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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

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Acronym description

CAGR	Compound Annual Growth Rate
CSR	Corporate Social Responsibility
EPR	Extended Producer Responsibility
FMCG	Fast-Moving Consumer Goods
GA	Grant Agreement
NFC	Near-Field Communication
NGO	Non-Governmental Organisation
PPWR	Packaging and Packaging Waste Regulation
RFID	Radio Frequency Identification
SUP	Single-Use Plastic
WP	Work Package
QR	Quick Response

Executive Summary

Developments in market pressure are increasingly indicating the necessity for developing and progressing reusable packaging for food and home care products. Consumer pressure on brands and retailers is building and demands sustainable and reusable packaging alternatives. Evidence of waste pollution from single-use packaging is making its negative impact undeniable. Disposable packaging will likely end up in incinerators, pressurised landfills, and, unfortunately, our waterways. Regulatory development gives producers the responsibility to ensure that packaging is properly collected and recycled. The greatest challenge remains in international supply chains. Taxes on plastic materials, fees for waste management, and fines for pollution put the industry in an uncomfortable position.

While occasionally reusable packaging initiatives pop up in Europe, national reuse targets set a new challenge for reusable packaging: to be scalable at industrial level. Technological and logistical developments open new opportunities for professionalised reusable packaging and reuse systems. However, technology is only one aspect of creating a viable reuse system. Consumer action and influencing behavioural change are essential to its ongoing success. Prevailing reusable packaging pilots and start-ups can provide preliminary insights on the relevance of introducing consumers to new systems, the need for simplicity and convenience, and assurance of hygiene standards. Not only is effective engagement with consumers relevant to the success of reusable packaging, but also secondary users such as shop staff and kitchen personnel who need to be trained to understand new procedures.

The physical design of packaging both influences consumer engagement as well as being pivotal for functionality. Due to the long-life cycle and the packaging journey of reusables, the design must host a wide range of aspects to meet expectations.

Stakeholders of the industrial value chain in the BUDDIE-PACK use cases share their expected needs and constraints when developing reusable packaging solutions both on a functional- and operational level. Recommendations are provided on material choice, closure mechanisms, sizing, labelling, tracking and tracing, cleaning- hygiene measurements and food safety, communication, setting-up reverse logistic systems, and end-of-life handling and solutions.

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1. Introduction

This report provides a baseline picture of reusable packaging. It gives relevant indications for the development of packaging designs for six market applications considered in the scope of BUDDIE-PACK research, which are:

- Catering trays for schools and nursing homes
- Take-away packaging for restaurants and food services
- Meat-skin packaging
- Packaging for homecare loose goods in supermarkets
- On-the-spot food packaging for consumption in supermarkets
- Bag-in-box® for the distribution of antiseptics in a humanitarian context

Further information on the use cases can be found in section 3, *Introduction of use cases*.

Information in this report is dedicated to providing *T 1.3* with relevant information for developing *specifications for reusable packaging*.

The report, therefore, investigates three relevant areas to assess stakeholders' engagement along the value chain.

Firstly, recent developments in market pressures are examined and are linked to resulting consequences for the value chain.

Secondly, needs and constraints of the industrial value chain when switching to reusable packaging options are identified through insights into the use cases of the BUDDIE-PACK research consortium.

Thirdly, the consumers' level of reuse and users' expectations across the six market applications are considered.

In conclusion, a set of recommendations is provided that may be used for developing packaging- and packaging system design guidelines. Relevant functional properties and technical and economic requirements are indicated.

Scope of the report

For this report, primary data in the form of gathering qualitative information is used. Information provided in this report is based on business insights. For this, consortium members of the BUDDIE-PACK programme involved in the industrial value chain of use cases have shared their insights.

Furthermore, secondary data from grey literature reviews are utilised to provide insights into consumer behaviour. Further research and primary data collection to better understand consumer behaviour and the implications for packaging design will follow past the deadline of this report.

As the report was compiled in the first six months of the research, it only provides preliminary insights that may need further re-evaluation later in the BUDDIE-PACK research program.

Furthermore, no interviews with chain actors outside the BUDDIE-PACK consortium are conducted at this stage which might limit the insights of the report. However, the BUDDIE-PACK consortium members involved cover most value chain segments and can provide relevant insights.

2. Recent development in market pressures

Reusable packaging is probably the oldest concept in product delivery and has been used successfully for centuries, and still is well established in transport packaging. The preference for single-use household packaging only surged in the last few decades.

However, FMCG businesses are increasingly keen to capitalise on the \$10 billion opportunity presented by replacing 20% of single-use plastic packaging with reusable alternatives, highlighted in 2017 by the World Economic Forum and the Ellen MacArthur Foundation (EMF). The combination of legislative reuse mandates, the public's increased appetite for sustainability, innovations from technology and service providers, and bold brand commitments all point to significant growth in this area over the next 5 years. This section maps relevant developments in market pressures that impact the reusable consumer packaging sector. Market pressures come from various sources, such as economic & political, sociocultural, environmental, technological, and legal. As these pressures create a sense of urgency for industry players to change their packaging strategies, this analysis report specifically looks at recent developments. The past five years (from 2018 onwards) are considered as a benchmark.

The section highlights the various developments that create market pressure to either move towards reusable packaging or on reusable packaging systems themselves.

2.1. Environmental market pressures

According to [WWF](#), scaling up European reuse systems by 20% by 2027 would save 1.3 million tonnes of emissions, almost 2.5 billion cubic metres of water, and 10 million tonnes of materials annually. At 50% by 2030, these figures would rise to 3.7 million tonnes of emissions, 10 billion cubic metres of water, and 23 million tonnes of materials in Europe alone.

- WWF points out that reducing plastic waste should be the ultimate focus in the pursuit of sustainable packaging, and reuse systems should always complement other reduction strategies, which include cutting down on unnecessary packaging and entirely phasing out single-use plastics where possible.
- Some still question whether reusable packaging will prove to be more sustainable than business as usual. When deciding if reusable packaging is a more sustainable option, there are many factors to consider, including impacts from transport from use point to refill point, energy and water use during cleaning, and whether it can be recycled at the end of life. However, Zero Waste Europe reports that out of 32 LCAs comparing reusable and single-use packaging, 72% showed that reusable packaging was more favourable for the environment. Key parameters affecting the environmental impact of reusable packaging included production phase, transport (type, distance, weights, and volumes moved), number of cycles the packaging can make, and end-of-life options (recycling, incineration or landfill).
- While the paradigm of many companies has been “doing no harm” through their business operations, ethics are evolving. “Doing good” is the new maxim for companies. Reporting and showcasing sustainability efforts is becoming common practice amongst companies. Becoming climate-neutral or reaching net zero is almost obligatory for companies if they want not to be publicly reprimanded. As a result, companies feel pressured to create environmental and social benefits. 90% of all companies in the S&P 500 index publish annual CSR reports.
- Within the scope of EU member states, a growing number of companies are providing data on their environmental impact due to reporting requirements. Since 2013, the non-financial reporting directive (NFRD) has required companies to share their greenhouse gas emissions. Furthermore, an advanced version of sustainability reporting, the corporate sustainability

reporting directive (CSRD), was introduced at the end of 2022. From 2023 onwards, companies will have to report on ESG, including resource management and pollution.

Risk:

Increased pressure from environmental reporting and divergent methodologies for measuring environmental impact can create undesirable ambiguities. Loopholes for incorrect reporting are opened, and greenwashing becomes a risk. Some companies may want to avoid making real changes in their operations but still feel the pressure to report positive environmental impact. Methodologies that are open for interpretation can be used as a distraction.

Opportunity:

Companies are more open to investing in sustainability strategies and integrating and adjusting their business model towards sustainable practices. As a result, the barrier for companies to change is lowered.

2.2. Economic & political market pressures

In the face of the escalating climate crisis, the issue of plastic pollution and insufficient infrastructure to handle plastic waste has gained attention in recent years. Caused by inadequate counteractive measures, the advancing climate crisis is beginning to put severe pressure on economic systems. Through this, weak spots of linear systems surface. Increasing pollution due to insufficient waste treatment infrastructure is high on the agenda. Companies involved in putting plastics on the market will therefore become more and more pressured to disclose their environmental and social impacts, to have mitigation strategies to minimise plastic pollution, and regenerative goals to “do good”.

- True pricing and decoupling material inputs from growth are becoming part of circular economy modelling. External costs of plastic are calculated to be 1000\$ per tonne ([FairFin, 2021](#)). **Liability costs** for repairing ecosystem services threatened by plastic pollution and increased health issues linked to micro-and nano plastics are anticipated to escalate up to 400 billion US\$ annually in the US alone ([Minderoo Foundation, 2022](#)).
- In recent years, the impact of plastic waste exportation has been uncovered and is justifiably criticised as a relocation of the problem. This will be addressed in upcoming regulations.
- Within the last two years, the first lawsuits on plastic pollution against FMCG giants have been brought forward. Lawsuits against FMCG giants are not only pressuring companies themselves but are also damaging their image. This may be a relevant factor for investors withdrawing from investment deals ([FairFin, 2021](#)). As a result, plastic packaging has become a risky investment sector.
- Legislative tools aiming to restrict plastic waste production and financing waste management create economic pressure on packaging producers and users.
 - EPR fees: The polluter pays principal is also being introduced in Extended Producer Responsibility frameworks across Europe. The costs of waste management, including cleaning up littered waste, are factored into EPR fees (see here as an example the [Dutch Single-Use-Plastic legislation](#)). For recyclable packaging, an eco-modulated fee applies: recyclable packaging will receive a positive financial incentive.

- Plastic tax: As part of the EU Green Deal to cut waste and CO2 emissions, the Plastic Tax (2021) has been introduced to levy non-recyclable plastic packaging at 0,80 cents per kg. Member states are obliged to contribute. However, how they collect the money internally is arbitrary. Many member states have, therefore, introduced national plastic taxes to be paid by manufactures and sellers. Reusable packaging is often excluded from such a tax (such as in Spain), making it attractive for businesses to switch.
- The **war in Ukraine** is impacting the world, particularly Europe, in several ways. The advancing economic crisis is putting financial strains on consumers. Basics such as food and energy are increasing in price due to supply chain difficulties from Ukraine and Russia. The rising prices of oil and gas have also led to higher costs for transport and production, leading to inflation of approx. 10% across Europe (by October 2022). People adopt austerity measures as a result.
- Geo-political developments immensely impact oil prices, which is reflected in increased plastic resin prices. Not only are rising prices an issue, price volatility is also unsettling producers. Influenced by turbulence in the market price of virgin materials, recycle prices are also unstable and on the rise. Reusing materials and steering away from the dependency on input materials through short product cycles becomes a hands-on solution.
- Further economic pressure comes from the non-recyclability of most packaging in FMCG. In the past years, the development of lightweight packaging has been the focus of most companies to reduce costs. The result is an increase in hard-to-recycle packaging and single-use options. In fact, in Europe's current recycling status, less than 40% of plastics are effectively recycled. Non-recyclable plastic waste is becoming expensive. Since 2021, each tonne of non-recyclable plastic waste has to be remunerated with 0,80 cents per kg for EU member states ([EU Commission, 2021](#)). Combined with upcoming mandatory recycling standards, the insufficient **availability of recycled feedstock** accelerates market prices, adding economic pressure on companies.
- More and more data is becoming available, unpacking reuse models' financial and environmental benefits. The World Economic Forum (WEF) and the [Ellen MacArthur Foundation](#) (EMF) determined a \$10 billion opportunity in replacing 20% of single-use plastic packaging with reusable alternatives.

Risk:

- The purchasing power of consumers decreases with rising costs causing consumers to cut back on non-necessity purchases. As a result, some companies changed their focus to offering affordable products instead of investing in sustainability.

Opportunity:

- A well-designed reusable packaging system can be cost-effective and decrease packaging costs over-time. High return rates are another critical factor in keeping the cost of the reuse system low. Only with high return rates and an efficient system in place can the initial purchase price of reusable packaging be overcome.

- Companies are at risk of paying environmental mitigation fees and taxes for virgin SUP plastic packaging released onto the market. At the same time, they have difficulty securing recycled feedstock. With increasing regulations, prices of recycled plastics may also increase, meaning that single-use packaging might become increasingly less attractive from a financial point of view
 - Developing reusable options reduces dependency on virgin and recycled feedstock.

2.3. Societal market pressures

Consumer pressure plays a key role in business change. For example, increasing awareness of plastic pollution through single-use plastic consumption is causing unprecedented pressure on businesses to adjust their packaging portfolio.

- **Zero Waste Movement:** Studies on consumer behaviour conducted post-COVID-19 show an increasing demand from consumers for companies to rethink their packaging. Not only do consumers expect more sustainable packaging in broader terms, but they clearly state the need for lifetime extension of packaging through reuse ([Trivium Packaging, 2022](#)). This leads consumers to alter their purchasing decisions. For example, they may refuse products served in single-use plastic packaging.
- The message from the consumer's point of view can be confusing. Out of 500 consumers asked in a US survey, 90% of respondents said sustainable packaging interests them, and up to 74% said they would pay more for sustainable packaging. However, only 6.6% said that all or most of their grocery shopping is from products available for refill in store in practice. The low uptake of buying groceries in reusable packaging was due to either lack of availability or awareness of availability. When asked what they liked about reusable packaging, the answers were based on three factors: convenience, cost-savings and waste prevention. Consumers were also asked what they didn't like, and responses focussed on lack of convenience, concerns about waste and hygiene, and lack of choice/availability. However, looking at the statistics mentioned in the paragraphs above, it's clear that consumers are looking for a change and readily accept trials with reusable packaging.
- Research shows that consumers perceive reusable packaging as much more sustainable than their disposable counterparts. This [report](#) states that the products served in reusable packaging are also assumed to be of higher quality even though the tested products were sensitive (i.e. yoghurt and ice cream). It continues stating that "they are more likely to recommend a product sold in returnable packaging and individuals with deep environmental concern are more likely to repurchase it. However, when signs of usage resulting from multiple uses were evident on the returnable packaging, attitudes were generally less positive. Individuals were also less likely to recommend and repurchase the product." These results highlight the importance of considering the adverse effects of wear and tear in returnable packaging design.
- More data is becoming available on behavioural change, what levers can drive a transition to reuse and ensure high return rates. Behavioural change frameworks are increasingly drawing from behavioural and social science research, enriching the more traditional intervention strategies 'information', 'material incentives' and 'rules & regulation' levers with those related to 'emotional appeals', 'social influences' and 'choice architecture', see for example [Rare's 'Levers of Behaviour Change'](#).

