CalRecycle

Needed State Report:

An Analysis of Actions and Investments to Achieve Source Reduction

A Plastic Pollution Prevention and Packaging Producer Responsibility Act Needs Assessment Technical Report

February 2026

Data and information used in this report provided by

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Prepared as part of contract number DRR24062

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Executive Summary

The Plastic Pollution Prevention and Packaging Producer Responsibility Act (Senate Bill (SB) 54, Allen, Chapter 75, Statutes of 2022) (the Act) established an extended producer responsibility (EPR) program to manage single-use packaging and single-use plastic food service ware (covered material) in California. The Act requires the Department of Resources Recycling and Recovery (CalRecycle) to conduct a statewide needs assessment to aid its implementation. CalRecycle awarded a contract to investigate the actions and investments needed to meet the requirements, specifically to source reduce single-use plastic packaging and single-use plastic food service ware (plastic covered material) 25% by 2032.

In this report, "source reduction" refers to reducing both the total weight of plastic and the number of plastic components in plastic covered materials. The goal is to reduce plastic use through design choices – such as removing unnecessary elements, making packaging lighter, simplifying components, and switching to nonplastic alternatives – so less plastic is needed overall. Under the Act, source reduction also includes using reusable or refillable items instead of plastic covered materials.

This report identifies potential approaches, and the associated actions and investments, to achieve the requirements in Public Resource Code (PRC) section 42057. These requirements include reducing plastic covered material 10% by 2027, 20% by 2030, and 25% by 2032. Transitions to reuse and refill systems must also meet minimum targets of 2% by 2027, 4% by 2030, and 10% by 2032.

The actions and investments identified in the report are not meant to be prescriptive. They are meant to illustrate how different strategies and investments provide opportunities across the entire system and value chain to achieve the requirements of the Act.

Harmonization and Collaboration Underpin System Needs and Costs

The distribution networks and logistics systems of today were developed over the past fifty years to minimize the cost of single-use packaging and plastic food service ware, often while creating negative environmental impacts. To achieve the source reduction requirements, new and updated infrastructure will be needed for reuse and refill alongside material design changes and innovations to reduce the weight of and number of plastic components of plastic covered material. Other source reduction strategies will require research and development and upgrading existing filling lines. All source reduction strategies will need education and outreach to build durable change across the state.

There are many benefits to a harmonized and collaborative approach to achieving the requirements, including cost savings, further environmental benefits, robust local economic development and a more accessible and affordable reuse system for all Californians.

Almost all stages involved in a reusable packaging or food service ware system are affected by system harmonization and collaboration between actors. System harmonization is the degree to which infrastructure is shared by different system actors, driven by the standardization of packaging/food service ware designs. Standardization of designs enables the same machinery (e.g., filling and washing) to be used for all producers selling a particular good and similarly allows one unit of packaging to be used by any producer selling that good. This results in more efficient sorting and transportation processes, reducing the amount of infrastructure needed, and helping to drive down costs. Data from systems outside the United States in published reports show the potential for pooled, reusable packaging systems to deliver cost savings.

Key Findings

Not all source reduction strategies will have an impact on both the weight of plastic covered material and the number of plastic components.

The characteristics of the plastic covered material should be considered jointly with the potential impacts of each strategy to ensure the reductions can be met for both weight and number of plastic components.

The contractor evaluated the source reduction baseline to understand the relative contributions to the total volumes in terms of sales channel (business-to-business [B2B] versus business-to-consumer [B2C]), type of plastic covered material (packaging versus food service ware; primary versus secondary versus tertiary packaging) and format (e.g., food service ware utensil, cup). This detailed breakdown facilitated the subsequent assessment of different source reduction strategies.

Overall, single-use plastic packaging (driven by B2B) was estimated to account for the majority of plastic weight, while single-use plastic food service ware applications account for a much higher portion of plastic components. Specifically, the evaluation highlighted that:

- Single-use plastic primary and secondary packaging accounts for about 50% of both total weight and number of plastic components, indicating source reduction strategies that reduce both weight and number of plastic components may be an effective prioritization for these items.
- Single-use plastic food service ware accounts for almost 40% of the number of plastic components, indicating strategies that reduce the number of plastic components may be an effective prioritization for those items.
- Tertiary packaging is estimated to make up more than 20% of the weight of plastic covered material, indicating strategies that reduce the weight of single-use plastic tertiary packaging may be an effective prioritization.
- More plastic components are associated with B2C channels compared to B2B channels, largely driven by the high number of plastic components used for B2C single-use plastic primary/secondary packaging, indicating strategies for reducing the number of plastic components from B2C may be an effective prioritization.

These findings illustrate that complementary strategies, like targeting different uses of plastic, provide opportunities necessary to achieve the requirements.

Some source reduction strategies have higher potential to reduce weight and number of plastic components.

Criteria were developed to evaluate the source reduction strategies and to identify the types of goods most suitable for reuse and refill systems, the types of packaging/food service ware most suitable for other source reduction strategies, and the possible level of reduction by weight and number of plastic components. These criteria included technical constraints, operational readiness, and end-user acceptance.

Based on the contractor's evaluation as outlined in this report, closed loop reusable food service ware and prefill in B2B contexts were identified as the reuse and refill strategies that were likely to be most effective in achieving the requirements for reuse and refill. Material substitution, elimination, and lightweighting for both B2B and B2C covered material were identified as the other source reduction strategies that were likely to be the most effective in reducing the weight of plastic covered material and number of plastic components.

Key Actions, Investments, and Opportunities

Building on the evaluation of source reduction strategies, the report presents two illustrative pathways to estimate the investments and outline actions for successful implementation to meet these source reduction mandates. In addition to source reduction strategies, each pathway incorporates the use of postconsumer recycled (PCR) plastic as an alternative compliance option.

This analysis does not prescribe how requirements should be met. Rather, it demonstrates multiple plausible scenarios and illustrates how different priorities, constraints, and implementation rates might shape industry response and outcomes.

Key Action: Design a system to build durable and equitable change for everyone.

Higher market penetration rates are predicted to result in an easier transition to reusable alternatives, rather than spreading effort thinly across a broader market. The analysis found that an average rate of 43% across the prioritized clusters of goods will likely contribute to successful implementation of the reuse programs. To allow for that level of market penetration, options for source reduced covered material should be available and accessible to a majority of Californians to support significant uptake across reuse, refill, and other source reduction strategies. Community engagement participants emphasized that source reduced options from trusted and culturally relevant brands were essential for widespread adoption. This highlights the need to consider reuse and other source reduction strategies through an equity lens, to create a system built for, and accessible to, everyone, to build sustainable and equitable change. Early investments that make sustainable choices accessible within existing shopping patterns, and leveraging inclusive design processes, combined with long-term infrastructure that reduces costs and increases convenience, can ensure reuse and refill systems work for all communities.

Unlike single-use packaging, which is often manufactured overseas, reusable packaging systems generally require local infrastructure for production, cleaning, logistics, and redistribution. This shift means that a substantial portion of the investments associated with reuse systems are likely to be reinvested locally, supporting California-based businesses and creating jobs. For example, reuse and refill will require new infrastructure development for washing, logistics, inspection, and container management across the state, which was estimated to create between 2,700 and 5,400 jobs in California communities to support the reuse system.

Key Action: Achieving the plastic component-based reduction targets requires either substantial material substitution, significant reuse adoption, or a combination of both.

Not all source reduction strategies simultaneously reduce the weight of plastic covered material and the number of plastic components; some just reduce one or the other. For example, lightweighting a plastic bottle reduces its weight, but it does not change how many plastic components were used for that bottle. By contrast, material substitution in which the plastic bottle is replaced with a nonplastic bottle reduces both the weight of plastic and the number of plastic components. Elimination, material substitution, and reuse/refill are the primary source reduction strategies that simultaneously reduce both weight and number of plastic components of plastic covered material. Strategies like concentration can sometimes reduce the number of plastic components, but it is not an inherent characteristic of that source reduction strategy. For example, concentration of a good in a plastic bottle can result in a smaller plastic bottle being used, reducing the weight but not the number of components. Alternatively, concentration of a liquid product to a powder format could allow for another type of container to be used, potentially reducing both the weight and number of plastic components.

The contractor modeled two pathways to compare the benefits of material substitution, combined with reuse/refill versus reuse alone as the primary source reduction strategy:

1. Pathway A prioritizes material substitution, or shifting plastic to nonplastic materials (e.g., paper, fiber, metal, glass), alongside incremental design strategies, while still meeting reuse targets.
2. Pathway B prioritizes reuse strategies, specifically with an emphasis on reusable food service ware in closed-loop settings to drive plastic component reduction.

The contractor evaluated required actions for each pathway, such as outreach to businesses to adopt source reduction strategies, forward and return logistics for reuse and refill, and research and development (R&D), plus their associated operational expenditures (OPEX) and capital expenditures (CAPEX). Comparing the two pathways, it was found that Pathway A would allow for the source reduction requirements to be achieved at a lower cost than Pathway B, but with less potential for job creation. This difference is largely a result of the estimated costs to establish new infrastructure for reuse systems, including washing, sorting, and repacking. However, opportunities for harmonization, standardization, and pooling could reduce costs associated with the new infrastructure. Additionally, encouraging reuse and refill strategies that do not require significant infrastructure investment, such as consumers bringing their own cups and containers to refill, provides an opportunity for more cost-effective strategies to be used alongside other reuse and refill strategies that require investments.

The estimated costs to achieve the source reduction requirements do not necessarily represent additional costs to companies, rather they represent costs that need to be strategically reallocated towards source reduction. For example, businesses are regularly updating their product lines and conducting R&D to design new types of goods and packaging. Costs associated with R&D and updating product lines specifically for source reduction could be integrated into existing budgets.

Investments made to source reduce plastic covered material will also have benefits for overall system costs when considering changes needed to meet other requirements of the Act. For example, moving plastic covered material to either a reusable or refillable alternative, or to a nonplastic alternative, will reduce the amount of plastic covered material required to meet the recycling rate requirements under the Act.

Key Action: Use closed loop systems and B2B context as starting points to build infrastructure that can support future expansion to open loop systems and B2C contexts.

Closed-loop food service ware programs (e.g., reusable food service ware at venues), B2B prefill, and tertiary packaging solutions offer strong opportunities for advancing reuse and source reduction in the shorter term because the dynamics differ significantly from consumer-facing models. These models also have the advantage of not requiring consumer collection infrastructure, reducing the amount of funding needed to realize near-term impacts while building other aspects of infrastructure, such as washing and logistics, that will also be critical enablers of consumer-facing reuse systems in the future.

