

Competitors: traditional waste management and recycling companies, which benefit from existing infrastructure and subsidies under Extended Producer Responsibility (EPR) schemes. These actors can process disposables at scale, whereas reuse operators must still build dedicated return and washing networks.

3.3. Costs and business model

The financial viability of reuse systems is heavily influenced by the costs of cleaning, logistics, container durability, and consumer engagement. In the early stages of deployment, these costs are obviously often higher than those of single-use systems, particularly when infrastructure must be built from scratch (Buddie-Pack deliverables 1.1, 4.1, 4.2 and 4.3).

Due to new calculations, this is actually no longer true. check updated report: In the scenario presented, the reuse system becomes more cost-effective than the current single-use packaging after approximately 3 years and delivers cost saving of 4,24% after 10 years.

The calculated average return before EoL are 13.9 reuse cycles per packaging unit

For DAWN MEATS, the reuse system becomes more cost-effective than current single-use packaging after approximately three years, delivering cost savings of 4.24% after ten years, with an average of 13.9 reuse cycles per packaging unit before end of life. The company also recognises that economies of scale and the potential to serve high-volume clients such as fast-food chains could further strengthen the business case. AUSOLAN notes that while cleaning and transport of reusable containers increase operational costs, the company can reduce its plastic tax liabilities under Spanish law. Furthermore, clients increasingly consider the environmental performance of service providers as a selection factor, suggesting **that brand value may partially offset direct financial costs.**
In the detergent sector, ASEVI reports that setting up refill stations and adapting backend logistics for reusable bulk packaging remains expensive and unattractive without clear commercial incentives. The upfront investment required for dispensing machines and bulk refill containers often exceeds the capacity of individual retailers, particularly smaller stores. For a single manufacturer, a dedicated machine is indeed rarely profitable because even large stores do not sell enough units of one brand to recover the investment. Conversely, sharing a machine across several products or competing brands could improve utilisation rates but risks commoditising the products and diluting brand identity.
Eco modulation of Extended Producer Responsibility (EPR) fees is seen as a critical policy tool for shifting this balance. **Stakeholders advocate for higher fees on single-use packaging** and **reductions or exemptions for certified reuse systems**. Financial incentives that support early investment—such as transition grants, low-interest loans, or shared infrastructure subsidies—could also reduce the perceived risk and encourage broader uptake.
Public procurement incentives are a powerful lever to accelerate the adoption of reusable food packaging across Europe. By integrating criteria that favour reuse in tender specifications—such as minimum share of reusable packaging or supplier take-back obligations—public authorities can stimulate market innovation and scale. The Packaging and Packaging Waste Regulation (PPWR, Regulation (EU) 2025/40), in force since February 2025, explicitly identifies Green Public Procurement (GPP) as a key tool to incentivise the supply and demand for sustainable packaging by specifying minimum mandatory requirements for public contracts related to packaging or products and services using packaging.
Such incentives could also deliver tangible environmental and economic benefits. According to impact assessments from EU Commission, increasing reusable packaging could yield **EUR 1.62 billion in material cost savings** and **EUR 461 million in reduced waste management costs**, with even greater gains by 2040[3].

4. Trends/innovations

4.1. Market interest and demand

Market interest in reusable packaging is growing, however not equally across sectors and geographies. Institutional and B2B settings such as school canteens, elderly homes, and public catering services are showing the most immediate engagement with reuse models. In Spain, AUSOLAN has reported an increase in client inquiries focused on **sustainable food service solutions,** many of which now explicitly request **reusable formats** as part of tender specifications. This suggests that sustainability considerations are beginning to influence procurement behaviour, particularly within public institutions.
In Germany, the company VYTAL has experienced increased interest from **event organizers** and **municipalities** seeking to make festivals and street events **more environmentally responsible**. These venues are proving fertile ground for reuse systems due to their short and predictable return loops. However, consumer interest in daily-use takeaway packaging remains modest, with challenges around habit formation and convenience still acting as barriers to broader uptake.

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=SWD%3A2022%3A384%3AFIN&utm

In the homecare sector, interest in refill models remains limited in several markets. ASEVI, the project partner focusing on refillable packaging formats for detergent products, reports that in Spain there has not yet been a significant shift at retailer or customer level. However, this picture is not uniform across Europe: some supermarket chains in the UK (e.g. Aldi and others) are already experimenting with or offering refillable homecare products rather than food. packaging formats for detergent products, has not yet observed a significant shift at retailers or customers level. Nevertheless, the regulatory mandate requiring large retailers to dedicate shelf space to refill stations by 2030 is expected to create future momentum.

In the meat distribution sector, the introduction of reusable semi-rigid skin packs is still at an early stage. According to DAWN MEATS, market interest remains limited, though exploratory conversations with other meat processors have begun as a result of the BUDDIE-PACK initiative. These engagements are not yet leading to widespread adoption, but they suggest the potential for first-mover advantage if trials are successful and costs can be managed.