- Active voicing goes as far as organised demonstrations and consumer initiatives such as [Consumers Beyond Waste](#) by the WEF. Consumers are concerned about plastic packaging waste in the ocean threatening marine- and wildlife. Where initially concerns were mostly about environmental and climate impacts, increasingly, health impacts are being mentioned. Data clearly shows microplastics and nanoplastics can be found in all elements of life: in the apples and fish that we eat, from the top of Everest to the arctic ice. The health impact of this has been unclear until now. [Microplastics have now been linked to reproductive health and maybe a significant cause of male infertility.](#)
- When **COVID-19** hit in 2020, single-use plastic packaging consumption increased. This development is linked to 1) growth in online shopping and home delivery and 2) increased **hygiene measures** in-store induced by hygiene regulations ([Queiroz de Oliveira et al., 2021](#)). In many cases, reusable packaging options in supermarkets and chain restaurants were stopped or paused due to the fear of contamination risk ([Vann, 2020](#)). This did not always reflect consumers' choice. Many reported being frustrated at not being allowed to bring their own packaging and continuing to pursue environmentally conscious consumption patterns ([Ikiz et al., 2021](#)). In many cases, the pandemic stimulated consumers to rethink their consumption behaviour. Developing smarter packaging systems to reduce environmental pressure has become part of the **'building back better'** movement.
- Public **media and NGOs are** accelerating the anti-SUP packaging movement, and pollution watchdogs are calling out individual brands over plastic pollution. Investigative journalists and NGOs want to highlight the environmental effects of plastic pollution and the need to improve the traceability of waste. Individual companies are criticised for their polluting factor, and their in-house sustainability strategies are being monitored ([Talking Trash](#)). As a result, it is becoming difficult for companies to neglect their negative impact.
- Pressure is often self-imposed with ambitious **Corporate Social Responsibility CSR targets to reduce plastic waste**. In fact, the food-and-beverage sector is one of the first to move towards reusable packaging in the form of refill ([Packaging Europe](#)). Because CSR significantly impacts brand image and the free market is built on outperforming the competition, introducing CSR targets has led to new dynamics. Most multinationals have set targets for 2025 or extended not-reached 2020 deadlines, respectively 2030. Studies confirm that among the top 100 companies in FMCG, almost all have announced sustainability targets ([McKinsey & Company, 2020](#)). Now the pressure is on to deliver those targets.
- The most common strategies are increasing recycled content and using more sustainable materials such as mono-materials and non-plastics. However, the reduction of packaging is crucial. To avoid greenwashing, companies must develop more advanced strategies.
 - Reuse is an increasing trend in the sustainable packaging strategies of companies. Today, 56% of the New Plastics Economy global commitment signatories are piloting or planning to pilot reusable packaging options. In addition, Plastic Pacts around the world are gearing up to make their reuse-targets SMART. In the UK, for example, the Plastic Pact UK specifies that each member retailer or brand owner needs to: 1) have completed at least one trial on innovative reusable packaging, including secondary packaging, by 2022, and 2) commercialised at least two innovative reusable packaging systems by 2025. It is clear that most major brands and retailers

are investigating refill/reuse business models, and some have dedicated resources to ensure goals become actions. However, the EMF Global Commitment [Report](#) notes an alarming lack of investment in alternatives to single-use packaging, with signatories reporting about **2%** of plastic packaging as reusable – where EMF says at least **20%** is viable for conversion to reuse. This is partly due to companies not prioritising investment internally and partly due to investment not being available. This trend is often referred to as “the missing middle” – a lack of connectivity between investment opportunities and the billions of capital needed for an operational circular economy.

Risk:

- Businesses might desperately seek more sustainable packaging solutions to satisfy their target audience. Consumers want to see solutions, but many don't know the difference between genuinely sustainable choices and what is marketed as 'green'. Choosing the wrong packaging solution can backfire and lead to accusations of greenwashing.
- Hygiene concerns around reusable packaging may lead to less acceptance of the system by specific target audiences, especially in the instance of a future public health crisis.
- Health concerns over single-use plastic may transfer to reusable plastic packaging formats.

Opportunity:

- Companies willing to work together within their sector or even with their competitors at an early stage might be able to develop industry standards for reusable packaging and will benefit most from the set-up, including financial advantages.
- Standardisation of hygiene and design standards for reusable packaging can remedy hygiene concerns and enable efficient systems. Third-party hygiene certification may be a solution.
- (Plastic) material health and safety regulations, as well as standardisation for cleaning, reprocessing, and traceability, can help address concerns about health impacts.
- Behavioural change data linked to SMART technology can inform product and system design.

2.4. Technological market pressures

Technological developments have revolutionised our food and packaging systems in recent years. New purchasing procedures and tracking technologies for reverse logistics have emerged.

- **Shift to more online groceries and shopping:** the e-commerce market grew by 17,1% in 2021, likely due to the COVID-19 pandemic. The market is expected to keep growing at an average of 8-10% for the next few years ([Oberlo](#)).
- **Augmented reality (AR) and virtual reality (VR)** are rapidly gaining popularity. VR creates an immersive virtual environment, while AR augments a real-world scene. VR is 75% virtual and requires a headset device, while AR is only 25% virtual. VR users move in an entirely fictional world, while AR users remain in contact with the real world. Augmented Reality is often used in retail for marketing and sales purposes and to enhance storytelling. It can also give online shoppers an in-store

experience allowing them to ‘walk through’ aisles online. This technology could demonstrate, for example, the function of a dispensing unit or how to take care of reusable packaging.

- **Automation and SMART packaging** should be explored when designing reusable packaging. It is no longer a nice-to-have but an imperative for sustainable growth. Automation offers a range of benefits for warehouses, from increasing productivity to reducing risks (safety, social, legal) related to a human workforce. However, to harness its full potential, retailers must invest in the efficiency of their supply chain. The warehouse automation market is forecast to reach \$51 billion by 2030, a CAGR of 23% ([McKinsey](#)).
 - Equipping reusable packaging with SMART technology such as QR (Quick Response) or RFID (Radio-Frequency Identification) enables the packaging to become part of this automated system. There is no longer a need to manually scan individual packages. RFID makes it possible to read information wirelessly and at a distance. This requires a tag (or multiple) and a reader. The passive tags (see image below) don’t require an energy source and will be activated through the antenna's signal on the reader. The most significant benefit of retrieving information wirelessly from a distance is that SMART packaging with an RFID tag does not have to be unboxed or depalletized. The data from an entire pallet load can be read at once. Stock can be kept secure, and product information retrieved without manual labour. In-store RFID allows for automated stocktaking and control, e.g., targeted discounts on products close to the expiration date.

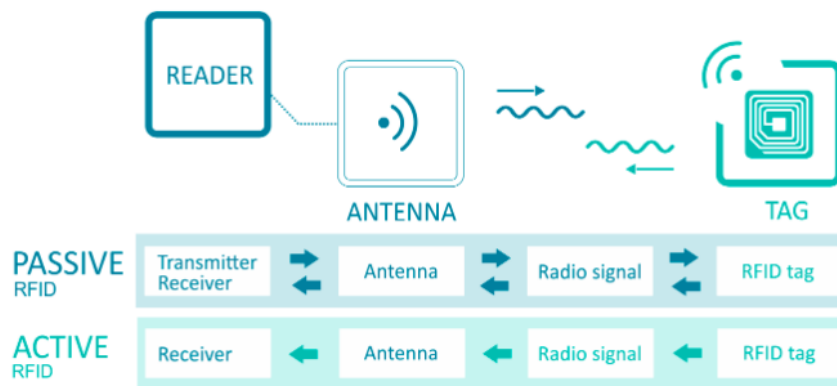


Fig 1: RFID labels, [Auxcis](#)

- Reusable consumer packaging can also be equipped with an NFC (near-field communication) chip. This means it can communicate with almost every smartphone in the area without downloading an app or manually scanning a QR or barcode. It is also possible to use multiple technologies simultaneously, allowing data to be readable throughout the entire value chain.

Risk:

- Technology is developing so quickly that it might need to be updated before reusable packaging reaches its break-even point (either financially or environmentally).

Opportunity:

- Consumers are already separating from physical grocery shopping and embracing the shift to a digitalised experience through delivery services. This might encourage consumers to engage with their packaging digitally by adding reusable options at the checkout.
- Technology can enhance consumer experience and provide engagement during online shopping.
- The traceability of SMART packaging can reduce/eliminate the risks of contamination and ease hygiene concerns.
- The traceability of SMART packaging can create insight into sales numbers, automate stock keeping, and speed up the process in the value chain
- Technology and SMART packaging can be used to create a personalised experience for users based on their behaviour and use customer loyalty elements to engage with them

2.5. Legal market pressures

In conjunction with rising consumer demand for reuse, a new **regulatory landscape** promoting reusable packaging solutions and systems is emerging.

- [EMF](#) reports that 47% of governments indicate ambitions to put systems in place, and 23% indicate they have been actively working on this. In Europe, regulatory developments will positively impact the drive for reusables from producers and consumers.
- The EU Plastic Tax on non-recyclable plastic packaging came into force in January 2021. Member states are opting for different solutions to meet the need to decrease unrecyclable plastic packaging on their market. For example, France will impose a 5% reuse rate by 2023 and 10% by 2027.
- Other regulatory drivers for reusable packaging include:
 - EU's Single Use Plastic Directive, which began to take effect in July 2021. It includes a ban on the marketing of certain plastic products, awareness-raising measures on products containing plastic and requirements on: Extended Producer Responsibility, labelling and design, consumption-reduction measures and monitoring, and increased collection and recycled content targets for PET bottles.
 - [Proposed European Packaging and Packaging Waste Regulation](#) (PPWR), which recently converted from a directive to regulation. The PPWR prevents and reduces the impact of packaging and packaging waste by setting targets for reuse and refill for food applications, including recycled content and full recyclability by 2030.

For more information on the regulatory developments and consequences for reusable packaging and country-specific contexts, please review document D1.1, review of legislative policy.

Risk:

- Directives, instead of regulations, allow member states to apply a regional interpretation to set targets. This hinders standardisation of solutions across EU member states and can lead to problematic development of incompatible systems and infrastructures.
- Targets for reuse in combination with recycling are often too ambiguous, creating artificial conflict between reusability and recyclability infrastructure. Without a clear hierarchy of solutions,

competition between strategies can happen instead of harmonisation. Companies question which strategy to invest in and feel insecure about the regulatory landscape.

Opportunity:

- Directives allow the exploration of pathways across different countries. As a result, the best solutions can be validated and taken up by other member countries.
- A needed push factor is created (a sense of urgency through regulations) to invest in reuse strategies, the development of reuse infrastructure, and the emergence of new reuse business models.

2.6 Key market developments enforcing reuse design

From the developments in market pressures mentioned earlier, a range of risks and opportunities can be identified that need to be considered when designing reusable packaging and related reuse systems.

Mainly due to the ongoing war in Ukraine, but also as a result of the recent COVID-19 pandemic, the purchasing power of consumers has decreased, leading to a shift in priority from sustainable to more affordable products. In order for a reuse system to be successful, it has to be **financially attractive** even to be considered for long-term engagement by users and producers. A well-designed reusable packaging system can be cost-effective and decrease packaging costs over time. **Durable design, limiting signs of wear and tear, and high return rates** are essential to keep the cost of the reuse system low. Only with high return rates and an efficient system will the initial purchase price of reusable packaging be overcome.

Plastic producing and importing companies are to pay EPR fees and virgin plastic tax for virgin single-use plastic released into the market. At the same time, only a limited amount of recycled feedstock is available. Due to a scarcity of recycled plastics and the regulatory pressure to use them, the prices of recycled plastics are likely to increase. This means that single-use plastic packaging (both virgin and recycled) could become less and less financially viable, opening the door for reusable packaging. Developing a successful reuse system reduces dependency on new feedstock. Reusable packaging made of **mono-material** allows for closed-loop recycling at the end of life, keeping materials in the loop. **Technologies** such as QR and RFID enable the **traceability of packaging** and optimised efficiency in collection, transport, and handling.

Consumer pressure plays a pivotal role in business change. Increasing awareness of plastic pollution through single-use plastic consumption puts unprecedented pressure on businesses to adjust their packaging portfolio. Wrong choices made by businesses can backfire and lead to accusations of greenwashing. Companies willing to collaborate within their sector or even with their competitors at an early stage might be able to develop industry standards for reusable packaging to their advantage and best anticipate coming changes. **Standardisation of hygiene and design standards** for reusable packaging must be developed. For FMCGs in general, but even more since COVID-19, there is a need for proof of hygiene. As a solution, a third-party hygiene certification can be considered. Standardisation of packaging, including the consideration of washability and suitability for centralised washing facilities, enables more efficient systems.