In B2B contexts, as several relevant parties interviewed attested, packaging is often standardized, managed in closed systems, and cycled between a limited number of partners. This reduces the complexity of behavior change and creates more predictable flows of materials for collection and return. The contractor analysis suggests that high-volume shipments, institutional procurement, and established logistics networks make B2B channels particularly well suited for reusable transport packaging, intermediate products and raw materials delivery, and other B2B prefill programs.

Key Action: Identify and collaborate with key enablers, especially for short-term infrastructure needs.

There are opportunities to leverage existing co-packers and contract manufacturers who already operate at scale and have the expertise, equipment, and regulatory compliance systems necessary to handle food-grade packaging. The contractor found that by building washing and logistics into existing operations, these entities can become central enablers of early reuse adoption. These entities can provide professional cleaning, standardization, and logistical reach that individual brands or small businesses are unlikely to achieve alone. This strategy can also address concerns expressed by businesses about needing to make significant investment on their own. Interviewees pointed out that co-packers and contract manufacturers are well positioned to lead in the development of new capacity.

Other existing infrastructure that could be retrofitted to support source reduction adoption, as well as other key enablers, should also be considered. For example, the contractor identified businesses that rent trailers outfitted with dishwashers; however, these units are typically deployed as temporary solutions (e.g., during restaurant kitchen renovations), not as part of programs to facilitate expanded use of reusable food service ware. Availability of mobile washing capacity, or unused washing capacity at existing wash hubs, can enable broader adoption of reusable packaging and food service ware across a wider range of establishments in the state.

1.0 Introduction

Background

The Plastic Pollution Prevention and Packaging Producer Responsibility Act (Senate Bill (SB) 54, Allen, Chapter 75, Statutes of 2022) (the Act), established an extended producer responsibility (EPR) program to manage single-use packaging and single-use plastic food service ware (covered material) in California. The Department of Resources Recycling and Recovery (CalRecycle) is required to conduct a statewide needs assessment to aid implementation and investigate the actions and investments needed to meet the requirements of the Act.

The law requires that by 2032:

- Single-use plastic packaging and single-use plastic food service ware (plastic covered material) be source reduced by 25%.
- Covered material be recyclable or eligible to be labeled compostable.
- Plastic covered material achieves a 65% recycling rate.

Study Overview

This report is part of a wider CalRecycle-commissioned study as part of the statewide needs assessment. CalRecycle contracted with Eunomia Research and Consulting (DRR24046) to investigate the actions and investments needed to meet the requirements of the Act, specifically that by 2032 plastic covered material be source reduced by 25%.

This report focuses on the plastic source reduction requirements outlined in PRC section 42057. The source reduction requirements, measured against a 2023 baseline, are as follows:

- By January 1, 2027, the Producer Responsibility Organization (PRO) shall source reduce no less than 10% of plastic covered material by weight and number of components, with no less than 2% of plastic covered material by weight and number of components source reduced through shifting to reusable or refillable packaging and food service ware systems.
- By January 1, 2030, the PRO shall source reduce no less than 20% of plastic covered material by weight and number of components, with no less than 4% of plastic covered material by weight and number of components reduced through shifting to reusable or refillable packaging and food service ware systems.
- By January 1, 2032, the PRO shall source reduce no less than 25% of plastic covered material by weight and number of components with no less than 10% of plastic covered material by weight and number of components source reduced through shifting to reusable or refillable packaging and food service ware systems or through eliminating a plastic component.

There is also a provision in the Act for meeting requirements through alternative compliance. Alternative compliance refers to a formula, to be developed by the PRO and approved by CalRecycle, that offers source reduction credit for postconsumer recycled (PCR) content integrated into plastic covered material. No more than 8% of source reduction may count toward the requirements through alternative compliance.

This report is the second of two focused on the source reduction, including reuse and refill. The first report evaluated the current use and availability of source reduction strategies and identified the barriers to and opportunities for implementing them. Building on those findings, this report evaluates the actions and investments that may be most effective in achieving the source reduction requirements.

Report Overview

The remaining sections of the report are structured as follows:

- **Section 2** provides an overview of the methodology undertaken for this assessment.
- **Section 3** summarizes the source reduction strategies considered in this assessment.
- **Section 4** explains how the contractor conducted further analysis on the source reduction baseline established by CalRecycle pursuant to PRC section 42057(b) to break it down into granular information to inform the reuse, refill, and other source reduction strategies.
- **Section 5** summarizes the evaluation of source reduction strategies to prioritize in preparation for developing pathways. A "pathway" represents a potential mix of source reduction approaches, including reuse, refill, and design-based strategies, deployed across goods and packaging categories to meet the statutory requirements for 2027, 2030, and 2032.
- **Section 6** brings together different source reduction strategies into two pathways to illustrate how different strategies and approaches provide different opportunities to achieve the requirements of the Act.
- **Section 7** provides detailed methodology for determining actions and cost calculations related to the pathways.
- **Section 8** details the actions and related investments associated with the two source reduction pathways.
- **Section 9** summarizes the limitations related to this analysis.
- **Section 10** summarizes the engagement conducted with interested parties as part of this analysis.

Supplementary information, results, and methodology are provided in Appendices A-K.

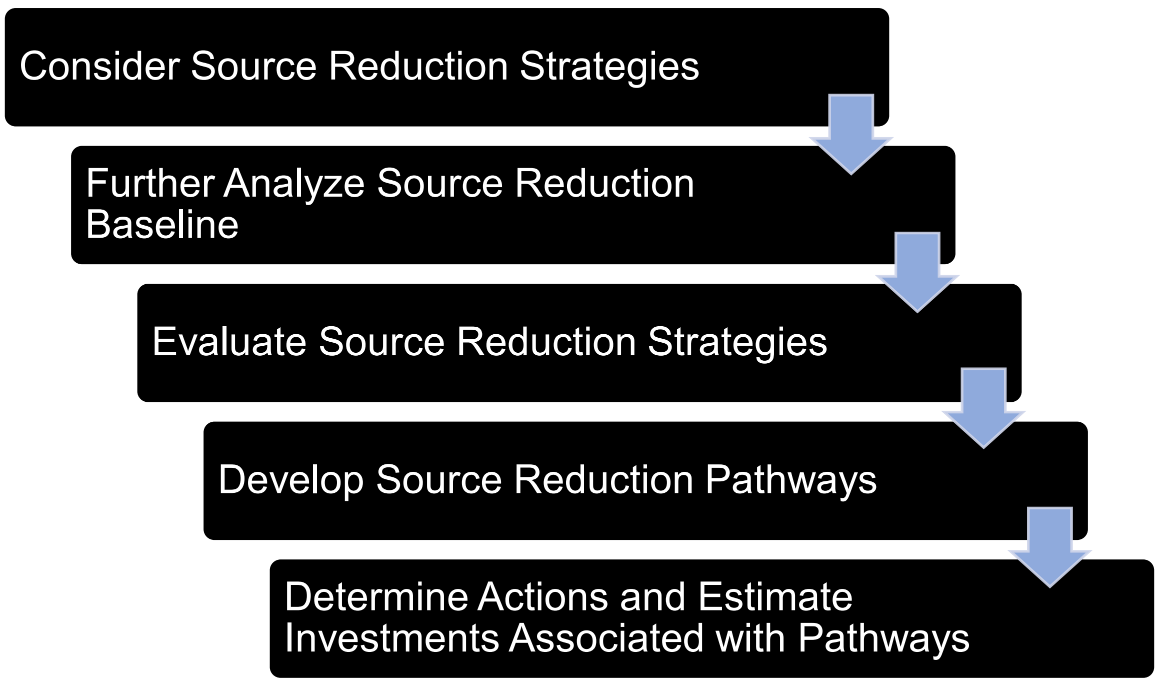
2.0 Methodology Overview

The contractor developed a methodology with the following key goals to:

1. Evaluate the potential of source reduction strategies by good and type of plastic covered material.
2. Design pathways to illustrate how different strategies provide opportunities to achieve the requirements of the Act.
3. Identify the actions and investments that may be most effective to implement these source reduction pathways.

An overview of the methodology is summarized in Figure 2-1. Each report section includes further detail on the methodological process for completing the study elements.

Figure 2-1: Source Reduction Methodology Overview



Consider source reduction strategies: The contractor consolidated the long list of source reduction strategies for the evaluation. As summarized in Section 3, for each strategy, using its expertise and input from interested parties, the contractor considered plastic reduction potential, timelines and rollout processes, cost factors, the role of online retail systems, equity impacts, and cross-cutting considerations for successful implementation.

Further analyze of source reduction baseline: In 2024, CalRecycle published the Source Reduction Baseline Report[1] (SRB), under contract DRR24011 to estimate the amount of plastic covered material sold, offered for sale, or distributed in California in the 2023 calendar year, by plastic weight and number of plastic components. The contractor evaluated the SRB to understand contributions by sales channel (business-to-business versus business-to-consumer), plastic use (packaging versus food service ware; primary versus secondary versus tertiary packaging), and plastic format (e.g., food service ware utensil, cup). This breakdown supported the assessment of source reduction strategies.

Evaluate source reduction strategies: The contractor developed criteria to evaluate all strategies considered in the report and to identify: the types of goods most suitable for reuse and refill systems; the types of packaging/food service ware most suitable for other source reduction strategies; and the estimated level of reduction by weight and number of plastic components. This was primarily a qualitative assessment, supported by quantitative data where relevant.

Develop source reduction pathways: The contractor considered how strategies could be combined to achieve required reductions in both plastic weight and component count. These were organized into two pathways, based on an evaluation of goods and covered materials suitable for source reduction and a quantitative assessment of ways to meet the source reduction requirements. This analysis does not prescribe a specific approach; it demonstrates multiple plausible scenarios and shows how varying priorities, constraints, and implementation rates could shape industry response and outcomes.

Determine actions and estimate investments associated with pathways: The contractor identified actions and investments necessary to implement the pathways and built the California Plastic Source Reduction Model (CPSRM). The CPSRM has three model components which include the analysis of the SRB (adapted baseline model), the reuse and refill model, and the other source reduction model. This model estimates the infrastructure and capacity for each action and calculates both upfront and ongoing costs. Only strategies included in the pathways were modeled. Details on inclusions and exclusions are in Section 7.0 and Section 8.0.

3.0 Summary of Source Reduction Strategies

Introduction

The Act mandates a 25% reduction in plastic covered materials by 2032, measured by both weight of plastic covered material and number of plastic components in plastic covered material.