4.2. Consumer and user feedback

According to the partners investigations, feedback from end users and staff engaging with reuse systems under the BUDDIE-PACK project reveals a mixed but encouraging picture. Municipalities & retailers are among the most proactive in experimenting with reuse. In institutional settings, clients increasingly view the use of reusable packaging as a marker of environmental leadership. For example, AUSOLAN has noted that reuse not only satisfies regulatory expectations but also enhances its **competitive profile** in the catering market. Customers perceive these practices as aligning with broader sustainability goals and are beginning to value them as part of a service provider's brand offering.

At the operational level, staff have responded positively when reuse systems are simple and well-integrated into existing routines. In catering environments, where meals are prepared and consumed in the same facility, the transition to reusable containers has been relatively smooth. Staff involvement is often limited to scanning items in and out or placing them in designated return bins. However, where new routines must be learned, such as in the management of return logistics or handling of personal BYOC (Bring-your-own-container), **training and visual instructions** have proven essential.

In sectors where returns depend on external customers, such as meat packaging or takeaway food, stakeholders have expressed concern about low return rates. DAWN MEATS, for example, has highlighted scepticism about the likelihood of achieving return rates above 90%, which are necessary for financial viability (Buddie-Pack deliverable 4.1). These concerns are grounded in logistical realities, including **the need to store used packaging** until it can be collected or returned.

Despite these barriers, partners agree that user engagement improves with **targeted communication, signage, and educational support**. **Incentives** such as deposit refunds or loyalty rewards are expected to play an important role in shifting behaviour over time. ADEME studies also show reuse works where return logistics are **simple and predictable**. The challenge remains to balance convenience with accountability and to **build the cultural habits** necessary for reuse systems to function reliably at scale.

4.3. Innovations identified during the project

The BUDDIE-PACK project harnesses robust technological innovations to support reusable plastic packaging (RPP) at scale:

- **Design and material innovations**: deliverables D1.3 and D1.4 include detailed technical specifications, design rules to minimise contamination risks (D2.1 and D2.2), and new functional materials for RPP, ensuring durability up to at least 10 reuse cycles (D3.1 and D3.2).

- **Advanced cleaning and decontamination systems**: D5.1 delivers specifications for **decontamination equipment and technologies**, including a pilot-scale cleaning line capable of maintaining hygienic safety and functional barrier properties even after repeated use.
- **Traceability and digital integration**: The systemic approach – including business case assessments and value chain modelling – implies the deployment of **traceability mechanisms** (e.g., QR codes, digital tagging) coupled with **digital databases** to track packaging through multiple reuse cycles, ensure data integrity, and optimize logistics. This is supported by the robust digital strategies and assessment frameworks outlined in D7.1 and D7.2 (definition of metrics, LCA/LCCA screening, data collection standards).
- **Demonstration of automatic and scalable systems**: the project's six mass-market use cases include **bag-in-box refill systems**, **bulk dispensing models** (e.g., for detergent refills via Smurfit Westrock Bag-in-Box and ASEVI) and **in-store collection machines in supermarkets** (see Figure 2 below), suggesting innovative dispensing solutions that minimize single-use containers and facilitate user convenience.

Figure 2: In-store collecting machine from NoWW in a supermarket in France (Source: NoWW)

5. Conclusions

The analysis carried out in this deliverable highlights both the opportunities and challenges facing the deployment of reusable packaging systems in Europe. The market remains highly fragmented, with reuse models representing less than 3% of packaging flows, constrained by structural barriers such as high initial investment, lack of interoperable infrastructure, and consumer behaviour that limits return rates. Nevertheless, the case studies from BUDDIE-PACK demonstrate that innovative approaches—ranging from durable packaging designs and advanced decontamination systems to digital traceability tools and automated dispensers—can provide viable alternatives to single-use formats.

Economic viability will depend on achieving sufficient scale, supported by harmonized standards (e.g., GS1, PR3), clear regulatory frameworks (e.g., PPWR), and financial incentives such as EPR fee modulation or public procurement criteria favoring reuse. Consumer education and staff training will be key to change the mindset and at the same time, collaboration across the value chain—manufacturers, fillers, washers, logistics providers,

retailers, and reuse operators—remains essential to overcome fragmentation and deliver consistent, cost-effective solutions.

Overall, BUDDIE-PACK partners are contributing to building an integrated ecosystem that aligns technological innovation, market readiness, and regulatory drivers. By addressing barriers and demonstrating practical use cases, the project helps pave the way for scaling reusable packaging systems in mass-market applications, ultimately reinforcing the transition towards a circular and resource-efficient economy.

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