During a public health crisis, hygiene concerns around reusable packaging may lead to less acceptance of the system. The traceability of **SMART packaging can reduce/eliminate the risks of contamination and ease hygiene concerns**. However, we must remember that technology is developing so quickly that a wrongly chosen SMART packaging might need to be renewed before reusable packaging can reach its break-even point (either financial or environmental). Therefore, any SMART packaging should be designed to be disassembled and updated with new technologies or improved design as needed.

Companies will inevitably have to react to market pressures. They must develop solutions that fit a changing economy whilst setting sustainability centre stage. It would be wrong to suggest that all companies consciously avoid sustainable packaging options. However, it can be difficult to see the wood for the trees in a fast-developing environment with a wide array of so-called sustainable packaging solutions. While it is relatively easy to substitute one material for another, changing an entire system from linear to circular is far less obvious.

Nonetheless, it is clear that the linear system must be made circular to maintain a licence to operate and boost brand value.



Since 1970, SUP packaging has gained such popularity that it has become an unchallenged norm. Producers favour plastic because of its **lightweight, low production prices, endless design possibilities and excellent barrier properties**, and consumers are accustomed to the convenience of grab-and-go, disposable formats. Reversing this mass attitude towards how we deliver, buy and consume food as we advance will require intensive innovation, collaboration and investments.

3. Introduction of use-cases

The BUDDIE-PACK program aims to develop and demonstrate sustainable strategies for RPP in the food and cosmetic/ personal care sector. For this, 6 use cases will be studied and developed.

To better understand the source and nature of requirements for reusable plastic packaging design, all 6 market applications are introduced here.

Ausolan is a cooperative company that offers catering and cleaning services. Ausolan already has a


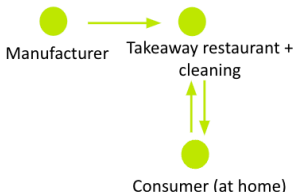
Use case information	
Catering trays for schools & nursing homes 	
Country of application:	Spain
Business model / Type of Reuse:	B2B: To be defined B2C: Return on site
Value Chain:	
Content of packaging:	<ul style="list-style-type: none"> Multi portion tray Single-portion tray Lids for all option
Packaging components:	<ul style="list-style-type: none"> Cold food Food that needs to be heated before consumption (oven and microwave)
Aesthetic/décor/coatings :	<ul style="list-style-type: none"> Anti-scratch and antimicrobial coating, QR code printed

reusable system, but with stainless steel containers. These containers are collected the day following use. Customers are only asked to empty them and return them to the Ausolan transporter. The dirty containers are carried to the same central kitchen they originated from, where they are washed and stored. The downside of the currently used stainless-steel containers is their weight. They also cannot be microwaved; some small establishments are not equipped with traditional ovens but only with microwaves.

Furthermore, Ausolan uses single-use plastic trays for meals that need to be individually packed due to dietary

restrictions. BUDDIE-PACK aims to develop reusable multi-portion as well as single-portion trays. The single-use trays also act as plates from which the end-user can directly eat.


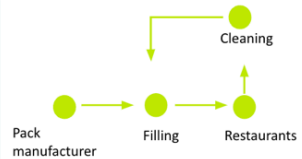
Vytal is a food tech company within the circular economy. They supply restaurants, caterers & canteens with different types of reusable bowls & cups which can be used for delivery and takeaway meals. The digital reuse system is free of deposit and charge for the user. Vytal offers a pay-per-use model to its partners, which charges between 0,10€ to 0,33€ per used container. Vytal tries to offer a solution for every type of food and drink. The current portfolio includes containers for sushi, burger, pizza, salads, bowls, soups and many others. The cups can be used for hot and cold beverages. In addition, Vytal offers a so-called white-label solution. White-label enables restaurant owners to integrate their own container types into the Vytal system. The idea behind the system is to provide a reusable solution for every food-

Use case information	
Take away trays for restaurants 	
Country of application:	France and Germany
Business model / Type of Reuse:	B2B: Pay per use B2C: Return on the go and return from home
Value Chain:	
Content of packaging:	<ul style="list-style-type: none"> Cold meals Hot meals
Packaging components:	<ul style="list-style-type: none"> Tray with compartments, consideration of different sizes Lid
Aesthetic/décor :	Screen coating

producing company, eliminating disposables. From a B2B point of view, Vytal offers its solution to restaurants, catering companies, canteens & canteen providers, bakeries, butchers, retail companies and also food producing companies. From a B2C aspect, Vytal offers a mobile application that helps users find food outlets offering Vytal containers. The mobile app also offers a pre-order function. The BUDDIE-PACK project aims to develop new container types with three-compartment options and investigate infrastructure improvement to improve reuse systems.


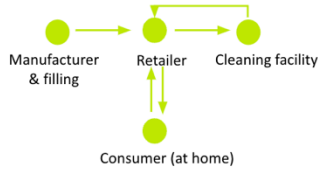
Dawn Meats Group is one of Europe’s largest food processing companies processing 1 million cattle and

3 million sheep per annum and producing 430,000 tonnes of added-value meat products, including consumer packs delivered daily to Europe’s retail outlets. Top retail customers include Sainsburys, Coop, Lidl, Aldi, Tesco and ASDA in the UK, Mercadona in Spain, Metro and Rewe in Germany, Carrefour and Casino in France, and Coop in Sweden and Denmark. Dawn’s main non-retail client is the Mcdonald's EU supply chain. Dawn Meats engaged with the BUDDIE-PACK consortium to further its sustainability agenda by examining novel packaging formats for some of its largest packaging applications – meat tray skin packaging. Next to developing a

Use case information	
Meat skin packaging for food service, fast food and pubs 	
Country of application (WP6):	UK
Business model / Type of Reuse:	B2B: Return on site
Value Chain (WP6)	
Content of packaging:	Cooled raw meat
Packaging components:	<ul style="list-style-type: none"> • Body/ tray: Reusable • Skin: Thermo- sealed with a recyclable high gas barrier mono-material film (recyclable). Optional solution might be a multi-nano layer mono material film.
Aesthetic/décor/coatings :	<ul style="list-style-type: none"> • Functionality is of main importance • Aesthetics are secondary. Slide discolorations will not be an issue



system for reusable plastic trays, BUDDIE-PACK is also investigating mono-material film material as part of the project scope. The goal is to create or find a recyclable option, as the current film material includes PDVC as an oxygen barrier. PVDC inclusion makes material unrecyclable and must be phased out with suitable alternatives.

Represented through **Asevi and Smurfit Kappa**, a refillable bottle system for laundry detergent, softener, and washing fragrances is envisioned to cut down single-use packaging in the current business model. Today, the bottles are made from PET with a PP cap; the body is made from 50% recycled content. Bottle and cap are both 100% recyclable. Asevi is producing and filling the bottles but will switch to mainly bottle production and filling of bag-in-box (BiB) bulk solutions. BiBs are sent to supermarkets and retailers, which consumers can dispense into their reusable bottles. The BiB (Bag-in-Box) will be provided by Smurfit Kappa. For the BUDDIE-

Use case information	
Refillable packaging for homecare + Bag-in-Box 	
Country of application:	Spain or France
Business model / Type of Reuse:	B2C: Refill on the go
Value Chain	
Content of packaging:	Home care (detergent / softener / scent booster)
Packaging components:	<ul style="list-style-type: none"> • Bottle with lid (reusable) • BiB
Aesthetic/decor :	Labeling option

PACK program, a large version (20-100L) of currently available sizes is planned, and an adjustment of closure elements for ideal flow regulation.



Uzaje is a French-based company providing solutions for each step of the reuse value chain: packaging solutions, reuse systems, deposit management, transport and high-efficiency cleaning, which is their core activity.

Use case information	
On-the-spot-consumption in supermarkets 	
Country of application (WP6):	France
Business model / Type of Reuse:	B2B: To be decided B2C: on site return
Value Chain (WP6)	
Content of packaging:	<ul style="list-style-type: none"> • Cold food • Food that needs to be heated before consumption (microwave)
Packaging components:	<ul style="list-style-type: none"> • Tray, consideration of different sizes • Lid
Aesthetic/décor/coatings :	<ul style="list-style-type: none"> • Anti-scratch • Durable QR code

The BUDDIE-PACK research project will allow Uzaje to improve its knowledge of consumer engagement regarding reuse and investigate the best reuse solutions for on-the-spot consumption. The packaging will mainly be used for ready-to-eat meals / fresh on-the-go food, for products sold on snacking shelves, salad bars and snacking corners in supermarkets and catering outlets. Food is for direct consumption or consumption on the go. The aim is to identify suitable packaging application(s) in

terms of material choice, convenient and safe design, as well as appropriate packaging systems and business models.

For its last large-scale demonstration, BUDDIE-PACK aims to collaborate with humanitarian NGOs to enable them to decrease their environmental impact. Currently, crisis management generally involves using prepacked products, such as single-use plastic bottles, with a typical volume of 150 to 500ml. An alternative recyclable BiB (Bag-in-Box) solution, provided by Smurfit Kappa within the BUDDIE-PACK project, could enable the local use of reusable containers, such as autoclavable glass bottles. The volume is yet to be defined, and closure elements will likely be adjusted to adapt to the content. Depending on the humanitarian mission and location in which this new system will be deployed, local companies could be contacted to ensure BiB recycling.

Use case information	
Bag-in-Box 	
Country of application:	To be determined, most likely outside Europe
Business model / Type of Reuse:	No reuse (will be used to enable local reuse of containers outside of the project)
Value Chain (WP6)	
Content of packaging:	Antiseptics (alcoholic solution)
Packaging components:	<ul style="list-style-type: none"> • Bag in Box • Specified tab/ dispensing solution
Aesthetic/decor :	To be defined

4. Identification of consumers' levels of reuse and users' expectations

In the following sections, engagement of consumers with reuse systems and users' expectations concerning reusable packaging and packaging systems is inspected through available contemporary research and literature. Points for considerations when developing reusable packaging and packaging systems are extracted.

Reusable packaging systems may help transition away from the current – make, use, dispose - linear economy approach. It is somewhat difficult, however, to determine clearly and concisely the share reusable packaging systems currently contribute to as a percentage across various market sectors. The purpose of this review is to collate evidence on consumers' engagement with reuse systems that are currently available, as well as expectations with respect to reuse systems and how these can shape engagement.

We define the 'consumer' as the citizen-individual who often consumes the product, be that in the home, at a restaurant or canteen or on-the-go.

We also utilise the term 'user' in order to acknowledge wider actors/individuals across the supply-chain, due to the importance of their role in maintaining engagement with reuse. For example, business members and staff employees which use reusable packaging systems as part of their job (e.g., a chef in a restaurant or canteen who purchases raw meat in reusable trays from a food manufacturing operator), will both engage with and have expectations of the reusable packaging system (therefore similar to a consumer), but ultimately, they do not personally consume the product.

4.1. Consumers' Engagement with Reuse Systems

One of the best insights is 'The Global Commitment', led by the Ellen McArthur Foundation (referred to as EMF hereafter), in collaboration with the UN Environment Programme (EMF, 2022a). Its member companies represent 20% of all plastic packaging produced globally. They share a common vision of a circular economy for plastics - through its five-progress metrics - to be achieved by 2025. Data suggests that whilst steps have been taken to ensure that 100% of plastic packaging is reusable, recyclable or compostable, this has often relied on improving the technical recyclability of plastic packaging (irrespective of whether the infrastructure exists in practice or at scale to recycle this successfully). On the other hand, the share of reusable plastic packaging across the signatories of the Global Commitment has decreased from 1.5% in 2019 to 1.2% in 2021. Moreover, despite the envisioned importance of reusable packaging being a cornerstone in enabling transitions to more environmentally friendly systems, the percentage of signatories having no actual or planned reuse models by 2025 has increased from 28% in 2020 to 32% in 2021. And with only 14% reporting an increase in its share of reusable packaging between 2020 and 2021, more than half of its signatories (57%) currently report no progress. The relatively low engagement with reuse systems internationally generally reflects the niche position that reuse currently occupies relative to single-use, linear systems. Indeed, several signatories of The Global Commitment are only just introducing quantitative reuse targets. Most notably, The Coca-Cola Company committed to delivering 25% of its beverage volume through reuse models by 2030, and PepsiCo announced its aim to sell 10% of all beverage servings in reusables by the same date (EMF, 2022a, Packaging News, 2022). Historically, beverage containers (e.g., beer, mineral water, and soft-drinks) have been exhibited as a successful illustration of Business-to-Consumer (B2C) reuse systems (Coelho et al., 2020). For example, reusable beverage bottles represented approximately 40% of the German beverage market in 2019, with sub-sectors such as beer (79%) contributing noticeably higher levels of reuse (FEA, 2021). Soft-drink manufacturer Coca-Cola Fomento Económico Mexicano, S.A.B. de C.V. (Coca-Cola FEMSA) reports its levels of soft drinks volume in returnable packaging for several of its

territories, including Mexico (45%), Central America (35%), Uruguay (20%), Columbia (20%), Argentina (19%), and Brazil (16%) (Coca-Cola FEMSA, 2022). In understanding these national variations of reuse, recent research has paid greater attention to the commercial drivers, regulatory factors, and provisioning systems in which they arise (see Beswick-Parsons et al., in review) over that of consumer engagement and expectation.