Developing source reduction pathways requires a detailed understanding of available strategies. This section builds on the previous report, An Evaluation of Reuse and Refill Systems and Covered Materials that Utilize Other Source Reduction Strategies (also referred to as the "Current State of Source Reduction Report"), by consolidating source reduction strategies into three main categories:

- **Reuse and refill source reduction strategies:** These replace plastic covered material with systems that enable multiple uses of the same container or item, including:
    - Refill in store
    - Prefill business-to-consumer (B2C)
    - Prefill business-to-business (B2B)
    - Closed-loop reusable food service ware
    - Open-loop reusable food service ware
    - B2C e-commerce transport packaging
    - B2B transport packaging
- **Other source reduction strategies:** These strategies achieve reductions through design changes rather than reuse or refill infrastructure, including:
    - Lightweighting
    - Elimination
    - Right sizing
    - Concentration
    - Large format
    - Material substitution
- **Alternative compliance:** Using post consumer recycled (PCR) plastic is not considered a source reduction strategy. However, no more than 8% of the plastic covered material may be considered source reduced through an alternative

compliance formula developed by the PRO that offers source reduction credit for PCR plastic (Public Resources Code (PRC) section 42057(a)(2)(B)(i)).

This section defines each strategy in plain language and provides practical examples. It summarizes investment and cost considerations, offering qualitative insights rather than detailed financial modeling. It also outlines key factors for successful implementation, including timelines, costs, the role of online retail systems, and equity impacts, based on findings from the Current State of Source Reduction report. These considerations inform the strategy evaluation process described in Section 5.0.

Reuse and Refill Source Reduction Strategies

This section summarizes how the reuse and refill taxonomy from the Current State of Source Reduction report was consolidated for assessing source reduction potential for the purposes of this report. The Current State of Source Reduction report provided a comprehensive taxonomy of reuse and refill models, including multiple submodels. To evaluate reuse and refill strategies and develop pathways, this report consolidates and refines these model and submodel categories into actionable reuse and refill strategies that can be modelled.

Some submodels were merged if operational differences did not significantly affect outcomes or could not be effectively modelled. For example, within the Current State of Source Reduction report, two prefill submodels — filling at a production facility and filling via fractional manufacturing — were combined into the prefill B2C strategy.

Adjustments were made to better capture B2B reuse systems. For example, the Current State of Source Reduction report did not separate B2C and B2B prefill systems, so this report includes two strategies: Prefill B2C and Prefill B2B.

Submodels that do not require significant infrastructure investment (i.e., involve consumer-owned packaging not recovered by a system) were excluded from the reuse and refill evaluation and modeling, but considered under other source reduction strategies. Examples include refill via cartridge, pod, pouch, container, concentrate, or large format packaging, dispensing at food service establishments to reduce packaging, and bring-your-own (BYO) cup or container programs for food service ware.

The resulting framework, Table 3-1, supports focused modeling and analysis of each strategy.

Table 3-1: Overview of Reuse and Refill Taxonomy in Source Reduction Reports

Refill/Reuse	Current State Model	Current State Submodel	Change Made for This Report	Rationale for Change	Strategy in This Report
Refill (consumer provides the container)	Dispensing to replace single-use plastic packaging (also includ es food packaging for nonprepared food)	Retail	Retained as a reuse and refill source reduction strategy – limited to B2C context only.	No change	Refill in store
	Dispensing to replace single-use plastic packaging	Food service establishment	Included as part of "other source reduction" analysis.	Dispensing at food service establishments to replace packaging does not require investment in major infrastructure to support the system and is more similar to using large format packaging.	N/A
		Bring Your Own (BYO) cup or container	Included as part of "other source reduction" analysis.	Dispensing into customer owned containers to replace food service ware does not require investment in major infrastructure to support the system and highly relies on customer participation.	N/A

Refill/Reuse	Current State Model	Current State Submodel	Change Made for This Report	Rationale for Change	Strategy in This Report
Refill (consumer provides the container)	Refill via single-use packaging	Refill via large-format packaging	Included as part of “other source reduction” analysis.	Refill via large-format packaging are more design based changes rather than needing system level reuse infrastructure, therefore they are more similar to the large format source reduction strategy.	N/A
		Refill via concentrate	Included as part of “other source reduction” analysis.	Refill via concentrate is more design based changes rather than needing system level reuse infrastructure, therefore they are more similar to the concentration source reduction strategy.	N/A
		Refill via cartridge, pod, pouch, container	Included as part of “other source reduction” analysis.	Refill via cartridge, pod, pouch, container are more design based changes rather than needing system level reuse infrastructure, therefore they are more similar to the concentration, large format, or format change source reduction strategy.	N/A

Refill/Reuse	Current State Model	Current State Submodel	Change Made for This Report	Rationale for Change	Strategy in This Report
Reuse (producer/ third party provides the container)	Prefill systems	Prefill previously used and returned packaging, filled at production facility	Merged with Filling via fractional manufacturing and limited to B2C context only. Prefill B2B is included as separate strategy.	Submodel was combined with Filling via fractional manufacturing to form Prefill B2C strategy to simplify modeling. Operational differences were assumed to have no significant impact on source reduction potential.	Prefill B2C
		Prefill previously used and returned packaging, filled via fractional manufacturing / co-filling site	Merged with filling at production facility and limited to B2C context only. Prefill B2B is included as separate strategy.	Submodel was combined with filling at production facility to form Prefill B2C strategy to simplify modeling. Operational differences were assumed to have no significant impact on source reduction potential.	Prefill B2C
		No previous submodel	Added new strategy specifically for Prefill B2B.	Strategy was added to capture closed loop systems for back of house packaging (e.g., reusable containers for ingredient storage and delivery), which offer high reduction potential in institutional and food service contexts. Previous model did not differentiate between B2B and B2C prefill.	Prefill B2B

Refill/Reuse	Current State Model	Current State Submodel	Change Made for This Report	Rationale for Change	Strategy in This Report
Reuse (producer/ third party provides the container)	Reusable food service ware programs	Open loop food service ware programs	Retained as a reuse and refill source reduction strategy.	No change	Open loop reusable f ood service ware
		Closed loop food service ware programs	Retained as a reuse and refill source reduction strategy.	No change	Closed loop reusable food service ware
	Reusable packaging for shipping and logistics	B2C reusable trans port packaging	Retained as a reuse and refill source reduction strategy but renamed. Only shipping mailers have been modelled as a proxy.	Mailers account for the most plastic weight and components of B2C transport packaging, therefore it is a reasonable item to use as a proxy.	B2C e-commerce transport packaging
		B2B reusable secondary packaging	Merged with prefill B2B category.	For modelling purposes primary and secondary packaging are modelled together and included under the same strategy.	Prefill B2B

Refill/Reuse	Current State Model	Current State Submodel	Change Made for This Report	Rationale for Change	Strategy in This Report
Reuse (producer/ third party provides the container)	Reusable packaging for shipping and logistics	B2B reusable transport packaging	Retained as a reuse and refill source reduction strategy.	Merged as they effectively involve same actors and reusable pallet wraps have been modelled as proxy	B2B transport packaging

As shown in Table 3-1, reuse and refill models and submodels from the Current State of Source Reduction report were consolidated into the following reuse and refill strategies considered in this report:

- Refill in store.
- Prefill B2C.
- Prefill B2B.
- Closed-loop reusable food service ware.
- Open-loop reusable food service ware.
- B2C ecommerce transport packaging.
- B2B transport packaging.

Each of these strategies is described in the following subsections.

Some reuse and refill strategies generally do not require significant investment in infrastructure because the reusable and refillable packaging is consumer owned and not recovered by a system. These strategies also have similarities to other source reduction strategies and were included in this analysis as part of other source reduction strategies (see next section). This section focuses on reuse and refill strategies requiring significant investments where the reusable or refillable packaging is managed by someone other than the consumer.

The following reuse and refill strategies are included in the Other Source Reduction Strategies section:

- Dispensing at food service establishments to reduce packaging.
- Bring your own (BYO) container or cup.
- Refill via large-format packaging, concentrate, cartridge, pod, pouch, and containers.

Refill in Store

Strategy Overview

Refill in store systems allow consumers to purchase goods by dispensing them into reusable, consumer-owned containers, either brought from home or purchased on site. These systems are typically found in package-free shops, co-ops, and refill sections within conventional grocery stores. Goods are dispensed from equipment, such as gravity bins, pumps, or spouts, and may include food, personal care, cleaning items, and other shelf-stable goods. Refill in store is consumer driven and relies on behavioral change, hygiene protocols, and store-level infrastructure. This strategy does not include BYO cups or container programs for food service ware.

Plastic Reduction Mechanism

For this analysis, the contractor assumed that consumers would bring their own reusable container and stores would not provide single-use containers to dispense goods into. The reusable container may originally be sold by the store selling the good through a refill system, but the consumer owns the container and continues to bring it to be refilled. The impact of this assumption is that for each time the reusable packaging is used, the weight and number of plastic components of the equivalent single-use packaging are source reduced.

Example Good Types

- Dry goods: rice, pasta, oats, and snacks dispensed from gravity bins or scoop stations.
- Liquids and condiments: oils, vinegars, syrups, and sauces dispensed from bulk containers.
- Home and personal care: shampoo, dish soap, and surface cleaners dispensed from pump bottles or spigots.

Examples in Action

- In California, zero-waste stores and select grocery chains (e.g., Sprouts Farmers Market) offer refill stations for dry goods, liquids, condiments, and cleaning goods.
- Examples outside of California demonstrate viability at scale:
    - France has scaled refill in store through major retailers like Carrefour, supported by CITEO's Solidarity Reuse Fund.
    - In the Czech Republic, a company called MiWa has developed a modular dispensing system for bulk goods that integrates smart packaging and digital tracking, enabling refill at retail while maintaining hygiene and traceability.

System Considerations to Inform Actions, Costs and Investments, and Adoption

For refill in store, the following are high-level considerations for implementation:

- Infrastructure needs including dispensing infrastructure (gravity-fed bins, pumps, or automated refill systems), sanitation stations, and Americans with Disabilities Act (ADA) compliant infrastructure.
- Operational changes including staff training, cleaning, inventory management, maintenance, and customer assistance.
- Changes to filling operations to ensure packaging compatibility with dispensing equipment.

Interviews conducted with retailers found that refill systems are generally more labor-intensive than shelving packaged goods, adding complexity and cost. Information gathered through interviews with businesses suggests that refill and BYO container strategies are generally the least favored refill and reuse strategy by businesses due to operational concerns and perceived hygiene concerns. As found during the Current State of Source Reduction report, refill solutions are safe and hygienic when correct procedures are followed. Therefore, there is an opportunity to overcome these perceived hygiene concerns.

Large-scale pilot programs, such as those in urban and suburban supermarkets in France, can be used to test dispenser usability and hygiene protocols. They also can evaluate the integration of loyalty programs and assisted payment systems, such as Supplemental Nutrition Assistance Program (SNAP) or Women, Infants, and Children (WIC). Learnings from these pilots can inform expansion to regional chains and discount retailers and support a broader range of product categories.

Key considerations for adoption include food safety compliance, multilingual signage, ADA accessibility, consumer education, inclusion of known and trusted brands, and the ability to use assisted payment systems to overcome convenience and access barriers.