Recent consumer research suggests high public concern surrounding plastic waste and an openness to change, including transitions to reusable packaging. For example, 67% of UK citizens say that plastic waste is an important issue to them personally (WRAP, 2021). Of the 4,083 UK adults surveyed by WRAP, 27% feel there is 'a lot' they can personally do, whilst the vast majority, 61%, consider there are 'some things' they can do. In a similar survey of 2,000 UK participants, 83% of consumers reported being open to reuse systems, with 41% reporting having already adopted reusable packaging (IGD, 2021).

The Ellen MacArthur Foundation's widely referenced report 'Reuse, Rethinking Packaging' introduces four separate forms of B2C reuse models (refill-at-home, refill-on-the-go, return-from-home and return-on-the-go). These differ in terms of packaging 'ownership' (consumer-owned vs business-owned) and the circulation of packaging (requirement of the user to leave home to refill/return packaging vs the collection/drop-off of products by businesses) (EMF, 2019). Comparing these reuse models reveals preferred methods of consumption by consumers. For example, refill-at-home and return-on-the-go options are considered more desirable than refill-on-the-go, i.e., in-store (IGD, 2021). As for current use, IGD reported that 31% of UK consumers have already used refill-at-home products, in comparison to 11% who have used refill-on-the-go options (IGD, 2021). Perceptions of extra effort in decanting in store and hygiene concerns act as significant barriers. Comparing this to return-on-the-go approaches with consumers returning packaging in-store or another location is considered less challenging than refilling their containers in-store (IGD, 2021). Nevertheless, >40% of respondents across 7 of the 8 reuse behaviours surveyed by WRAP (2021) exhibited a receptiveness to engaging with reuse options, conveying a significant opportunity for reusable packaging systems to grow.

Evidence suggests that willingness to engage with reuse remains limited, with people more willing to recycle or dispose of products (Greenwood et al., 2021). Additionally, observations of consumer interaction with packaging have related more to the development of recycling than reuse. For example, the recognition of the recyclability of packaging (87%) and packaging made from recycled materials (82%) are most noticeable to consumers. In addition, material substitution (e.g., cardboard, paper, and compostable/biodegradable materials), the removal of plastic packaging, smaller pack design and light-weighting of packaging have all been more appreciable than reuse options (WRAP, 2021). Nearly half of UK citizens (48%) have not observed the sale of pouches for refilling at home, while 62% have not noticed any products referring to containers on sale for refill in store. Despite this, 32% of UK consumers reported purchasing refill pouches for at-home refill across household laundry and cleaning products. In addition, 29% reported purchasing a refill pouch for personal care products (e.g., shampoo), in the past 3 months. As such, anecdotal evidence from UK Plastics Pact members suggests that citizens' reported engagement levels with systems of reuse are often higher than actual sales levels or the uptake of behaviours observed by brands. Suggesting that reported and observed behaviour may differ (WRAP, 2021). One suggestion is that consumers are already practising and exhibiting behaviours of reuse, informally engaging with, and modifying single-use packaging to reflect performances of refill-at-home (Beswick-Parsons et al., in development). It is also relevant to consider citizens reporting that they have tried several reuse behaviours, yet few have fully adopted and integrated these into their everyday life (WRAP, 2021).

Developing connected national and regional plastics pacts globally (see The Ellen MacArthur Foundation's Plastics Pact Network) has brought businesses across the value chain together to tackle

plastic waste. Two of its four measurable targets for 2025 refer to reuse, with target 2 specifically aiming for '100% of plastic packaging to be reusable, recyclable or compostable' (WRAP, 2022). As part of its roadmap to 2025, the Pact aims for reuse systems to become more visible and rolled out business-wide. As such, several Pact members, retailers and brands have recently conducted reuse trials identifying engagement levels with different reuse systems. We briefly consider two examples, Asda's refill in-store trial and Tesco's prefill model below.

The current lack of scope and coverage of reuse systems across both product sectors and (inter)national markets may make it difficult for consumers to become accustomed to and engage with reuse. Indeed, the EMF suggests the overall decline and lack of progress conveyed by The Global Commitment signatories is a result of these reuse pilots and trials remaining fragmented and not being embedded in a business strategy that could enable and lead to reuse at scale over time. As such, it is suggested that 'a shared infrastructure for distribution, cleaning, and logistics of reusable packaging across businesses' via cross-industry collaboration would enable reduced costs through economies of scale and catalyse the reuse sector (EMF, 2022a).

Case study: Tesco

In partnership with Loop, Tesco ran two pilots across a two-year period on the development of pre-fill packaging services in Britain. This included a one-year pilot (July 2020 – June 2021) selling 150 grocery products in reusable packaging through Tesco’s online service, and an in-store pre-fill pilot shortly afterwards (September 2021 – June 2022), across ten stores. More than 50 branded lines (including Persil, Coca-Cola, Heinz, and Tetley Tea) and 35 own-branded essentials (including sauces, yoghurts, soaps, cereals, and washing detergent) were available in-store and, in total, more than 200 products were available across both pilots. The trials were designed to be as straightforward as possible for citizen-consumers, shopping in a similar way to when purchasing conventional packaged products.

With more than 80,000 transactions over the course of the two-year period, consumer motivation primarily referred to environmental drivers relating to doing their bit for the planet (50%) and wanting to reduce single-use plastic (50%). Despite the aim of making engagement with reuse as convenient as conventional packaging, only 21% of consumers were motivated by the ease of shopping pre-fill and only 18% of consumers considered it easy to return the used container after use.

Insights suggest that despite prefill shopping being almost as convenient as conventional shopping, further simplification of paying deposits and returning packaging once used, are required. These are not necessarily consumer driven actions however but require both retailer and product specific engagement. (Tesco, 2022)

Case study: Asda

In partnership with WRAP and Unilever, Asda’s in store trial aimed to consider a deeper understanding of whether and how citizen-consumers interact with instore reuse zones, and what barriers are needed to overcome this. The trial took place in two stores, with the core focus on ‘refill on the go’ and to a lesser extent, ‘return on the go’. More than 80 product lines were trialled in refillable format, including rice, pasta, tea, coffee, cereal, and baking items. Unilever-branded laundry and personal care products were trialled in both refill on the go and pre-filled (return of the go) formats.

Key barriers to consumer engagement included personal barriers in the shape of apprehension of being unsure what to do, and lack of confidence to try the reuse zone regarding concerns of something going wrong and/or making a mess and feeling embarrassed. More practical apprehension included knowing how much a product will cost and the initial investment required to purchase reuse containers.

Further product specific barriers included concerns regarding freshness of products stored in hoppers and the impact on product quality, as well as hygiene issues when touching hoppers and encountering spillages by previous customers. The lack of a full range of products (both branded and non-branded) in comparison to conventional packaged products were also a concern.

Insights suggest multiple considerations must be considered relating to pre-shopping, when in-store, and when at home behaviours.

(WRAP, 2022)

4.2. Consumer engagement across BUDDIE-PACK market applications

Paying particular attention to the market applications associated with the BUDDIE-PACK project, we refer to further consumer engagement insights and briefly review several of the market applications concerning their levels of reuse.

Personal care

The household care sector provides several examples of reusable packaging products, both refill and prefill. In the UK, brands such as SESI and Miniml are present in independent refill/zero-waste stores, often in a refill-on-the-go format. Larger retailers and brands have also been trialling options recently. Most notably, Persil's prefill ('return-on-the-go') option in collaboration with Asda's reuse zones, and Lidl GB's 'Formil' brand in collaboration with Algramo's vending machines, which offers a refill on-the-go service in store. While most (93%) of the 'household and personal care sector' signatories of The Global Commitment are currently developing reuse pilots or models, none have made progress in increasing their share of reusable plastic packaging. 45% do not have any reusable plastic packaging in their portfolio to date (EMF, 2022b).

Research suggests that in total, close to one in three (32%) UK citizens have reported that they have purchased a refill pouch for laundry/cleaning products in the past three months (WRAP, 2021). However, the frequency and consistency of this behaviour could be improved, with 12% of citizens regularly purchasing multiple products in this format, 11% regularly purchasing for 1-2 products, and 9% have purchased a product in this format but not regularly. Furthermore, there is also scope for this reuse sector (refill at home) to grow, with 45% of UK citizens not yet engaged with refill packs for laundry/cleaning products but receptive to the behaviour. The two most significant barriers for these individuals are 'refill packs are difficult to find' (39%) and 'I don't think this is available for the brands I buy' (28%). Finally, when asked about the progress made by the laundry/cleaning product sector to address plastic waste, 24% of UK citizens felt 'significant' or a 'fair amount' of progress had been made. Whilst 43% considered 'some - but not enough', 14% felt that product retailers and brands have 'not made any progress'.

Unilever's use of its Persil brand as part of the reuse trials with Asda reveals the aim of using large mainstream brands familiar to the public to encourage consumers to try reuse and test the model at scale (WRAP, 2022). However, learnings from the trial - with its prefill bottle - identified that while well-known brands appeal to some, the lack of variety, including detergent formats (for example, capsules, liquid, fragranced vs non) means that only a proportion of the public will engage.

The detergent packaging case presents a hybrid model to the examples already referred to above. The bag-in-box dispenser (aimed to be fully-recyclable through existing waste management systems) and bottle represent 'refill on-the-go', with the consumer refilling the bottle several times. However, the bottle will eventually be returned to the manufacturer (return on-the-go), and industrially cleaned before being used again by another household.

Takeaway Consumption of Food

Takeaway food includes purchasing (hot and cold) drinks in coffee shops and cafes; food served by fast-food retail outlets, independent restaurants, and takeaways; and a quick sandwich or meal deal on the go (e.g., at supermarket retailers).

Research suggests that consumers are open to borrowing and returning cups for takeaway drinks (64%) and containers for takeaway meals (63%) (Hubbub, 2022). Similar research suggests that 40% of UK citizens have used a reusable cup for takeaway hot drinks in the past three months, while another 40%

have not but are receptive to doing so (WRAP, 2021). These statistics suggest that there is scope for reuse to expand significantly in this sector and, indeed, to become the standard approach. However, the selection of reuse is inconsistent, with only 5% of UK consumers always using a reusable cup for hot drinks. This figure is even less (<4%) for consumers using reusable containers for either takeaway breakfast, lunch or dinner (Hubbub, 2022).

In 2019, it was estimated that 10.7 billion packaging items were wasted annually in the UK, equating to 276 items per person (Hubbub, 2019). The same research suggests that buying lunch on the go is a growing practice. However, it should be noted that this research was conducted prior to the COVID-19 pandemic. Recent academic research has critiqued and challenged the view that food on-the-go is a consumer-driven lifestyle choice with an insistence on 'convenience'. Instead, Hirth et al. (2021, p.122) criticise this over-emphasis on consumer attitudes and behaviours, stating that 'industrial socio-technical practices' must also be considered. With this in mind, public perception of the progress made to address plastic waste across these sectors, coffee shops and cafes is that it has made more progress (32%) than takeaway and fast-food restaurants (19%). However, 50% and 64% of the public surveyed consider that 'some, but not enough' or 'no progress' has been made by coffee shops and cafés; and takeaway and fast-food restaurants, respectively (WRAP, 2021). The on-the-spot consumption case represents one attempt to make progress around food on the go, particularly the delivery of pre-prepared sandwiches and salad, into which, up to now, little research or innovation has been conducted. Uzaje previously participated in a similar reuse trial, testing glass containers in the 'snacking' catering area at a Franprix store throughout 2019 (see Uzaje, 2019).

One business that has made significant progress toward reuse is Boston Tea Party, an independent small café chain, the first business in the UK to ban single-use cups in 2018. They now require consumers to either bring their own cup, buy a reusable cup, or rent one from their loan cup scheme (Boston Tea Party, no date a). Before the ban, the business sold approximately 340,000 takeaway hot drinks a year, representing 5% of its turnover (Boston Tea Party, no date b). Unfortunately, it is worth noting that Boston Tea Party reported a 25% *decrease* in turnover in takeaway coffee sales in the first year of implementing the reuse system across its 22 branches around England (BBC News, 2019), suggesting that not all consumers were ready to engage with the reuse model.

Vytal

Vytal is a digital reuse system operating across 9 countries in various food and drink businesses, including national and international retailers, restaurants, takeaways, coffee shops, and canteens. On average, 60,000 transactions are conducted per week using Vytal across all its markets. However, due to a lack of knowledge relating to the total bowl and cup transactions across these markets, it is difficult to identify the proportion of the market which is catered by reusable packaging.

Most of its operators, approximately 98%, function on a hybrid system that offers both the Vytal reuse option and single-use alternatives. Single-use options are often the default option in the markets Vytal are engaged in. To counteract this, some establishments have placed an additional charge on single-use packaging in an attempt to increase the usage of reusables. Only a small proportion of its operators (~2%) offer only reusable containers, thus compelling the consumer to use reuse packaging.

Currently, Germany represents its largest market, with approximately 5 million transactions over the previous three years. Its canteen sector (including corporate food courts and university campuses) represents 80% of its business transactions, yet only 10% of its partners. At these sites, the rental of their bowls can be used both when eating in and for takeaways. Furthermore, the recent introduction of an obligation by qualifying operators to offer reuse as an option to customers has resulted in more

businesses joining the app service. It must be noted however that this does not make it compulsory for the consumer to engage with reuse systems.

In the UK, The University of Sheffield's campus has acted as a 'Living Laboratory' in which Vytal has been introduced across several of its cafe spaces. Preliminary data over an 18 months period suggests that whilst engagement with the service has been low, the return rate is 98.5%. Even though only the bowls were marketed, the majority of rentals have been for cups (~82% of rentals). Despite this, the proportion of takeaway drinks purchased in reusable cups remains nominal, with ~500,000 single-use cups sold on-campus per year. Over the course of the trial, approximately 170 people have registered and used the service, with approximately 20% using it in the past month (as of February 2023).

Business to Business

Reusable packaging is also pertinent to the Business-to-Business (B2B) market. More traditionally associated with the use of transit packaging (crates, pallets, drums and wrappers), the use of boxes, containers and soft packages to transport goods between warehouse and store has become increasingly popular in driving improvements across the wider supply-chain (Coelho et al., 2020; Błażejowski et al., 2021). Lukas Sattlegger's (2021) ethnographic research of negotiating the substitution of single-use plastic wrap for reusable ties in a warehouse of an organic wholesaler in Germany provides an in-depth example of the impact this has on everyday work practises. As such, engagement with reuse is not only required at a consumer level. As with the two use cases of Dawn Meats and Ausolan, we must highlight the importance of a broader user engagement considering business-to-business interaction and the required buy-in by businesses and their staff users.

Dawn Meats

All of Dawn Meats B2C and B2B provision of raw meat is delivered in single-use packaging, with skin packaging representing its most popular packaging format. To their knowledge, this approach reflects other food processing companies and the sector as a whole. Dawn Meats has a specific commitment to make all of its plastic re-usable, recyclable, or compostable by 2025. Its skin pack trays offer an average recycled content of up to 90%. Until now, business innovation has primarily focused on enabling the viable recycling of skin-packs and packaging delivered to businesses.

The case aims to introduce reuse formats into its B2B practice supply chain, replacing its single-use skin pack meat packaging in pubs and restaurants. If successful, the transition to B2C re-usable skin pack trays could number millions of packs per week, given that 100% of all retail beef steak packed in the UK is in skin pack format.

Ausolan

Ausolan is a cooperative company that primarily provides catering to businesses, schools and nursing homes, delivering either to their (customer's facilities) on-site kitchens or directly from its central kitchens. They are currently Spain's third largest business within the pre-prepared catering meal sector. Most of their meals are already delivered in reusable stainless-steel containers, meaning that catering staff already know and interact with reusable packaging systems. Geographical variation is evident, though, with the Basque Country facilitated primarily by reuse, whilst in other places, single-use plastic packaging is predominantly relied upon (e.g., Burgos). More anecdotally, private businesses are considered to be more receptive to the use of reusable packaging systems than public partners. It is suggested that this is due to awareness of plastic waste produced and the selling point of being 'environmentally progressive'. In contrast, public business requirements concerning food safety, shelf-life and other factors result in more use of single-use packaging. Currently, Ausolan generally retains

responsibility for selecting the type of trays to use with reusable stainless-steel containers prioritised. That being said, several factors result in the use of single-use plastic trays. For example, Ausolan utilises single-use when there are not enough portions ordered to justify using larger trays. The reluctance to use smaller trays ('half' and 'quarter' sizes) in these scenarios results from them often not being returned. This lower return rate is a consequence of dealing with smaller clients not equipped with the necessary infrastructure (ovens); personalised deliveries; and allergies and intolerances, dietary, religious or health reasons.

The development of reusable plastic catering trays highlights questions regarding whether existing staff practices and engagement will easily map onto this innovation. Furthermore, consumers do not interact with these catering trays as meals are decanted and served separately on plates. However, the possibility of serving single-portion trays straight to the end-user (the consumer) to eat directly from will introduce new engagements with and expectations of the food container.

4.3. Users' expectations of reuse systems

In considering how to accelerate progress towards reuse systems, it is crucial to view users' expectations. As we have already stated, this includes both individual consumers, as well as staff users. Several reports have already extensively considered users' expectations when engaging in a reuse system (see IGD, 2021; WRAP, 2021; Hubbub, 2022; WRAP, 2022). As such, we conducted a workshop with members of the BUDDIE-PACK project to explore what they consider critical user expectations. Using an online professional diagram collaboration software, Miro, the workshop sought to evaluate i) consumer and user expectations of reusable packaging in general (see Appendix 1); and ii) consumer and user expectations of reusable packaging specific to each market application (see Appendix 2). In the following section, we cover several key discussion topics from the workshop and relate this to the broader consumer research literature. It is acknowledged, however, that there is not one singular issue or requirement that can enable systems of reuse in isolation, but rather a multitude of factors that are more or less important across different sectors.

Cleanliness and hygiene

Statements including 'food safety', 'safe - hygienic', and 'cleanliness - spoilage contamination' refer to assurances that the product container is not contaminated from its previous use and was one topic of discussion. This was particularly relevant for reusable containers storing food, especially concerning the meat skin packaging market application. This reflects concerns by consumers in existing research, with reassurances on hygiene being particularly important for ready-to-eat food and drink products in the refill-on-the-go sub-sector (Hubbub, 2022; IGD, 2021). This is not surprising given that the most frequently cited benefits that food packaging provides include (i) *keeping products safe and hygienic* (46%); (ii) *the protection of food in the shop and on the way home* (46%); and (iii) *keeping the product fresher for longer* (34%) (WRAP, 2021). It is important to note, however, that there is "a strong association between the perceived benefits of packaging and age, with 18-34s significantly less likely than the population average to identify benefits" (WRAP, 2021, p.6). Furthermore, it is suggested that such concerns may be a perceived rather than an actual barrier, and as a result, hygiene concerns may decrease as reuse becomes more mainstream (Hubbub, 2022).

Aesthetics

Comments regarding packaging 'aesthetics', being a 'status symbol' and 'desirable', or more generally, looking 'like new' references perceptions by members of the project that consumers consider packaging

to be more than a functional device and require it to be socially desirable. This is reflective of a broader picture in which the very nature of fast-moving consumer goods has led to a preference for pristine packaging with no imperfections. For example, research has found that consumers tend to avoid packaging with superficial damage in a supermarket context (White et al., 2016), and other research has shown that people are largely unwilling to reuse containers that show signs of wear (Baird, Meade, & Webb, 2022). This highlights a potential misalignment between the technical life-span of a container and the social acceptance to continue using it after signs of wear. For example, reusable containers typically require more raw material to ensure that they are more durable than their single-use counterparts (Coelho, et al., 2020) and must be used multiple times to counteract the increase in resource consumption. Given that reusable packaging will need to be used multiple times to ensure environmental benefits, consumers will likely need to become accustomed to using packaging that shows signs of previous use.

Convenience

A widespread expectation identified from the workshop is convenience. This broad concept encompasses the entire reuse system for the consumer, from purchasing a product to its use through to its return. Several points also relate to convenience regarding users involved in B2B contexts, including the ease of use in existing B2B systems and rationalisation of empty packaging for transportation.

References in the workshop to not taking 'additional effort', ease of use, and 'no added complexity for the consumer' align with current research, suggesting the transition from single-use to reuse must be as 'convenient' and 'frictionless' as possible (Hubbub, 2022). This is something made harder by the fact that currently, single-use systems are enormously convenient. Sustainable alternatives such as reuse must compete against a single-use culture long established and embedded over several decades. The achievement of making reuse 'as easy as using the one-way alternative' as suggested by a participant in the workshop, will therefore be challenging given that reuse systems are relatively new. Engaging with the system could create both uncertainty and apprehension (WRAP, 2022). Factors that influence positive engagement with existing single-use systems, however, could also be used to enable reuse, including the availability of products, both in-store and on online platforms; and integrating reuse services with the usual shops, instead of being a separate service (IGD, 2021).

A UK survey reported that 34% of participants would be encouraged to engage with reuse if there was a wider availability of schemes in their local area. A similar proportion (32%) reported they would be encouraged by not having to go out of their way to do it (Hubbub, 2022). References to reuse's 'ease of use' through its general availability and access to it were, however, referred to little during the workshop. Instead, aspects associated with engagement with the container after its use, for example, its consequent storing ('easy to store when not using', 'not requiring lots of storage space to store packs before returning') and return ('easy to return - lots of drop off points', 'collect centre [sic] close to home or easy to drop at every store') were more of a factor. Collaborative workings between businesses and policymakers may unlock these user expectations by introducing "a system working across multiple brands, locations and platforms will be more convenient and less confusing for users" (Hubbub, 2022).

Incentivisation

Incentivisation to encourage the use and return of reusable packaging is regularly touted to motivate consumers to purchase reusable packaging, 'offering instant gratification and a very tangible, personal benefit which makes consumers feel valued for their actions' (IGD, 2021). Several members in the

workshop refer to the use of ‘rewards’ or a ‘reward system’. Currently, the reward of loyalty points has a higher appeal amongst consumers over that of a deposit return in a UK context. However, it is considered that this feeling may shift once a Deposit Return Scheme (DRS) is implemented (IGD, 2021), normalising this deposit transaction. The upfront cost of a deposit can put people off, and alternatives to this could include only charging for unreturned packaging or subscription models for frequent or large-volume purchases (Hubbub, 2022). However, these also have limitations for inclusivity, requiring app access. It is also emphasised that rewards can lead to an over-complication when engaging with reuse (Hubbub, 2022) and, as a result, conflict with the ‘convenience’ expectation previously discussed.

Price Parity

Keeping the price down or as close as possible to a single-use alternative is viewed as a key driver, with 41% of a UK-representative survey saying they would be encouraged to use reusable packaging for food and drink if it incurred no extra costs (Hubbub, 2022). Members of the BUDDIE-PACK project refer to an expectation of a ‘cost incentive to refill’ or that ‘costs are not visible (no extra costs)’. Similarly, the Asda and Unilever reuse store trial identified the user expectation of price parity between reusable packaging and its single-use or recyclable alternative by introducing its ‘Refill Price Promise’. The in-store retail trial highlights the importance of helping customers understand price differences between packaged goods and refillable counterparts and clearly communicating this, both in the reuse zone and where the equivalent packaged goods are sold (WRAP, 2022). Clarity and communication of messaging is also essential, focusing on the monetary amount saved in communicating the benefits of reuse (IGD, 2021).

Environmental Impact

Given the often-stated beneficial environmental impact of transitioning to reusable packaging systems, consumers perceive this to be a motivator, particularly those already engaging with methods of reuse (IGD, 2021; WRAP, 2021). For example, 38% of UK respondents reported being encouraged to use reusable packaging if they knew it was better for the environment (Hubbub, 2022). Interestingly, while comments from the workshop also identified this user expectation, it was referenced alongside comments regarding avoiding greenwashing, being ‘genuinely more sustainable’, ‘easy for the consumer to understand the sustainability benefits’, and a level of transparency.

Points for consideration when developing reusable packaging

Preliminary findings provide insight into the current baseline of consumers’ and users’ engagement and expectations of reusable packaging. They highlight relevant points for consideration when developing reusable packaging and packaging systems. Some insights can be used as direct recommendations, while others indicate a need for further investigation and research on specific aspects. Both are summarised below:

- Ensure easy access, as in availability, to reusable packaging. Brands need to (better) communicate reuse and refill solutions available to consumers.
- Familiarise consumers with the system of reusable packaging. Communication may be required to reassure consumers. This might include clear instructions on how to return containers, informing consumers of the cleaning process, and highlighting the success of engagement in the attempt to create a new social norm (Hubbub, 2022; IGD, 2021).

- Optimise consumer convenience through the standardisation of systems in a geographical area. This includes easy return infrastructures such as standardisation of return of systems.
- Provide the same variety of products regarding brand, cost, and ethical and dietary preferences. Ensure the consumer doesn't feel like they have to compromise their preferences.
- Investigate consumers' disinclination towards reuse models or why they continue to prefer single-use options. Theories are diverse, ranging from reuse systems needing to cause less friction to users habituated to single-use systems. In contrast, others pledge that totally different approaches are required to disrupt habitual behaviour.
- Further investigation is needed into consumer constraints for using reusable packaging for on-the-spot consumption and takeaway services.
- Investigate what sizes of packaging consumers perceive as convenient and why.
- Recognise and consider that consumers' perception and tolerance of appearance can change with the introduction and acceptance of reuse systems.
- Prove and communicate the positive impact of reusable packaging over single-use options. Provide reassurance of the wider benefits of reuse systems, including environmental and economic savings in comparison to recycling or single-use. If possible, calculating the positive environmental impact of individualised action can boost motivation (IGD, 2021).
- Ensure sustainable training of staff when implementing reuse systems.
- Reusable packaging systems need to be straightforward to use not only for private consumers but also for large-scale B2B operations and public institutions (e.g., school canteens, hospitals, and elderly homes).
- Develop reuse systems that incentivise all users, not only consumers, to return packaging.

5. Needs & constraints of the industrial value chain

This section elaborates on the needs and constraints of partners in the industrial value chain. For this, use-case partners have shared insights concerning:

- Current packaging specifications.
- The envisioned concept for the substitute reusable packaging.
- Emerging needs and potential constraints when switching to a reusable packaging system.

A generalised value chain for reusable plastic packaging has been used to highlight anticipated needs and constraints within different segments in the value chain with each other.