Role of Online Retail

Refill in store is inherently tied to physical retail environments and cannot be replicated through conventional online channels. However, mobile refill hubs or hybrid models (e.g., online ordering with local refill) may offer future potential.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

The Current State of Source Reduction report highlighted significant barriers related to access of reuse and refill options for rural and low-income communities, including having retail stores with refill in their communities. Geographic Information Systems (GIS) mapping found that retail stores, including those with refill in store options, tend to align with population clusters, leaving rural or less populated areas underserved.

GIS mapping also found that only about 25% of Californians live within 1 mile of a store offering partial refill options and just 1% live near a full refill store. Further community engagement found that 62% of participants identified refill stations challenging due to time and convenience with only 38% of community participants classifying them as easy to use. Refill systems are often perceived as niche or premium, with limited brand choice.

Opportunities include integrating refill stations into mainstream supermarkets and culturally relevant grocery stores, ensuring ADA-compliant design, and providing multilingual signage. Mobile refill hubs or partnerships with local community groups could help bridge access gaps.

Prefill B2C

Strategy Overview

Prefill systems involve products that are filled and sealed by producers or third-party fillers in reusable packaging before reaching customers. Consumers can purchase prefill products in stores or online, as they do today, with additional steps required to return the containers. This section provides insights for both in store and online sales with additional context provided for online retail. Unlike refill systems, where consumers bring their own containers, prefill shifts responsibility for container management to the producer or a designated system operator. After use, consumers return empty packaging via designated collection channels where they are cleaned and redistributed for refill.

Prefill systems require coordination across multiple parties:

- System operators that manage container pools (shared standardized containers), logistics, cleaning, and tracking.
- Producers and fillers that must adapt filling lines to accommodate reusable formats.
- Retailers that must allocate shelf space for prefill packaging and facilitate returns, often through deposit-refund strategies.
- Consumers who must purchase and return containers.

Plastic Reduction Mechanism

For this analysis, it was assumed that each time the reusable packaging is used, the weight and number of plastic components of the equivalent single-use packaging are source reduced.

Example Good Types

- Food
    - Dry goods like pasta, rice, oats, and dried spices in reusable containers.
    - Canned and jarred goods like jams, sauces, pickles, and baked beans in reusable jars.
    - Food liquids like oils, vinegars, and syrups in reusable bottles.
    - Prepared meals in reusable trays, often with a single-use seal or film lid for hygiene and tamper evidence.
- Beverage
    - Reusable bottles for milk.
- Home and Personal Care Products

    - Shower gel, shampoo, conditioner, dish soap, and cleaning agents in reusable bottles.

Examples in Action

- The Current State of Source Reduction report identified limited pilots for prefill in California, mostly within zero-waste programs and niche retail partnerships. One moderate-sized example is Straus Family Creamery in California operates a reusable glass bottle program for their customers who use and return 2.75 million bottles annually.[2]
- Outside of California, France's Citeo program funds large-scale prefill initiatives, requiring standardized reusable packaging across brands. Carrefour and Loop operate systems where consumers purchase products in reusable containers and return them via retail drop-off or home collection. Germany's beverage sector demonstrates mature prefill systems, with standardized glass bottles reused across multiple brands.

System Considerations to Inform Actions, Costs and Investments, and Adoption

For Prefill systems, the following are high-level considerations for implementation:

- New and modified infrastructure including:
    - Collection Infrastructure: for example, networks of retail drop-off bins, reverse vending machines (RVMs), and mail-back options.
    - Washing Hubs: industrial-grade washers, inspection systems, and sanitation protocols; costs can vary by capacity and automation.
    - Filling Line: modifications or installation of dedicated reusable packaging lines.
- New operating requirements including:
    - Labor for collection, cleaning, and logistics.
    - Reverse logistics for container transport and redistribution.
    - Energy and water for cleaning and sorting.
    - Initial stock of reusable containers plus additional containers to account for damaged or nonreturned containers.

Pilot programs help establish processes and procedures, infrastructure needs and locations, and best practices for consumer engagement. This can help efficient scaling and expansion of washing and filling capacity, as well as integration with retail and online platforms ultimately leading to standardization, optimization, and alignment with broader reuse systems.

Key considerations for adoption include:

- Harmonizing packaging formats across brands that sell the same product type.

- Establishing shared reverse logistics and washing facilities to maximize efficiency and scalability, enabling pooling, and reduce sorting complexity.
- Providing consumer incentives to ensure high return rates.

Role of Online Retail

Prefilled reusable packaging can be sold in stores, but e-commerce also offers an opportunity for scaling prefill systems. Prefilled products can be integrated into online retail platforms and subscription models, enabling access for households without nearby physical retail. Return-by-mail programs and local drop-off points can facilitate container recovery, especially in rural or transit-dependent communities. This approach can also support consumers with mobility challenges by reducing reliance on in-store returns.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Prefill systems can improve access for underserved communities by leveraging online retail and mail-back options, reducing the need for travel. However, equity considerations include affordability, the value of a deposit refund if used, and integration with assisted payment programs (e.g., SNAP, WIC). Public engagement and outreach suggest that convenience and cost are critical factors for adoption among low-income and rural populations.

Prefill systems are currently niche in California, with only a few examples identified in the Current State of Source Reduction report. International models demonstrate scalability when supported by standardized packaging and financial incentives plus investment by PROs. France and Germany show that centralized washing hubs and harmonized packaging standards are effective for cost efficiency and environmental performance.

Interviews with companies showed that retailers and manufacturers see prefill systems as less disruptive to operations than refill in store. Prefill allows them to use centralized washing and filling infrastructure, which simplifies logistics. Liquid goods are especially well-suited to this approach because they work well with existing equipment.

Prefill B2B

Strategy Overview

Prefilled B2B systems replace single-use primary and secondary plastic packaging used to contain ingredients, cleaning products, personal care items, and other goods in commercial and institutional settings with reusable packaging. Often, these systems involve bulk containers. These systems operate in closed-loop formats, leveraging existing delivery networks and business contracts to enable reuse across restaurants, hotels, cafeterias, and catering services.

Plastic Reduction Mechanism

For this analysis, it was assumed that each time the reusable packaging is used, the weight and number of plastic components of the equivalent single-use packaging are source reduced.

Example Good Types

- Bulk food ingredients (e.g., sauces, grains, dairy).
- Cleaning supplies.
- Personal care products for institutional use.
- Prepared food components for catering or food service.

Examples in Action

- In California, a limited number of pilots were identified, primarily in niche food service operations and catering businesses. Interviews for the Current State of Source Reduction report showed that businesses are interested in these systems, but face barriers related to washing infrastructure and logistics.
- Outside of California, France and Germany have advanced B2B reuse systems for food service and ingredient delivery. For example, reusable crates and tubs for dairy and sauces are standard in many European institutional kitchens, supported by centralized washing hubs and standardized container designs.

System Considerations to Inform Actions and Investments, and Adoption

For prefill B2B systems, the following are high-level considerations for implementation:

- New and modified infrastructure including:
    - Durable reusable containers (e.g., tubs, crates, drums).
    - Washing hubs and sanitation equipment.
    - Filling facilities are co-located with manufacturers or distributors.
- New operating requirements including:
    - Reverse logistics for container collection and redistribution.
    - Labor for washing, inspection, and quality control.
    - Inventory management systems to track container cycles.

Key considerations for adoption include food safety compliance, container standardization, and coordination with existing distribution networks. Establishing wash hubs and reverse logistics for B2B applications can help support deployment of B2C prefill systems by building infrastructure that could be used for both B2B and B2C prefill strategies.

Role of Online Retail

Online platforms can enable ordering and scheduling for reusable container delivery and pickup, particularly for small businesses or rural institutional buyers. Integration with e-commerce systems could streamline logistics and provide visibility into container return compliance.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Although indirect benefits are not consumer-facing, they include job creation in washing hubs and logistics. Equity considerations focus less on consumers and more on ensuring that small businesses and rural institutions can access reuse systems without facing prohibitive costs.

Only two active B2B prefill solutions were identified in California. Despite their limited number, interviews with businesses highlighted these systems as having significant potential impact. One business interviewee reported that 3-gallon plastic tubs used in food service accounted for more than 1.1 million pounds of plastic in the U.S. market in 2024, highlighting the scale of opportunity for reduction in this sector.

Interviews with interested parties indicated strong business interest but also noted barriers around infrastructure and cost-sharing models. Centralized washing hubs and standardized containers were identified as key enablers.

B2B systems were identified as a promising opportunity for near-term scaling. While they require much less consumer behavior change, they do require users to be educated to ensure containers are returned. This strategy can be more easily integrated into existing logistics and procurement systems. International examples (e.g., France's Citeo-funded programs) demonstrate that reuse in B2B food service can achieve significant reductions in single-use plastic packaging when supported by industry-wide standards and logistics coordination.

Open-Loop Reusable Food Service Ware

Strategy Overview

Open-loop reusable food service ware systems allow consumers to take reusable containers, cups, and utensils off-site for to-go meals and return them later to participating locations. This also includes take out/delivery food service ware from restaurants and other food service locations. Unlike closed-loop systems (e.g., dine-in or stadiums), open-loop models require coordination across multiple businesses and rely on consumer participation, often supported by deposit-refund systems, loyalty rewards, or app-based tracking. These systems are best suited to dense urban areas where multiple vendors can share infrastructure. They require return logistics and consumer engagement to manage loss rates and ensure reuse.

Plastic Reduction Mechanism

For this analysis, it was assumed that for each time the reusable food service ware is used, the weight and number of plastic components of the equivalent single-use plastic food service ware item is source reduced.

Example Food Service Ware Types

- Reusable cups, bowls, lids, and containers for to-go food and beverages.
- Reusable cutlery, straws, and stirrers.

Examples in Action

- In California, 62 instances of this strategy were identified, mainly in urban areas, often managed by reuse service providers partnering with cafes and restaurants (see Current State of Source Reduction Report).
- Outside of California, cities like Paris and Berlin have implemented citywide open-loop networks for reusable food service ware, supported by standardized containers and app-based return systems. These programs demonstrate that coordinated networks can significantly reduce single-use plastic food service ware when paired with strong consumer incentives.

System Considerations to Inform Actions and Investments, and Adoption

Capital costs for implementing an open-loop reusable food service ware system typically include container procurement and supporting infrastructure. This involves purchasing reusable items such as cups, bowls, and lids, as well as investing in return systems, which may require bins, signage and educational materials. Additional costs may arise from washing operations, including upgrades to mechanical, electrical and plumbing systems in an industrial space, along with equipment such as washing and drying machines, conveyor belts and storage areas.