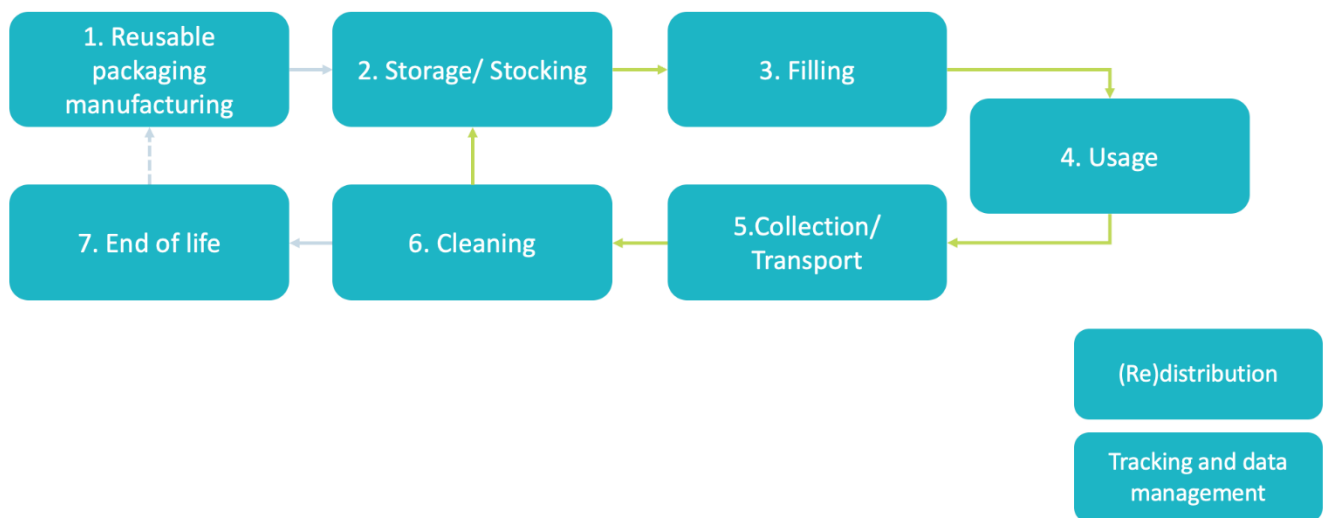


Fig 2: Generalised value chain of reusable plastic packaging

The image of the value chain (VC) shows a generalised version of the RPP applications studied in the BUDDIE-PACK program. For almost all applications, there will be deviations from this generalised version, of course, mainly in the order of value chain steps (e.g., cleaning takes place before collection). On the right side of the image, two extra chain segments are visible: (re)distribution and tracking and data management. These elements are relevant for investigating needs and constraints for design specifications but do not have a specific position in the VC. These steps are almost omnipresent and mostly reoccur multiple times during one cycle (e.g., tracking packaging data after filling, after usage, and after cleaning). While the green arrows show the in-use cycle of RPP, the light blue arrows include the production and end-of-life aspects. The arrow between “end-of-life” and “RPP manufacturing” is dotted, as regulations are not clear on the legality of closed-loops recycling for reusable packaging. However, technically this could be a possibility.

5.1. Findings

For this section, it must be considered that the information provided is predominantly based on assumptions and expectations of industrial partners. Needs and constraints are shared from a forward-looking hypothesis, as most use cases do not yet have reusable packaging in place. This said it cannot be

ruled out that specific needs and/or constraints might have been overlooked or are valid for another application or user scenario. A reevaluation at a later stage in the research is recommended.

As the findings will feed into T1.3. *specifications for reusable plastic packaging*, the assessments of needs and constraints in the industrial value chain are organised according to the input needed in T1.3.:

- Technical aspects, including washing, safety, and quality
- Socio-economic requirements
- Consumer expectations

When switching from single-use packaging applications to reusable systems, needs and constraints must be fully understood. Needs indicate what aspects are regarded as necessary properties for the new reusable packaging. Constraints indicate challenges anticipated or experienced when switching to a reusable alternative. Together, the needs and constraints provide essential insights for designing the packaging and the system in which it operates.

Input is generated through the input of relevant stakeholders along the chain segments. However, not all stakeholders are actively engaged in all value chain segments. Therefore, stakeholders only represent the needs and constraints of selected chain segments.

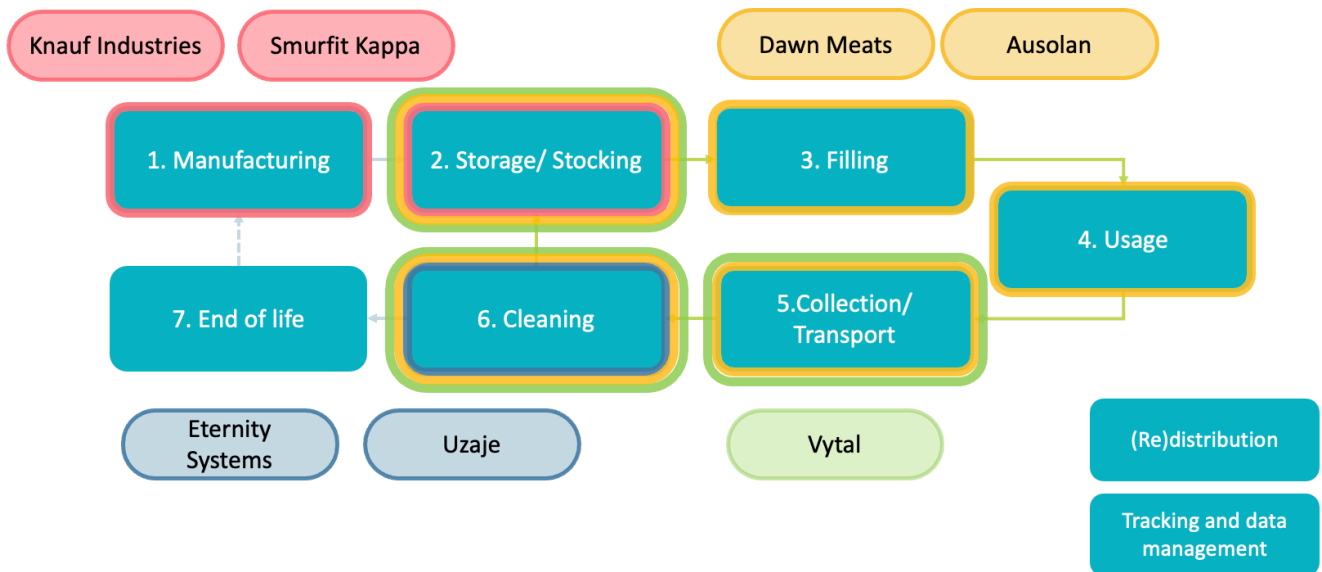


Fig 3: Involvement of use-case partners along the industrial value chain

- Packaging manufacturer
- Packaging owner (owning customised reusable packaging used for their company only)
- Packaging provider (renting system)
- Industrial cleaning company

However, chain actors also indicated needs and constraints which might be anticipated in chain segments in which they are only indirectly involved (e.g., needs of the cleaning companies that must already be considered in the manufacturing stage). Therefore, the differentiation of companies is made to understand best where information is coming from, which is relevant in the research for developing business models.

Reusable packaging manufacturers

Within the BUDDIE-PACK research project for the development of six reusable packaging applications, four companies are responsible for manufacturing the applications.

- Knauf Industries will manufacture the packaging for the use cases:
 - Rigid takeaway trays for restaurants
 - On-the-spot consumption in supermarkets
 - Semi-rigid catering trays for school and nursing homes
- Smurfit Kappa will manufacture the flexible bag-in-box solutions for:
 - Refill for personal care
 - Refill for antiseptics
- The Technological University of Shannon will manufacture:
 - Reusable meat skin packaging (R&D) Tray. The film component will be investigated by IPC (functionality of multi-material nanolayer film) or be sourced outside the consortium.
- Asevi:
 - Refillable bottle for home care product

Packaging owners

- Ausolan: Catering services (B2C)
- Dawn meats Group: Meat-skin packaging (B2B)
- Asevi: Refillable bottles for homecare products (B2C)

Packaging providers

Along the industrial value chain, there are two packaging providers in the BUDDIE-PACK consortium who will provide reusable packaging to end-users. These are B2B (business-to-business) and B2C (business-to-consumer) models.

- Vytal: Reusable packaging for restaurants (B2B)
- Uzaje: On-the-spot consumption (B2C)

Industrial cleaning companies

Despite some use cases being able to be cleaned in-house, most packaging does need to be washed by an external industrial cleaning facility. Two cleaning companies specialising in reusable packaging are part of the BUDDIE-PACK consortium.

Eternity systems:

- For all use cases except for on-the-spot consumption

Uzaje:

- On-the-spot consumption

In the following overview, a baseline of needs and constraints along the industrial value chain of reusable packaging is provided. Insights from individual use cases are merged. Insights on needs from individual use cases can be found in Annex I.

1. Manufacturing

For needs connected to manufacturing, several aspects are found. Most are of technical nature, some of which will re-occur in other chain segments. Technical needs are the main determinants for making the right material choice. For this, aspects and requirements of the packaging content (such as different kinds of foods) are considered, as well as the way the content needs to be prepared and stored.

Temperature resistance, including standing oven and fridge temperatures, must be considered. Depending on the content of the packaging, aspects such as permeability must also be considered. This applies, for example, to the packaging of meat, as the oxygen and gas barriers play a crucial role in preserving the food inside. In addition, protection against light (artificial or sunlight) should be considered for certain products which are light sensitive which causes unattractive oxidation.

Furthermore, the durability of material is crucial to packaging providers. Although maintenance of packaging, such as washing, and handling, may play a key role, the right material choice is imperative to allow a long product life. Relevant criteria indicated are durability, no discolouration, scratch resistance, and lasting closure functions linked to lids. Generally, durability is highlighted by all use cases as a need for packaging design.

Moreover, and rightly, the end-of-life scenario of packaging is mentioned as a need for packaging design in manufacturing. This is also linked to material, in this case, making the right choice of easy-to-recycle materials (mono-materials). Besides, including maximum recycled content is indicated as a need to maximise the sustainability of non-food packaging.

From an economic perspective, the need to allow price neutrality with single-use packaging is highlighted and shall be considered in the material choice and production technique.

Furthermore, a logistical need is noted related to the availability of packaging. Packaging users indicate the possibility of a sudden rise in demand for reusable packaging. Avoidance of extended delivery times and prompt availability will be relevant to satisfy customers and prove the viability and convenience of reusable packaging systems.

However, constraints of the manufacturing process related to economic factors are also expressed. The new, reusable packaging might no longer be compatible with existing filling lines. This would cause a fundamental change of logistics and investment in machinery, which companies are not likely willing to make.

2. Storage/ Stocking

Different to single-use packaging, reusable packaging needs to be stocked and stored in between use cycles. Stakeholders of the industrial value chain therefore stress the need for nestability or stack-ability of packaging. This is relevant to minimise required storage space and optimise its use. This also accounts

for the transport of packaging. It must be considered that packaging is transported in three conditions: filled, empty and dirty, and empty and clean. The design of the packaging must accommodate ideal storage in all conditions.

Furthermore, companies highlight the need to be able to stack packaging in standard box formats in order to maintain existing storage- and handling systems. Storing is not only happening in the back end but also in the store, visible to consumers. Consumer-facing storage, therefore, needs to be efficient in not taking up too much space as well as looking attractive to engage with.

As anticipated, quite some constraints for stocking, multiple sizes, uncertainty about volumes, and extra efforts in the packaging handling process are emphasised. An open question from companies concerns the need for different packaging sizes. How many different sizes are needed? Companies perceive a possible constraint, as different sizes might affect the ability to stock and store efficiently. Furthermore, being unfamiliar with reusable packaging systems, value chain partners feel a constraint in estimating how much packaging is needed to be stored. Especially for products with a longer shelf-life, such as home care products, a consumer might develop a rotating system, having 2-4 packages in use at the time. This likely, but uncertain behaviour is perceived as a constraint from industrial value chain players when switching to reusable packaging. It also directly links the need to deliver packaging quickly from the manufacturing site, if needed. There are also concerns about storing that may require manual handling, which costs time and would add to the costs of the packaging system.

3. Filling

Filling-related needs concern saleability and control mechanisms. Leak-proof lids, also after several use cycles, are a must for packaging users to be able to exploit reusable packaging systems. Furthermore, fresh content requires heat-sealable packaging. In scenarios where consumers consume food from the packaging and food is prepared for direct consumption, packaging needs to be able to maintain the food in a hot-to-warm condition.

Another aspect is integrated visual control mechanisms in the packaging. Allowing visual insight into packaging without re-opening is stated as a need. Opening packaging between filling and final consumption must be avoided to eliminate risks of food contamination.

Constraints in the filling process are related to food safety and logistical challenges.

Contamination of content with molecules from previous fillings (cross-contamination) is a worry. This risk can be minimised through standard cleaning procedures and an integrated hygiene testing step before cleaning.

A key concern is the impact of reusable packaging on the shelf-life of products. Food waste is a non-acceptable trade-off to eliminate plastic waste. This is especially relevant for sensitive products such as meat. Not only does the objective shelf-life play a role but also the visual state of content. Meat, for example, is prone to oxygenation, causing discolouration of products. Consumers will not accept a limited product condition. Hence, reusable packaging must ensure the same shelf-life conditions as single-use packaging.

Reusable packaging will not only be filled on industrial sites. Refillable packaging will demand consumers to fill packaging themselves (in-store or at home). Value chain partners perceive main constraints in the

cleanliness of the filling process and lacking control over the amount of product filled. Spilling and adequate measuring come across as the biggest concerns.

4. Usage

Most needs in the usage stage are related towards consumer handling. Communication, ease of use, and pre-cleaning instructions are overarching needs. As reusable packaging requires considerably more user engagement than single-use packaging, communication on *how* is needed. To convey information on rules and regulations of packaging use, it must be able to display and communicate via the packaging, point-of-sale, or other methods, e.g., a QR code to a site with more info. This may include information such as return cleaning instructions and return options. Some chain partners expect packages to be pre-cleaned, while others prefer as little cleaning as possible. Too much consumer cleaning, and with that usage of water, can negatively impact the LCA of reusable packaging. Regulations may also restrain eating from packaging with sharp cutlery, such as kitchen knives. Appropriate handling is a relevant aspect to extend the packaging life.