Operating expenses for an open-loop reusable food ware system include the costs for labor for processing container returns, drivers and reverse logistics, and the staff and management responsible for washing and sorting operations. Additional costs arise from inputs such as water, energy and detergents. Recurring expenses also include losses due to damaged or missing containers and the subsequent replacement necessary to maintain adequate inventory levels for uninterrupted service.

Key considerations for adoption include consumer education, standardized container design, and integration with delivery platforms. While there is no coverage of secondary packaging requirements, the FDA publishes Best Practices for Online or Third-Party Food Delivery Services, which discusses considerations such as temperature control, tamper evident packaging, and protection from contamination during transport.

Role of Online Retail

Meal delivery platforms (e.g., DoorDash, Uber Eats) can integrate reusable container options for participating restaurants, allowing consumers to opt for reuse. Subscription-based meal kits could also adopt reusable packaging for ingredients and containers.

In underserved areas, e-commerce could support mail-back programs or hub-and-spoke models, where regional washing hubs serve multiple communities. Local grocers or post offices could act as drop-off/pick-up points.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Community engagement highlighted that open-loop systems are less feasible in rural areas due to limited vendor density and longer travel distances. Equity strategies include community-based hubs, mail-back options, deposit systems, and multilingual instructions to ensure accessibility.

Community engagement showed strong interest in reuse for to-go food but there were concerns about convenience and hygiene. Interested parties, ranging from consumers to current operators, emphasized the importance of deposit-refund systems and digital tracking to reduce loss rates.

Closed-Loop Reusable Food Service Ware

Strategy Overview

Closed-loop reusable food service ware systems operate in controlled environments where made-to-order food and beverages are served and consumed on-site. These systems are ideal for settings such as dine-in restaurants, cafeterias, campuses, stadiums, airports, and event venues. Customers receive food with reusable food service ware, which is then collected after use, cleaned either on-site or at nearby washing hubs, and reused.

Closed-loop systems generally benefit from high return rates, low loss rates, and simplified logistics without significant behavior change needed by consumers. They are particularly effective in high-traffic venues with centralized operations and predictable consumption patterns.

Plastic Reduction Mechanism

For this analysis, it was assumed that for each time the reusable food service ware is used, the weight and number of plastic components of the equivalent single-use food service ware item is source reduced.

Example Food Service Ware Types

- Reusable cups, bowls, and containers for food and beverages
- Reusable cutlery, straws, and stirrers
- Food containers for dine-in or on premises consumption

Examples in Action

- In California, 55 active pilots in stadiums and university campuses were identified for closed-loop reusable food service ware systems, often in partnership with reuse service providers. These programs use standardized containers and on-site or nearby washing facilities (see Current State of Source Reduction Report).
- Outside of California, Seattle Public Utilities (SPU) and the Seattle Office of Economic Development collaborate with businesses and venues to implement infrastructure for collecting, washing, and redistributing reusable cups. Additionally, large-scale programs in European airports and stadiums use standardized reusable containers and on-site washing facilities, achieving significant reductions in single-use plastic food service ware. These programs are often supported by public-private partnerships and policy mandates.

System Considerations to Inform Actions and Investments, and Adoption

Capital costs for implementing a closed-loop reusable container system are largely comparable to those for open-loop systems. These include the purchase of reusable containers such as cups, bowls, and lids, as well as investment in return infrastructure, which may involve simple equipment (e.g., collection bins), signage and educational materials. Additional costs may be associated with washing operations, including mechanical, electrical and plumbing upgrades within industrial spaces, along with line equipment such as washing and drying machines, conveyor belts and storage areas.

Operating costs include labor for processing returns, drivers and logistics for reverse distribution, and staff and management for washing and sorting operations. These costs also include essential inputs such as water, energy and detergents. Additionally, recurring expenses arise from container loss and replacement of damaged or missing items to maintain sufficient inventory for uninterrupted service.

Key considerations for adoption include food safety compliance, ADA-compliant drop-off stations, and consumer education to support proper return behavior.

Role of Online Retail

Closed-loop systems are primarily tied to physical venues, but integration with online ordering for dine-in or event pre-booking can help manage container inventory and predict demand. For example, stadium ticketing platforms could include a reuse option for food and beverage service.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Closed-loop systems primarily benefit institutional and public venues, which serve diverse populations. Equity considerations include ensuring accessible drop-off points and multilingual signage.

Community engagement revealed strong public support for closed-loop systems in high-traffic venues, citing convenience and environmental benefits. Businesses emphasized the need for washing capacity either on site or through shared washing facilities and standardized containers to simplify operations.

B2C E-commerce Transport Packaging

Strategy Overview

E-commerce reusable transport packaging systems replace single-use plastic e-commerce transport packaging, such as plastic mailers, and protective fillers, with durable, returnable and reusable alternatives. Consumers receive online orders in reusable containers and return them via mail-back programs, drop-off points, or during subsequent deliveries. These systems rely on standardized packaging, reverse logistics, and digital tracking to ensure containers are returned, cleaned, and reused.

This model is particularly suited for direct-to-consumer brands, subscription services, and large online marketplaces. It leverages existing delivery infrastructure, making it a scalable solution for reducing single-use plastic packaging in the growing e-commerce sector.

Plastic Reduction Mechanism

For this analysis, it was assumed that for each time the reusable transport packaging is used, the weight and number of plastic components of the equivalent single-use transport packaging is source reduced.

Example Packaging Types

- Mailers.
- Boxes.
- Protective fillers.

Examples in Action

- In California, eight pilots were identified, which included niche zero-waste e-commerce platforms offering reusable mailers for clothing and household goods.
- Outside of California, Boox and RePack provide reusable mailers for fashion and lifestyle brands.

System Considerations to Inform Actions and Investments, and Adoption

Capital expenses related to the establishment of a reusable transport packaging system for e-commerce entail the initial acquisition of reusable mailers, boxes, and protective inserts that are specifically engineered to be used for several shipping cycles. More investments might be needed for reverse logistics facilities (depending on the packaging return model), for example, return bins, prepaid mailers, and tracking systems to manage the flow of packaging back to distribution centers. Cleaning hubs for the washing and inspection process are also a capital expense that allows returned packaging to meet hygiene and quality standards before reuse.

Operating expenses are those that cover the everyday activities necessary to maintain the system in good working order. They are the costs of return shipping and container recovery as well as those of cleaning and redistribution that require labor, water, and energy. The loss rates for nonreturned or damaged packaging are thus a recurring expenditure, although these costs can be lowered by efficient tracking and customer engagement strategies.

The Current State of Source Reduction Report found that despite the higher upfront costs, long-term savings might be achieved through less material consumption and waste management costs.

Key considerations for adoption include consumer convenience, return compliance, and cost-sharing models between retailers and logistics providers.

Role of Online Retail

E-commerce platforms are central to scaling reusable packaging. Integration with order management systems allows consumers to opt into reuse programs at checkout. Subscription models and loyalty programs can incentivize participation.

For underserved areas, mail-back programs and partnerships with local post offices or retail hubs can provide convenient return options.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Reusable e-commerce packaging can improve access for rural and underserved communities by leveraging mail-back systems and hub-and-spoke models. Equity considerations include ensuring no additional cost burden for consumers and integrating assisted payment programs for subscription services. Community engagement findings emphasized the importance of deposit-refund systems and loyalty rewards to encourage returns and build consumer habits.

Interviews with businesses and logistics providers revealed strong interest in reusable e-commerce packaging, particularly among sustainability focused brands and subscription services. The Current State of Source Reduction report identified reverse logistics and consumer compliance as key challenges. Without convenient return options, loss rates increase and system costs rise.

International examples (e.g., Boox, RePack) demonstrate that standardization and partnerships with major retailers accelerate adoption and reduce costs. In France, the PRO, Citeo, allocates €50 million annually to a Solidarity Reuse Fund, supporting large-scale reuse initiatives. This includes reusable e-commerce packaging pilots that integrate standardized containers, digital tracking, and centralized washing hubs.

B2B Transport Packaging

Strategy Overview

Reusable transport packaging used in B2B settings, mainly reusable pallet wrap, strapping, and pallet covers, are designed to replace single-use plastic packaging such as stretch film, shrink wrap, and other items used to secure goods during transport. Made from durable materials like woven polypropylene or reinforced polyester, reusable wraps can be reused hundreds of times. They typically feature adjustable straps or hook-and-loop fasteners to secure palletized loads without generating single-use plastic transport packaging.

This strategy operates entirely within B2B supply chains, making it implementable through logistics contracts and internal operational changes. It is particularly relevant for distribution centers, manufacturers, and large retailers handling high volumes of goods. However, B2B reusable pallet wrap solutions are still maturing, so there is uncertainty in their potential impact and feasibility at scale. Interviews for the Current State of Source Reduction report found challenges with standardization, return logistics, and added transport weight.

Plastic Reduction Mechanism

For this analysis, it was assumed that each time reusable transport packaging is used, the weight and number of plastic components from equivalent single-use transport packaging are source reduced.

Example Good Types

- Palletized goods in retail and wholesale distribution.
- Bulk shipments of packaged food, beverages, and household goods.
- Warehouse-to-store or warehouse-to-warehouse logistics.

Examples in Action

- In California, pilots by logistics providers and large retailers using reusable pallet wraps in distribution centers were identified. Companies like Green Spider and Pallet Wrapz are developing wrap-as-a-service models, though neither had rolled them out as of November 2025.
- Outside of California, European logistics companies were found to use reusable pallet wraps in closed-loop systems, supported by standardized pallet sizes and centralized washing hubs. These programs have demonstrated opportunities for reductions in single-use plastic packaging and cost savings over time.

System Considerations to Inform Actions and Investments, and Adoption

Capital costs for implementing reusable transport packaging in B2B operations include purchasing durable pallet wraps, with costs varying based on material and durability. Additional investments may be required for storage systems at distribution centers to manage wrap inventory, as well as optional tracking systems such as radio-frequency identification (RFID) tags or barcodes to monitor usage and reduce losses.

Operating costs primarily involve labor for applying and removing wraps during shipping cycles, along with cleaning and maintenance, which are minimal compared to reuse systems for food service ware. Loss rates for damaged or misplaced wraps represent another recurring expense, though these are generally low in controlled environments. The Current State of Source Reduction report found that B2B reusable transport solutions tend to provide cost savings to businesses over time, with some savings coming from labor efficiencies. Additional savings can come from reduced costs for single-use transport packaging.

Key considerations for adoption include standardization of pallet sizes, staff training, loss prevention measures, cleaning protocols, and inventory tracking systems.

Role of Online Retail

While reusable transport packaging is primarily a B2B solution, they support e-commerce fulfillment operations by reducing packaging waste in distribution centers. B2B transport packaging can help provide reusable solutions throughout the supply chain to support B2C solutions.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

While primarily a B2B strategy, reusable pallet wrap programs can create job opportunities in logistics and inventory management, particularly in regional hubs which could be located in underserved communities.