Not only is displayed information about cleaning needed, but pre-cleaning activities should also be easy. This means no shapes that are complicated to handle or materials that require specific washing detergent. Ease of pre-cleaning does not only count for private consumers but also for B2B business cases: restaurant and canteen staff need to integrate the pre-cleaning process in their overall tasks easily.

Furthermore, and most central, reusable packaging must serve consumers. Through single-use packaging, consumers are used to the convenience of packaging. Packaging providers, therefore, indicate that reusable packaging should essentially work the same as single-use packaging for consumers to accept it. More insights on what consumers need in contrast to what value chain players assume they need is given through more in-depth information in D 2.1. *report describing how consumers interact with reuse systems including how aspects of contamination influence engagement.*

Constraints in the usage process relate to the handling in terms of cleaning as well as the continued performance of the product. Specifically, in restaurants in industrial circumstances, packaging must be pre-cleaned in order to maintain the overall hygiene of kitchen environments. This means more work for personnel. Since, from a packaging perspective, immediate cleaning might not be needed (industrial cleaning after 1-2 days might be sufficient), industrial chain partners see a constraint in that the picture of the overall kitchen, packaging hygiene is overlooked. Pre-washable set-up is therefore stressed as an important point.

Further constraints are anticipated in the closing of the packaging and the maintenance of the overall shape. Packaging becomes intolerable if packages shrink or deform too easily through usage.

5. Collection/ Transport

Transport is a key aspect of reusable packaging. Although transport ways and distances should be kept to a minimum, it is not avoidable. Depending on the packaging concept (pre-fill or refill in-store) packaging is transported either empty or filled to the user/consumer (B2B or B2C). It is then collected after consumption for cleaning and later redistributed to fillers and users/consumers.

For both distribution and collection of packaging, mainly technical and logistical aspects play a role. As transport type and distance play a significant role in the life-cycle assessment, designing reusable packaging to be as light as possible is relevant.

As logistics have a huge impact, well-organised systems, shared transport options, and efficient distribution services are mentioned as a need linked to collection and distribution. This has implications for the shapes and sizes of the reusable containers to avoid transporting pockets of air or inefficiently packed pallets.

All transport modes pose challenges to packaging keeping contents safe. Some packaging users see a possible constraint in liquids escaping packaging during transport movements since reusable packaging can't be heat-sealed.

6. Cleaning

Cleaning is key to reusable packaging systems. Several aspects are regarded as needs from industrial chain partners.

Hygiene and appearance obviously are central needs to the cleaning process. However, hygiene and appearance are not equivalent. Assuring HACCP (hazard analysis and critical control points) standards is required for all packaging types, regardless of content. More information on HACCP will be provided in D5.3.

Despite compliance with HACCP, packaging can show an inadequate appearance. Stain resistance is a need across all packaging formats. This accounts for stains from food residuals as well as stains from cleaning. Proper drying is, therefore, also a need that categorises under appearance.

Another technical need is traceability. During the cleaning process, data on the food previously contained in the container and the number of cycles the packaging achieved must be accessible. Access to this information is mainly relevant to stakeholders for being able to justify product safety and, in case, to understand at what stage things went wrong.

Proximity plays a role in justifying outsourcing cleaning to industrial cleaning facilities. Cleaning on premises such as restaurants, supermarkets, or catering facilities can be possible. Stakeholders of the industrial value chain highlight the need to determine whether cleaning on-site or outsourced cleaning makes more sense from an environmental perspective.

An anticipated constraint in the cleaning process is drying. Plastics are not as easy to dry as other reusable packaging materials such as glass and steel. A risk of not correctly dried material is the nesting and growth of microorganisms. However, the appropriate drying techniques are readily available, according to the cleaning partners in this project.

7. End-of-life

After a certain amount of reuse cycles, packaging reaches its end-of-life. Systems to determine the indicators for end-of-life typically note by which parameters a packaging is no longer fit to be re-introduced in the filling cycle. Different factors such as material deterioration, odour, or aesthetics can evoke end-of-life.

To create truly sustainable packaging, all elements must be reusable. This is a shared need of all stakeholders in the industrial value chain. However, in some packaging where films and flexibles are irreplaceable, single-use elements combine with reusable packaging. In the scope of this research, we work with single-use bag-in-box solutions for bulk-dispensing systems. Furthermore, meat-skin packaging might include some single-use elements, such as film. Generally, flexible packaging is likely not to be reused. Hence, especially for those elements, recyclability is essential. Value chain actors indicate the need to increase recyclability to a maximum to circumvent adverse effects on the overall system. For this, closed-loop recycling is important to consider.

Next to the importance of the recyclability of single-use packaging components, the end-of-life of reusable packaging is relevant regarding recyclability. Compared to reusable packaging made from glass or stainless steel, reusable plastic packaging has a reduced lifetime. Recyclability of the packaging is therefore imperative. Stakeholders perceive most constraints in the choice of the material. To maintain high recyclability of packaging certain material choices such as multi-material combinations, additives, and colours are excluded. Also, materials that withstand heat, such as cPET, can be problematic as they are not well recycled in most countries. The recyclability of the overall packaging must therefore be an elementary part of the packaging design process.

Closed-loop recycling could be an option for some reusable packaging. Specific packaging which only carries the same type of food, e.g., meat skin packaging, stands a chance for this solution. For other reusable packaging applications that contact different types of foods throughout cycles, such as catering- and takeaway packaging, closed-loop recycling is more problematic. Furthermore, legislation is viewed as a constraint. Closed-loop recycling is not accepted in all geographical contexts. This requires special attention for packaging crossing borders. An understanding of legislative context and infrastructure needs to be obtained.

Traceability

Traceability is an element relevant throughout the entire value chain. Data about the packaging and the contents is required in multiple chain segments and steps. This means that traceability systems must serve the needs of numerous stakeholders in the supply chain. Traceability is not only linked to understanding the packaging journey but also to tracing the content of the packaging to assure product- and food safety.

Most highlighted needs from stakeholders are of a technical and logistical nature.

Some companies must keep current labelling systems to comply with the overall labelling system of a company.

A further criterion is the reusability and recyclability of the tracking systems. Labels need to withstand multiple washing- and use cycles. This is especially relevant for imprinted labels, such as lasered versions. Looking at the end-of-life, some incorporated tracking device choices can complicate the overall product recyclability. This is imperative to avoid.

Companies currently see constraints in defining the advancement level of tracking systems. What data needs to be generated, what data must be stored, and for how long? For research purposes, of course, as much as possible should be collected to give in-depth insights into the system. However, an applied data and control point system needs to be developed. With data generation, also data management will be required, which is another cost factor for the reusable system. However, smart data management is vital to generate higher consumer engagement and return rates.

6. Recommendations

The findings provided above lead to several recommendations in terms of needed specifications for reusable packaging applications.



Material choice

From conducted material tests, there is no “one size fits all” solution. Depending on consumer needs and adaptation behaviour (B2B or B2C), financial viability, environmental benefits, and functional requirements, the selection can be made for most suitable material.

Withstand required temperature and temperature fluctuations

When thinking of the needed temperature threshold for packaging, remember that all packaging needs to be washed, and some packaging will be cooled or heated. I.e. packaging that is designed for chilled food needs to withstand washing temperatures bound to effectively eliminate bacteria according to HACCP standards. Washing temperatures range from minimum 43°C to a maximum of 84°C depending on length of washing time and causticity percentage.

For packaging that contains food that requires pre-heating, it is vital to determine if microwaving is a suitable solution and oven temperatures can be avoided. This allows for more freedom in material choice which is relevant for a sustainable end-of-life of packaging.

Material selection needs to avoid breakage, and should be durable, resistant, light enough to facilitate transport, and resistant to cold (1 to -4°C) and humidity during transport.

Inviolability/ Durability

Aesthetics

Material selection needs to consider consumer-appeal: they must be attractive and clearly recognizable as reusable by the consumer. It is also very relevant that the packaging is designed for durability and tamper-proof. However, shared reusable packaging has different boundaries than packaging that is reused and owned by consumers (household level).

Shared reusable packaging must meet higher standards in terms of aesthetic requirements such as discolouration and scratches (signs of use). Any functional durability that goes beyond aesthetic durability of the packaging might be purposeless. Therefore:

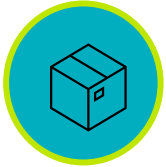
- invest in material that maintains aesthetic features (no discolouration, scratch- proofness, no smell uptake) as long as possible.

Consumer acceptance of reusable packaging is tightly bound to norms and experience. This may vary greatly depending on packaging types. To learn more on consumer acceptance for defining the limits of reusable packaging, read more in report D 2.1.

Opening and closure mechanisms

Lasting closure mechanisms are a relevant factor for the lifetime of reusable packaging.

- The opening must be large enough to allow the filling, hermetic, stackable, as transparent as possible, tamper-proof, and/or sealable. They must adapt to industrial production lines.
- Design closure mechanisms which last and are not prone to wear and tear. The closing system must be resistant to shocks during transport in heavy trucks, on (filmed) pallets.
- Make sure replacement parts are available if packaging must consist of more than one part (e.g. lid and tray). This way, not the entire product needs to be replaced in case of defects.
- Design spill-proof packaging which can withstand transport and handling movements. This includes a leak-resistant lid system.
- Incorporate a good seal for packaging, which can be standardised and harmonised, just like the packaging body. Design to prevent contamination, preserve quality, and avoid counterfeiting.



Storage/ stocking

Effective storing/ stack-ability

Compact storing is key for reusable packaging. Effective storing takes place in different environments: empty, new and cleaned packaging stored in warehouse before use, filled in stored and during transport, dirty on-site and during transport.

Think of different systems that allow compact storing during all these phases. Consider the different conditions of packaging (empty-clean, filled, empty-dirty).

There can be different solutions. Think of:

- Foldability
- Stackability (on top of each other in a secure way)
- Nestability (inside each other)

Design packaging that is stackable when full and nestable when empty. Include stackable lids and preferably modular sizing.

For consumer packaging, the size of the packaging should be adapted to be hold in a refrigerator. The design also needs to consider fragmented and on-the-go consumption (seal/re-seal ability or re-closable packaging).

Size & Volumes

Because different sizes of packaging are needed, also more storage is needed with empty boxes that are used in case of a peak in demand. A solution to reduce storage of many sizes is to design size-adjustable packaging. This way, packaging can be used in any case and can be enlarged or scaled down if needed. A modular design is recommended to accommodate this feature.



Filling

Shelf-life

Design packaging that doesn't compromise on shelf-life of food. This accounts especially for all packaging that is not designed for consumption within 1-2 days. Not all reusable packaging requires hermetic sealing, but some do (such as meat packaging). Sealing solutions for reusable plastic packaging are unfortunately likely to be single-use. Another solution can be vacuum packaging through a one-way valve system, a technique that requires further large-scale testing.

Control

For many applications, the see-through functionality of packaging is desirable. Not opening the packaging between filling and final use is required to exclude risks of contamination. For e.g. in the catering sector, visual controls of food is a requirement by contracted facilities.

Especially for fresh food, consumers like to visually check food before purchase. Using transparent packaging can also enhance shelf-appeal.

A see-through lid or window should therefore be considered in the design phase.

There is also a downside to transparent packaging, as it is more prone to discolouration. Consider an advanced labelling system for the packaging over choosing materials with a shorter lifetime.

Infrastructure compatibility

When designing reusable packaging, take the technicalities of current filling lines into account. Ensure that packaging is compatible with filling lines and don't disrupt current practices or require new filling machinery to reduce investments needed when switching to reusable packaging systems.

Contamination

Not all materials are suitable for reusable packaging. A chosen material must not migrate to the product or vice versa.

- Conduct migration test for food contact materials

Definition: 'Migration is a known phenomenon defined as the partitioning of chemical compounds from the packaging into food.'

Migration testing is done for all materials introduced as food contact material (FCM), the essays are often time-consuming because testing requires specific conditions (temperature, storage time, impact in transport) to investigate the behaviour of the packaging in different situations. When the migration from material to the product or vice versa increases over time, the material is not suitable for multiple uses. For single-use packaging only one migration test is performed to test migration. For reusable packaging, three tests are performed with washing cycles in-between tests, and the migration levels in the third migration test counts. The materials that are approved for single-use packaging are therefore not necessarily also approved for reusable packaging. If higher levels of migration are measured in the third test compared to the first test, this type of packaging is not considered to be suitable for reuse.

For more information, read report D 3.1.



Usage

Communication: pre-cleaning

Define where and how the reusable should be cleaned.

Consumers should be informed of cleaning recommendations when purchasing the reusable, and such information should be readily available for reference later on. Furthermore, it is relevant to:

- Communicate clearly what level of cleanliness is expected from the consumer
 - E.g. no cleaning at all, or swept clean with a dry cloth/paper tissue, or cleaned with soap and water, or cleaned thoroughly and disinfect with food-grade disinfectant.
- Instructions should be available/ visible on the package or container label.
 - Alternatively, in-depth information can be displayed at the point of sale or via QR code online.
- Be extra careful in providing cleaning and sanitation instructions to consumers when the content is prone to microbiological spoilage and pathogens (e.g. dairy or fresh meat)
 - Especially for these types of products, offering on-site solutions for consumer cleaning may be considered.
- For cleaning at home, the process should involve readily accessible products and familiar mechanisms.
 - If specialty items such as a bottle brush are needed, such items should be available for reusable packaging.
- Make reliable and free resources available to consumers to guide them through a proper cleaning and sanitation process at home.

Communication: convenience and reward systems

Reusable packaging will require behavioural change and asks consumers to change the way they consume. To facilitate consumers to switch from single-use to reuse-options, a high convenience level must be offered.

Reusable packaging concept should be straight-forward, and mainly work the same way as single-use packaging.

- Design the packaging and packaging system in a way that minimises (time) effort to operate the reusable system (open/closing, filling, washing, returning), and encourages consumer retention. Highlight the ease of the system.
- Design the packaging system in a way that prioritise perceived or real costs over longer-term benefits. It is nevertheless important to communicate the impact/benefits in an app and in store.
- Provide step-by-step instructions, and use bigger, more prominent communication material with visuals/icons.
- Train staff handling the packaging so that they can promote reuse and answer questions effectively.

For refill systems, make sure packaging is designed in a way that the filling process is clean and efficient.



Collection/ Transport

Reverse logistics

To ease and optimise logistics, there are several points that should be considered for designing a reusable packaging system:

- Use a standardised design to enable pooling and scalability: ensure packaging is well-stackable, to ensure efficiencies in logistics.
- Work with a centralised system, such as pick-up services: collaboration is vital for success. Use a shared collection service with other reusable packaging users to collect empty containers from premises. Smart drop-off points which are easily accessible can be a suitable option to also enhance convenience for end-users. For more specific design guidance on collection points see [PR3 guidelines](#).
- Proximity: Pick a logistics company that is specialised in reverse logistics to make sure use is made of empty back-loads. Also check the geographics coverage of the logistics provider to avoid unnecessary distances.
- Regular pick up: transport heavily influences the environmental performance of reusable packaging. Therefore, make sure that transport is efficient and utilise empty loads. Type of transportation also plays a role in limiting emissions. Evaluate therefore the type of transport and type of energy used (hydrogen, electric, fossil fuel).
- Preliminary storage: provide collection bins as part of the reusable packaging system. If a daily pick-up of dirty packaging doesn't make sense (not enough packaging), store packaging in pick-up bin to avoid any contamination of surroundings.
- Weight: next to distance, weight is a heavy factor in the environmental impact of packaging. To mitigate transport distances, design packaging light-weight (not at the expense of durability or recyclability).
- Consider secondary and tertiary packaging (transport packaging) when designing reusable packaging. Make sure packaging is compatible to standards sizes of crates and pallets.



Cleaning

Environmental impact

For a sustainable cleaning process the following factors should be considered:

- Distance: Location of cleaning facilities should be as close as possible to the refill location.
- Equipment: Ensure cleaning and sanitising processes are designed with minimum environmental impact. Consider closed loop systems for water, renewable energy sources for heating, and low toxicity options. Industrial dishwashers are 17 times more efficient from a carbon footprint point of view than manual cleaning.
- To define ideal washing process, the TACT (time, action, chemistry, temperature) principle can be used. The four criteria are interdependent, if one is lowered another one has to be increased to assure hygiene. The ideal combination of factors should be defined for each packaging and material.

Hygiene

When working with food packaging, packaging users are required to assure HACCP (Hazard Analysis Critical Control Points) guidelines. Make sure to cooperate with a cleaning facility that is certified. To be able to guarantee hygiene, inspection results should be recorded.

To enhance hygiene, the initial packaging design is crucial:

- Avoid packaging with hard-to-reach areas where dirt/bacteria can become trapped.
- If not consisting of 1 part, make sure packaging is easy to assembly – disassemble.
- The decisive hygiene factors generally **residual soiling**, the **amount of germs**, the **degree of dryness** and **storage conditions**, so that micro-organisms do not multiply. If the containers are largely dry and shaped in a way that air can still circulate even when stacked, the risk is very low. (Handwashing-drying is a no-go from a hygienic standpoint)

For washing, define what is required to ensure the safety of the product intended to be filled into the container, and mark those points that apply to the product:

- A sanitising step based on the safety requirements of the product:
 - Immediately after cleaning
 - Before filling/use
- A control step for pathogenic bacteria is necessary based on the safety requirements of the product.
- A control step for food allergen contamination is necessary based on the safety requirements of the product.
- A control step for product residues is necessary based on the safety requirements of the product.
- A control step for off-odours is necessary based on the safety/quality requirements of the product for cleaning.

Return of packaging in decent condition & no food leftovers

1. Communication to customers (no leftovers in packaging)
 - Companies might suggest that they do not accept packaging that is filled with food rests.
 - Standards/ acceptance criteria.
2. Training of partner venues
 - For consumption on the go the drop-off location needs to be trained
 - Visual scan

Control state of packaging before cleaning

Define **acceptance criteria**:

- How many scratches /cuffs/grooves are accepted if any?
- Should the packaging be odour free?
- What is the accepted colour range?
- How flexible or inflexible can the packaging be in comparison to its original structure?

Define **how to inspect**:

Visual inspection: defects are checked visually by inspecting the container.

Physical inspection: defects are checked by handling/ feeling the container and/ or swabbing for micro-organisms.

Automated inspection: by systems such as cameras, vision or x-ray.

Define the **scope of inspection**:

- How often
- When and where (before or after washing, filing, and/or storing)
- How extensive should the inspection be
- Consider that over time, some packaging may have gone through more cycles than others and are not representative. Take this into account when considering random checks



Traceability

Compatibility with existing systems

Choose a tracking and data management system which interfaces / is part of existing inventory management systems.

Standardisation

For tracking mechanisms: standardisation is recommended. Currently, data management programmes for reusable packaging have largely been operating in isolation. The PR3 initiative has developed a great [outline for standardisation of data systems](#).

Reusability

Labelling shouldn't compromise the reusability of packaging. Fast development of tracking technology must be anticipated when considering labelling options. While selecting the most suitable technology, working with washable, removable labels could be considered.

Permanent information

Permanent 'labels' are best applied to a place where they will have as little damage as possible throughout their lifespan, often this can be either at the bottom of the packaging or protected by embossed parts on the packaging.

- Brand owners that own reusable packaging can choose to put permanent branding on the containers, but this is not encouraged
- The reuse symbol (i.e., PR3 standard) is recommended on containers and must be included on the outer surface of the container. It must be applied in the required colour(s) of orange, black, and/or white or be colourless (e.g. embossed). Colour of symbols:
 - The colour used for symbols should be black. If the colour of the package is such that the black symbol would not show clearly, a panel of a suitable contrasting colour, preferably white, should be provided as a background.
 - Care should be taken to avoid the use of colours which could result in confusion with the labelling of dangerous goods. The use of red, orange or yellow should be avoided unless regional or national regulations require such use.
- Containers must include text that indicates the container is returnable and instructions for container return and cleaning. Instructions could be provided through a link or QR code, and product info can be shared through digital tools or tracking.

Temporary information

Temporary 'labels' must be easy to apply, resistant to damage in transport, and easy to remove in the wash cycle without leaving any residue. These labels are typically used

- 1) to share content-specific information; and
- 2) when packaging is pooled/shared by several brands.

In the last case, there is a standard packaging that can be cleansed and shipped over to the closest venue where there is demand, at this venue a brand's temporary label can be attached to the reusable packaging.

- Brand owners that share reusable packaging can choose to put temporary branding on the containers
- Any labelling information that is specific to the contents of the container, such as batch number, must be removable and reapplied in subsequent use cycles.

For more digital design guidelines, review the [PR3 guidance](#).

Recyclability

Chose an option which enables the reusable canister to be recycled at the end of its life. For example, RFID chips contain aluminium and other materials which affect recyclability. Moreover, the RFID chip contains aluminium, which is an energy-intense material and mining it causes severe environmental damage.

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Annex I - Needs and constraints along industrial value chain of reusable packaging

Manufacturing (1)

Needs:

Technical needs		Use case application
Temperature	Oven able (120°C)	Take-away (1), catering (4)
	Microwavable	Take-away (1), on-spot consumption (2), catering (4)
	Blast Chiller (8°C)	Take-away (1), catering (4)
	Fridge (4°C)	Take-away (1), on-spot consumption (2), catering (4)
Inviolability/ Durability	Scratch proof	Take-away (1), on-spot consumption (2), catering (4)
	Lasting lid function (closure)	Take-away (1), on-spot consumption (2), catering (4)
	Durable colour	All
Material	Recyclability	All
	Durability	All
	Maximum recycled content	Personal care (3)
	Permeability properties for oxygen, gasses, and light	Meat-skin (5)

Economic needs		Use case application
Costs	Clients typically request cost neutrality compared to standard packaging	Meat-skin (5)

Logistical needs		Use case application
Availability	New containers need to be delivered short term if there is an urgent demand	Take-away (1)

Constraints:

Technical constraints		Use case application
Production	New, reusable packaging options might not be compatible with existing filling lines.	Manufacturer

Storage/ stocking (2)

Needs:

Technical needs		Use case application
Stack-ability	Relevant to optimise/ minimise storage conditions	Take-away (1), on-spot consumption (2), catering (4)
	Improving the quantities during deliveries	Manufacturer

	Packs will need to be storable in a standard box format to fit within the existing storage system	Take-away (1), on-spot consumption (2), catering (4), Meat-skin (5)
	Packs will need to be able to arrange efficiently on shelves in supermarket retail units	Personal care (3)

Constraints:

Logistical constraints (system design)		Use case application
Size	Question on how many pack sizes need to be available (e.g. S/M/L). The more pack sizes, the more storage at the location is needed.	On-spot consumption (2)
Volume	Question on how much packaging (brand new) needs to be in stock.	Catering (4)
	Consumers might keep more than one pack at a time (rotation system). Stores need to be equipped with enough packaging as well as expecting mass returns.	Personal care (3)

Filling (3)

Needs:

Technical needs		Use case application
Seal-ability	Leak-proof lid	Take-away (1), on-spot consumption (2), catering (4)
	Heat stable	Take-away (1), catering (4)
Control	There needs to be the possibility to see the container contents to avoid opening and closing (contamination) and avoid the risk of handing out the wrong mela to the consumer.	Catering (4)

Constraints:

Technical constraints		Use case application
Contamination	Migration of food molecules, the possibility of cross-contamination → test before filling	Catering (4)
	All product needs to be removed. No remnants of possible allergens	Personal care (3)
Shelf life	Should not negatively impact the shelf-life of products Should be hermetically sealable to avoid any discolouration of food.	On-spot consumption (2), Meat-skin (5)

Logistical constraints (system design)		Use case application
Control	The filling process by customers must be clean and controlled (amount of product)	Personal care (3)

Usage (4)

Needs:

Technical needs		Use case application
Communication	Rules & regulations of usage must be visible to users.	Take-away (1), personal care (3)

	Return of packaging in decent condition & no food leftovers.	Take-away (1), on-spot consumption (2)
Ease of use	Should work essentially the same as current single-use packaging in operation.	Meat-skin (5)
	Convenient to eat from.	Take-away (1), on-spot consumption (2), catering (4)
Pre-cleaning	Should be easy to clean and store in the client's premises before removal for cleaning.	Catering (4), Meat-skin (5)

Constraints:

Technical constraints		Use case application
Handling	Needs to be pre-cleaned to maintain hygiene standards at premises.	Catering (4), Meat-skin (5)
Sealing	Packaging should be capable of sealing effectively over a defined number of multiple re-uses. Packaging should not deform due to re-packing requirements or deteriorate in quality over agreed multiple uses.	All

Transport (5)

Needs:

Technical needs		Use case application
Weight	Light-weight to allow positive LCA	All

Logistical needs		Use case application
Logistic service	Integration into delivery apps	Take-away (1)
	Distribution service	On-spot consumption (2)

Constraints:

Technical constraints		Use case application
Leakage	Through movement while transport, liquids might escape.	Catering (4)

Cleaning (6)

Needs:

Technical needs		Use case application
Hygiene	Compliance with HACCP standards	All food related
Appearance	Stainless	B2C
	100% dry	All
Traceability	Understand the cycles the package has made	All
	Information on what it had been filled with before	All

Logistical needs		Use case application
Proximity	Clarity over what is more sustainable: washing at premises or with an external cleaning company	Take-away (1), catering (4)
	Re-distribution between supermarkets	On-spot consumption (2)

Constraints:

Technical constraints		Use case application
Hygiene	If stacked before completely dry, risk of microorganisms	Cleaning company

End-of-life (7)

Needs:

Technical needs		Use case application
Recyclability	Preferably closed loop, especially for items that cannot be reused (film meat-skin, BiB)	Meat-skin (5), BiB (6)

Constraints:

Technical constraints		Use case application
Legislation	PP, which has been used as reusable food packaging, cannot be recycled and used in the food sector again.	Take-away (1)
	Recyclability of PP, cPET needs to be looked into	Manufacturer

Traceability

Needs:

Technical needs		Use case application
Compatibility	Essential to keep using the labels we currently use. Necessary for the central kitchen's logistics.	Catering (4)
Reusability	Labels need to withstand washing- and use cycles (durability)	On-spot consumption (2)
Material	Clarity on what tracking system works the best and allows recyclability of the packaging. IML or QR code on container - paper sticker or engraved.	All

Constraints:

Technical constraints		
Laser engraving	For now, it is not possible to identify the parts another way, but it marking/engraving (data matrix) is tested with different partners. This new technology should be implemented at the end of 2023.	Manufacturer
Data management	Clarification on how advanced the tracking system must be and what information is necessary to store/ use.	Personal care

Annex II - Consumer and user expectation of reusable packaging



Annex III - Consumer and user expectation of reusable packaging by market application