Interviews with businesses as part of the Current State of Source Reduction report highlighted strong interest in reusable pallet wraps due to potential cost savings and opportunities for operational simplicity. Barriers include initial investment costs and behavioral change in warehouse operations. Companies like Green Spider and Pallet Wrapz are actively developing reusable pallet wrap services in California, with plans to scale up in the future. These early movers provide a foundation for broader adoption across the state.

Cross-Cutting Considerations for Reuse and Refill to Maximize Successful Adoption

Scaling reuse and refill systems will be most effective through coordination between users, system operators, and infrastructure. Reuse and refill strategies included in this section require new physical infrastructure, changes in processes and procedures, new operating models, and behavioral shifts from both businesses and consumers. Other types of reuse and refill strategies, such as BYO, will not require the same level of new infrastructure.

The Current State of Source Reduction report findings from community engagement and expert interviews consistently emphasized that investing in infrastructure, reducing operational complexity, ensuring equitable access, and building consumer trust will make implementation of reuse and refill strategies most effective. This section outlines the potential infrastructure investments and systemic enablers to transition from niche pilots to scalable, cost-effective, and inclusive reuse and refill systems across California.

Infrastructure Investments

Building the physical and operational backbone for reuse and refill is essential to achieving scale. The Current State of Source Reduction report identified infrastructure gaps as one of the most significant barriers to adoption, while community engagement highlighted convenience and trust as critical to consumer participation. The Current State of Source Reduction report also highlighted that beginning with B2B and closed-loop systems, where logistics are more controlled and return rates are higher, can help establish the infrastructure, operational models, and consumer familiarity needed to support the eventual scaling of Prefill B2C and open-loop systems.

The following infrastructure components are cross cutting supports that help facilitate multiple reuse and refill strategies:

Standardization of packaging

Why it matters: Nonstandardized packaging formats increase costs and limit interoperability. Standardization enables pooling, simplifies logistics, and supports economies of scale.

Current State of Source Reduction report insight: Expert interviews revealed that brands recognize the benefits of standardization but are concerned about losing brand identity. Industry wide pooling models were cited as essential for cost effective scaling.

Actions that may be most effective include:

- Begin with B2B and closed-loop systems to test and refine standardized formats before expanding to B2C and open-loop contexts.
- Develop interoperable packaging standards and harmonized labeling (e.g., PR3 standards in development).
- Launch multi-retailer regional pilots using pooled packaging in high-volume categories (e.g., cleaning products).

Potential barriers include:

- Brand differentiation concerns.
- Lack of finalized standards (PR3 still in development).

Cost considerations:

- Main investments are for design and tooling.

Timing:

- Initial adoption in B2B and closed-loop pilots followed by broader harmonization and expansion to B2C and open-loop expansion in a medium-term timeline.

Collection networks

Why it matters: Low return rates undermine the environmental and economic benefits of reuse.

Current State of Source Reduction report insight: Community engagement emphasized the need for convenient, everyday return locations, such as schools, libraries, and gas stations, and individual and collective incentives to encourage participation.

Actions that may be most effective include:

- Use closed-loop and B2B systems to pilot return infrastructure and build operational experience before expanding to open-loop and B2C models.
- For open-loop systems, install shared return bins at high traffic locations (e.g., grocery stores, stadiums, transit hubs).
- Integrate return infrastructure with existing collection systems (e.g., CRV redemption infrastructure, partnerships with local jurisdictions for curbside pickup).
- Smart bins or QR enabled systems for tracking, with nondigital alternatives for inclusivity.

Potential barriers include:

- Contamination risks.
- Space constraints.
- Inconsistent consumer behavior.

Cost considerations:

- Investments are dependent on leveraging existing infrastructure such as existing washing facilities, logistic systems, and existing collection networks.

Timing:

- Pilots in closed-loop and B2B settings are feasible within one to two years with broader integration into B2C and open-loop systems likely within four to six years.

Resources:

- Logistics providers, reuse service operators.

Shared Reverse Logistics Networks

Why it matters: Efficient reverse logistics systems will reduce costs and environmental impacts of transporting reusable packaging.

Current State of Source Reduction report insight: Experts stressed that shared logistics will allow for reuse systems to scale up in a more cost-effective manner. Integration with existing delivery and waste collection routes was identified as a key opportunity.

Actions that may be most effective include:

- Begin with B2B and closed-loop systems to test reverse logistics models before scaling to open-loop and B2C reuse.
- Develop shared backhaul systems for reusable packaging and food service ware.
- Coordinate with existing delivery and municipal waste collection networks.

Potential barriers include:

- Coordination among competing brands.
- Operational complexity.

Cost considerations:

- Required investments are dependent on leveraging existing transport systems and capacity.

Timing:

- Urban pilots in B2B and closed-loop contexts are feasible within one to two years with regional scaling and B2C integration likely within four to five years.

Resources:

- Logistics providers, municipal waste collection systems, reuse system operators.

Shared Washing Facilities

Why it matters: Washing capacity will be needed for reuse and refill systems. Individual businesses may not be able to afford their own washing facilities for reusable packaging and food service ware, however, shared hubs provide an opportunity for more efficient washing that is compliant with food safety standards.

Current State of Source Reduction report insight: Businesses and reuse operators emphasized the need for centralized washing hubs, especially in high-volume environments like stadiums and campuses. Community engagement highlighted the importance of visible, trustworthy cleaning processes.

Actions that may be most effective include:

- Start with closed-loop and B2B systems to build demand and operational models before expanding to B2C and open-loop reuse systems.
- Integrate washing into co-packing facilities and contract manufacturers for efficiency.
- Invest in automated washing systems for food-grade compliance.
- Set up regional hub-and-spoke models to minimize transport costs and emissions.

Potential barriers include:

- High capital costs.
- Fragmented demand.

Cost considerations:

- Upfront investment will be needed for washing hubs, however, per-unit costs decrease with scale. Integration with co-packers and contract manufacturers may be more cost-effective.

Timing:

- Closed-loop pilots are feasible within one to two years with regional hubs for broader reuse systems likely in three to five years.

Resources:

- Public private partnerships, co-packers, neutral third-party operators.

Digital Tracking and Data Systems

Why it matters: Tracking enables deposit management, return compliance, and performance monitoring which are effective for scaling and optimizing reuse systems.

Current State of Source Reduction report insight: Community engagement raised concerns about tech-only systems excluding low-income or older populations. Nondigital alternatives provide opportunities to ensure equitable access.

Key actions include:

- Pilot systems in B2B and closed-loop environments to refine systems before expanding to B2C.
- Deploy container tracking and deposit systems (e.g., QR codes, RFID).
- Integrate with point-of-sale (POS) and e-commerce platforms.

Potential barriers include:

- Data tracking and data systems may create privacy concerns for consumers.

Timing:

- Initial deployment in B2B and closed-loop pilots are feasible within one to two years with broader integration with B2C and open-loop systems likely within three to five years.

Resources:

- Tech providers, retailers, reuse service operators.

Innovative Business Models

Scaling reuse and refill systems may be most effective using business models that balance convenience, cost-effectiveness, and operational feasibility. Compared to systems for plastic covered material, reuse systems introduce new costs and responsibilities, while reducing costs in other areas. New costs include container collection, cleaning, and tracking, that can be addressed through innovative business models. There are also opportunities for reducing costs, such as reducing raw material needs for packaging. The Current State of Source Reduction report highlighted several promising models, while also identifying key risks, particularly around equity and digital access.

Digital Platforms for Tracking and Rewards

Description: Smartphone apps and digital systems track container use, manage deposits, and offer rewards for returns.

Current State of Source Reduction report insight: While digital tools can improve efficiency and consumer engagement, community engagement flagged concerns about tech-only solutions excluding low-income, older, or digitally disconnected populations. Nondigital alternatives must be offered to ensure equitable access.

Prefill Systems with Pooled Packaging

Description: Brands or distributors fill standardized reusable containers that are returned, cleaned, and refilled for future use.

Current State of Source Reduction report insight: Businesses and reuse operators identified prefill systems, especially those using pooled packaging and shared logistics, as the most scalable and cost-effective reuse model. These systems are already in use in B2B and closed loop settings and can serve as a foundation for B2C expansion.

Advantages:

- High control over logistics and hygiene.
- Easier to monitor return rates and container cycles.
- Potential for industry-wide cost sharing through pooled infrastructure.

Subscription-Based Refill Services

Description: Consumers receive regular deliveries of goods in reusable containers, which are returned and refilled on a recurring basis.

Examples include meal kits, personal care, and cleaning products.

Current State of Source Reduction report insight: Subscription models were seen as a promising entry point for reuse, particularly in urban areas. However, community members noted that affordability and convenience are key to long-term participation.

Deposit-Return and Loyalty Programs

Description: Consumers pay a deposit for reusable containers, which are refunded upon successful return. Loyalty points or discounts can further incentivize participation.

Current State of Source Reduction report insight: Engagement participants supported deposit-return systems but emphasized the need for clear communication and easy return options. Community members noted that financial incentives are critical to achieving high return rates.

Key Business Considerations for Scaling

Starting with B2B and closed-loop models may be most effective because these environments offer controlled conditions, predictable volumes, and lower risk, making them ideal for testing and refining business models before expanding to B2C and open-loop systems.

Cost sharing models may be most effective because shared infrastructure (e.g., washing hubs, logistics) can reduce costs for individual businesses and lower the barrier to entry for small and medium enterprises.

Retailer and brand collaboration through multi brand partnerships and pooled systems may also be effective for achieving scale and interoperability.

Clear communication, visible hygiene practices, and consistent user experience will build consumer trust and drive adoption.

Consumer Education and Behavior Change Strategies

Consumer behavior is central to the success of reuse and refill systems. Unlike other source reduction strategies that operate more in the background, reuse and refill generally require active participation, from returning containers to navigating new systems. Community engagement revealed that while many consumers are interested in reuse, they often perceive it as inconvenient, unfamiliar, or inaccessible. Effective education and engagement strategies can normalize reuse, build trust, and ensure inclusivity across California’s diverse communities.

The following subsections identify key actions and opportunities to influence behavior change related to reuse and refill systems. These actions are applicable to both reuse and refill strategies discussed in this section and those referenced under other source reduction strategies (e.g., BYO reusable food service ware).

Multilingual and Culturally Relevant Education Campaigns

Why it matters: Language and cultural relevance will support equitable access and participation.

Current State of Source Reduction report insight: Participants emphasized the need for reuse systems to reflect their communities, through language, product selection, and retail context.

Actions that may be most effective include:

- Develop multilingual campaigns in English, Spanish, Cantonese, Mandarin, Tagalog, Vietnamese, and other languages.
- Use culturally relevant messaging, visuals, and examples (e.g., staple foods, trusted brands).
- Partner with community-based organizations to co-design and deliver outreach.

Normalize Reuse and Refill Behaviors

Why it matters: Reuse will be more successful if it is seen as the convenient default and not an inconvenient, niche, or premium option.

Current State of Source Reduction report insight: Participants described refill stations as “bougie” or inaccessible unless integrated into mainstream retail.

Actions that may be most effective include:

- Encourage retailers and food service establishments to establish “skip the stuff” policies to reduce default use of plastic covered material.
- Make reusable food service ware the default for dine-in settings (e.g., reusable cups and plates).
- Position reusable and refillable options in familiar aisles (e.g., rice in a refillable container in the rice aisle alongside rice packaged in single-use packaging), not in separate zero-waste sections of the store.
- Launch visible pilots in high-traffic venues (e.g., stadiums, campuses, transit hubs) to build familiarity.

Incentivize Participation Through Gamification and Rewards

Why it matters: Incentives can help build habits and increase return rates.

Current State of Source Reduction report insight: Engagement participants supported loyalty programs and collective incentives, especially when tied to community benefits.

Actions that may be most effective include:

- Offer deposit return rewards and loyalty points for reuse participation.
- Gamify reuse through apps, in store challenges, and community competitions.
- Fund community projects (e.g., school gardens, local cleanups) based on collective return rates.

Build Trust Through Transparency and Education

Why it matters: Consumers need to trust that reuse systems are safe, clean, and effective.

Current State of Source Reduction report insight: Participants expressed concerns about hygiene and wanted reassurance through visible cleaning processes.

Actions that may be most effective include:

- Provide clear, multilingual signage and videos showing how containers are cleaned and reused.
- Highlight environmental benefits and potential cost savings to reinforce the value of participation.
- Use storytelling and testimonials from early adopters to build social proof.

Timeline for Scaling

Scaling reuse and refill systems can use a phased approach that balances infrastructure development with consumer engagement. The Current State of Source Reduction report findings suggest that near-term opportunities lie in controlled environments, while longer-term success depends on systemic infrastructure and cultural normalization.

Other Source Reduction Strategies

Other source reduction strategies can generally be implemented through design change. While reuse and refill strategies discussed in the previous section require new infrastructure and system changes, this section also includes reuse and refill strategies that do not require significant infrastructure investment (e.g., BYO reusable food service ware).

Lightweighting

Strategy Overview

Lightweighting involves reducing the weight or thickness of plastic components while maintaining the necessary good protection and performance. It is one of the most established and widely adopted source reduction strategies. Typical applications in flexible packaging include thinner bottle walls and closures in home and personal care, reduced resin use in trigger and pump components, optimized blown bottle bases, and downgauged films (replacing thicker film with thinner film in the same application, while providing the same protection for the good). Approaches range from use of plastic efficient proportions and neck finish optimization to the addition of reinforcing ribs or contours for stiffness. In flexible packs, simplified or downgauged laminate structures are common and for blown and molded packaging components, improved material distribution during forming also contributes to material savings.

Considerations to Inform Actions, Costs and Investments, and Adoption

Factors that should be considered for lightweighting include:

- Design and research and development (R&D): Structural redesign, packaging performance modeling, and testing to ensure reduced weight does not compromise good protection, drop resistance, or stacking strength. R&D investment may also be required for pallet or case optimization to reflect new dimensions.

- Tooling and equipment: New or modified molds, potential change parts, recalibration of blowing, forming, or sealing settings, and occasional resin reformulation are needed to achieve equivalent mechanical properties.
- Line and quality assurance: Trial runs and setup adjustments to confirm new parameters, including inspection systems tuned to thinner walls or reduced closure torque.
- Logistics and good protection testing: Distribution trials to verify that downgauged packs withstand transport, warehousing, and handling stress; good protection testing to confirm that barrier performance (e.g., oxygen, moisture) and shelf life remain within specification.
- Supply chain and procurement: Qualification of alternative suppliers of plastic finished goods or resin grades, coordination of minimum order quantities for new specs, and potential lead time for material sourcing.
- Regulatory and compliance: Food contact and safety documentation updates, if new materials or thicknesses change performance characteristics.
- Marketing and communication updates: Artwork resizing where necessary.

General Timelines and Other Implementation Considerations

- Indicative timelines: Flexible formats can typically be adjusted within three to six months following trials. Rigid formats requiring new tooling often take 12 to 24 months. Multi-region implementation or packs exposed to hot-fill or retort conditions (high temperatures in thermal processing and sterilization) can extend to 24 to 36 months due to qualification cycles.
- Technical limits: The extent of material reduction is constrained by good protection requirements, impact resistance, stacking strength, and closure integrity. Hot-fill and retort processes add further limitations due to heat and pressure requirements.
- Operational reality: Brands relying on stock bottles or standardized component platforms may face limitations in further optimization. In contrast, bespoke tooling — custom-made tools designed to meet precise specifications — can deliver greater reductions in material or cost, but it carries higher upfront expenses and longer payback periods.
- Consumer perception: Excessive lightweighting can make packs feel flimsy or less premium, increasing the risk of deformation or leakage. Retaining tactile quality through geometry, detailing, or localized thickening helps mitigate this.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Feedback from communities with disabilities found that lighter-weight items are generally preferred over heavier items that are harder to grip, which increases spill and burn risks.

Interviews with brand owners indicated that lightweighting was considered most feasible when packaging lines could be retooled without significant capital investment, and when consumer experience remained unaffected.

Packaging manufacturers noted that many high-volume products are already nearing their lightweighting limits. Some businesses expressed concern that source reduced packaging would fail to adequately protect goods from damage or spoilage, creating an unfavorable trade-off.

Elimination

Strategy Overview

Elimination involves removing unnecessary plastic components or redesigning plastic packaging so that certain elements are no longer required, without adding any new nonplastic components in their place. The goal is to achieve the same or improved functionality with fewer total components. This can include removing redundant plastic components entirely or consolidating multiple plastic pieces into a single element that performs multiple functions. It directly reduces the total amount of plastic used, either by weight of plastic or number of plastic components, while sometimes simplifying the packaging system and improving recyclability. Common examples include removing over-lids, or plastic sleeves from food and dairy packs; consolidating multi-part triggers, tamper features or pumps in home and personal care; and removing plastic components that are not essential. The approach can deliver immediate and measurable plastic reductions, particularly in categories with redundant or duplicative plastic components.

Elimination is also relevant to food service ware. This requires less redesign and more behavior change to no longer supply the items. A common example might include a takeout restaurant not supplying plastic — or any alternative nonplastic — utensils with a delivery order. BYO cup or container programs at restaurants are included in this analysis alongside elimination of single-use plastic food service ware because they have similarities, including that no infrastructure is required for collection and washing.

Considerations to Inform Actions, Costs and Investments, and Adoption

- Design and engineering: Packaging redesign and functional revalidation to ensure that the removal or consolidation of plastic components does not compromise sealing, good protection, or consumer usability.
- Tooling and equipment: Adjustments or replacements of filling, capping, or assembly tooling when component geometry changes. For consolidation strategies, such as tethering caps to tamper bands or integrating multiple plastic

parts within a trigger mechanism, new molding tooling is required to accommodate the redesigned components. These investments can vary widely depending on cavity count in the injection molding, material type, and production volume.

- Line and process validation: Testing and line trials to confirm sealing integrity, torque performance, and fit across automated filling and packing systems.
- Good protection and logistics trials: Distribution and transport testing to verify that packaging remains stable and secure without the eliminated component (e.g., no increased risk of leakage or contamination).
- Supply chain and procurement: Revision of component specifications, qualification of new packaging stock-keeping units (SKUs), and coordination with converters or co-packers where supply contracts are affected.
- Regulatory and compliance: Review of any safety, hygiene, or tamper-evidence requirements to ensure regulatory compliance post-removal.
- Marketing and communication updates: Artwork and packaging-size revisions, along with consumer messaging to explain visible changes such as the removal of an over-lid, tamper seal, or secondary feature.
- Food service establishment engagement: Outreach to restaurants to promote BYO programs or encourage the elimination of unnecessary food service ware.

General Timelines and Other Implementation Considerations

- Indicative timelines: Straightforward component removals can often be implemented in three to six months. Consolidation projects requiring new molds, testing, or multiple supplier changes generally take 12 to 24 months.
- Technical and functional limits: Components that contribute to hygiene, tamper-evidence, or transport protection are often non-negotiable. Any elimination must ensure equivalent good protection and consumer safety.
- Operational considerations: Simplifying component sets can streamline production and reduce assembly time but may also require line recalibration or minor modifications to filling or capping stations.
- Consumer perception: Visible packaging simplification can affect perceptions of quality, convenience, safety, or reassurance. Transparent communication helps maintain trust.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

While elimination can deliver immediate and measurable plastic savings, the results of this engagement suggest its suitability depends on the functional role of each component. Interviewed businesses noted elements that support hygiene, tamper evidence, or transport protection cannot always be removed.

From an operational perspective, elimination is often more accessible and cost-effective than redesigning the full packaging, since it typically involves design rationalization rather than new tooling. However, consolidating or removing components can still require adjustments to filling, capping, or packing lines to accommodate new configurations, as consulted experts affirm.

Although BYO cup and container programs to eliminate single-use plastic food service ware are more widespread today, they have operational and consumer culture challenges, as reported in community and expert engagement. Carrying refillable containers, especially for transit-dependent individuals, places the burden on the consumer.

Right Sizing

Strategy Overview

Right sizing involves optimizing the dimensions, proportions, and design of single-use plastic packaging so that it uses only the amount of material necessary to protect, contain, and present the product. The goal is to remove excess space or volume within the primary packaging, or between primary and secondary packaging, and at the tertiary packaging level, while maintaining good protection and usability. This strategy is widely applied across food, personal care, and home care categories. Examples include reducing unnecessary headspace (the empty space between the lid or top of the packaging and the top of good inside the packaging) in detergent or sauce bottles, optimizing pouch dimensions for powders and granules, and tightening the fit between individual products and their secondary packaging in multi-pack snack formats. Right sizing can also involve rebalancing packaging shape or geometry to improve pallet efficiency, reducing total packaging and transport emissions together.

Considerations to Inform Actions, Costs and Investments, and Adoption

- Packaging design and R&D: Structural redesign to reduce void space, adapt geometry, and maintain required top-load and impact strength. This includes 3D modeling, drop testing, and stacking simulations.
- Tooling and equipment: New or modified molds, forming tools, or sealing jaws to achieve revised dimensions or fill levels. Adjustments may also be required to case packaging formats, conveyors, and end-of-line machinery to handle the new packaging sizes efficiently. Where stock packaging is replaced with bespoke right sized designs, new tooling investment is often required.
- Filling and line validation: Adjustments to filling volumes, headspace tolerances, and sealing parameters to ensure accuracy, speed, and consistency with new packaging proportions. Production lines may need to be reconfigured or respaced to accommodate different packaging heights or footprints.
- Good protection and logistics testing: Distribution trials to confirm that reduced packaging dimensions maintain protection through transit and storage, including assessment of pallet stability and case packing efficiency.

- Supply chain and procurement: Coordination with suppliers to update component specifications, transport packaging, and material orders to reflect new sizes or counts.
- Marketing and communication updates: Artwork and labeling adjustments to reflect new dimensions, volume declarations, and to ensure product shelf presence remains strong despite reduced size.

General Timelines and Other Implementation Considerations

- Indicative timelines: Minor adjustments to headspace or fill levels can often be implemented within six to 12 months. Full packaging redesigns requiring new tooling, testing, and supply chain revalidation typically take 12 to 24 months or longer.
- Technical and operational considerations: Headspace reductions must account for foaming during filling, product settlement, and machine tolerances. Inadequate allowance can cause filling inefficiencies, packaging deformation, or product damage.
- Consumer perception: Smaller or shorter packaging may be perceived as offering less value. Adjusting graphic proportions, maintaining familiar shapes, and clear on-packaging communication of product weight or volume can help preserve brand presence and trust.
- Manufacturing efficiency: Many brands use shared containers across multiple product sizes for efficiency, which can lead to unnecessary void space. Moving toward modular tooling or size-specific molds can improve material efficiency but requires upfront cost and will likely add to supply chain complexity.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Right sizing can create differences in appearance, such as reduced product size, said some of those interviewed. Some businesses felt that consumers may incorrectly associate this with reduced product value.

Right sizing was broadly viewed by many of the businesses interviewed as a practical, incremental strategy toward meeting the source reduction requirements, particularly as reuse systems develop. The Current State of Source Reduction report found that there was potential to drive cost savings and lower transport emissions through lower material use. Some interviewed packaging manufacturers identified up-front costs of changing molds.

Concentration

Strategy Overview

Concentration, a type of format change, involves reformulating a good so it delivers the same performance using a smaller quantity of the good, thereby requiring less packaging per use. Because a format change or a change in the physical state of a good sometimes results in a smaller quantity of good, this allows it to be packaged in a fundamentally different way that can be less plastic intensive. This strategy is widely used in home care, personal care, and food categories. Concentration and format change can be achieved through reducing the good's water content, reducing other bulk, or changing the physical state of the good altogether. This can include switching liquid formulations into solids (e.g., stick, tablet, sheet), powders, or pastes.

Common examples include concentrated laundry liquids, surface cleaners, and dishwashing detergents, as well as food goods like bouillon, sauces, and ice cream mixes with reduced water content. Concentration can be combined with reuse and refill systems. Other common examples include liquid hand soap reformulated into bar form for carton or paper packaging, deodorant roll-ons reimagined as solid sticks in fiber-based tubes, and liquid laundry detergents replaced by soluble sheets or capsules in paper packaging. These changes can eliminate the need for plastic bottles or pumps entirely and often make refill, reuse, or paper-based alternatives viable.

Considerations to Inform Actions, Costs and Investments, and Adoption

- Formulation and R&D: Reformulating the good into a new physical format while maintaining its performance, stability, and safety at higher concentration levels. This often includes laboratory testing, sensory testing, compatibility assessments, adjustment of ingredients to suit solid or concentrated forms and shelf-life validation.
- Packaging and process adaptation: Development of new packaging formats suitable for concentrated goods, such as smaller bottles, sachets, cartons, or solid formats, and validation of fill, seal, or dosing performance. Changes may also be required to dosing caps, closures, or applicators. Development of new packaging systems suited to the changed format of the good, such as carton structures, molded fiber cases, or coated paper wraps. Design must ensure protection from moisture and contamination while meeting usability expectations.
- Equipment and tooling: Investment in new filling, mixing, or dosing equipment. New or adapted production and filling lines are often required, particularly when moving from liquid to solid or sheet formats. This can involve investment in mixing, extrusion, cutting, and wrapping equipment not typically used in liquid operations.
- Third-party production and outsourcing: To avoid interrupting existing production, to leverage external expertise or to test new formats before scaling up, some businesses choose to use third-party fillers or co-manufacturers. This approach can reduce operational disruption and accelerate learning but introduces additional logistics coordination and typically higher short-term costs.
- Good protection and logistics testing: Trials to ensure concentrated goods retain adequate protection against moisture, contamination, or physical damage throughout transport and storage. Behavior validation of new products during storage and distribution, ensuring that solid or dry formats resist humidity, breakage, or deformation while maintaining functional integrity.

- Supply chain and procurement: Identification and qualification of new material suppliers and packaging partners capable of producing or filling the new format at the desired scale.
- Regulatory and compliance: Review of labeling, safety, and hazard classification, particularly for higher-strength cleaning or chemical formulations.
- Marketing and communication updates: Artwork, labeling, and consumer communication to clearly convey the concentrated nature of the product, correct dosing instructions, and value equivalence compared with standard formats. Significant advertising and communication investment is often required to build awareness of the new format, explain how to use it, and reassure consumers about performance and value.

General Timelines and Other Implementation Considerations

- Indicative timelines: Format changes typically require 18 to 36 months, depending on formulation complexity, safety testing, equipment sourcing, and consumer validation.
- Technical and operational considerations: Reformulated goods may behave differently in storage, transport, or use. Solid or sheet formats may require specific humidity controls and may demand additional secondary packaging to ensure shelf-life. Pilot-scale runs confirm machinability, stability, and usability before scaling.
- Consumer behavior and usability: Concentrated goods sometimes require consumers to dilute, dose, or mix at home. Success depends on intuitive usage instructions and consistent product performance to avoid misuse or overuse.
- Consumer acceptance and retail performance: Format change is most effective if accompanied by clear communication and education to support new usage behaviors, such as dissolving a sheet in water or applying a solid deodorant stick. Success depends on maintaining product performance and convenience while clearly highlighting the reduced plastic benefit. Breaking category norms in shape, size, or appearance can reduce visibility or perceived relevance unless supported by shelf presence, strong artwork design, and communication. Smaller packaging can be perceived as lower value if pricing and shelf communication do not clearly indicate equivalence. Clear on packaging messaging such as “makes X gallons” or “same cleaning power, less plastic” can support consumer trust and adoption.
- Operational and supply chain factors: Concentration can simplify logistics by reducing transport volume and weight, and it is often combined with reuse systems, such as refill pods or dissolvable sachets. These combined models can create additional design and operational complexity, as they require compatible refill containers and clear guidance for consumer use.
- Economic implications: Although format changes can significantly reduce plastic use, they require reformulation, capital investment, and behavioral changes.

Over time, these costs are typically offset through reduced material use, improved logistics efficiency, and alignment with sustainability targets.

- Strategic benefits: When successful, format change can shift entire product categories away from plastic covered material, unlocking new business models such as refill-at-home systems, waterless formats, or e-commerce-optimized delivery models. New reformulated formats are often introduced as an additional option alongside existing products to allow gradual consumer migration and attract new shoppers from competing brands.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

The Current State of Source Reduction report engagement found that concentrates could be a good alternative to large, heavy products for people with smaller housing and limited storage space (e.g., urban apartments, multifamily housing). For example, liquid hand soap reformulated into bar form may take up less space and be lighter in weight. Furthermore, people with disabilities and older adults indicated that large containers can be heavy and difficult to manage, therefore concentrated goods can be easier for them to manage due to their lighter weight.

Concentrations can create differences in appearance, such as reduced product size, said some community members interviewed. Businesses engaged felt consumers may incorrectly associate this with reduced product value. However, several participants of the community engagement said concentrated formats could help overcome the challenge of paying more upfront for economy-size packaging. By reducing container size while maintaining volume through dilution, concentrates were seen to combine affordability with lower plastic use.

Community engagement survey results found that buying concentrates was viewed as one of the easiest plastic-reduction behaviors compared to buying package-free, declining plastic single-use food service ware, or bringing personal containers to refill stations.

Reformulating goods often requires investment in R&D, testing, and production line modifications to ensure good stability and consistent performance in different formats. Findings from engagement with companies showed that format changes can reduce packaging costs per use but may require substantial upfront development and retooling investment as it demands new packaging and filling technologies. When successfully implemented, findings from this engagement suggest format changes can deliver substantial reductions in packaging material use and logistics impact, while also supporting the transition toward alternate packaging materials beyond plastic.

Large Format

Strategy Overview

Large format packaging reduces the overall amount of plastic covered material used per unit of good by increasing the packaging size, volume, or number of uses per container. The strategy distributes the amount of plastic covered material across more units of goods. It is particularly effective for products with consistent, repeat-use patterns where larger quantities can be stored or dispensed over time. Common examples include bulk household cleaning products, pet food, cereals, and family-size food items such as condiments or sauces. Large format packaging can be combined with reuse and refill systems.

Considerations to Inform Actions, Costs and Investments, and Adoption

- Packaging design and engineering: Redesign of bottles, pouches, tubs, and primary and secondary wraps to optimize material use while safely accommodating the increased volume and weight of larger formats while ensuring strength and usability.
- Tooling and equipment: New or modified molds and line parts to handle larger container sizes, including adapted capping and labeling systems. In some cases, entirely new production lines are needed, particularly when packaging sizes exceed the limits of existing capabilities.
- Filling and logistics adjustments: Validation of filling speeds, stacking strength, and pallet configurations, as larger packaging can place higher loads on filling lines and secondary packaging.
- Third-party production and outsourcing: To avoid interrupting existing production or to test new formats before scaling up, some businesses choose to use third-party fillers or co-manufacturers. This approach can reduce operational disruption and accelerate learning but introduces additional logistics coordination and typically higher short-term costs.
- Good protection and transport testing: Trials to ensure that larger, heavier packs maintain integrity during distribution and do not deform, leak, or fail under stacking pressure.
- Retail and merchandising changes: Adaptation of shelf layouts, planograms (visual representations or diagrams that illustrate how products should be displayed in a retail environment), and replenishment systems to accommodate larger formats.
- Marketing and communication updates: Revised artwork and labeling to communicate value per use, refill compatibility, or environmental benefits compared with smaller packaging.

General Timelines and Other Implementation Considerations

- Indicative timelines: Changes to packaging sizes within an existing packaging platform can often be implemented in six to 12 months. When entirely new container geometries or line modifications are needed, timelines can extend to 18 to 24 months.
- Technical and operational considerations: Larger packaging must maintain stability and durability during transport and handling. This often requires thicker walls or reinforced structures, which can offset material savings if not carefully

optimized. Additional features, such as carry handles, grips, or spouts, may be added to improve usability and ergonomics for heavier packaging, but these increase component count and reduce the overall impact of source reduction. Structural and ergonomic testing are critical to balance performance and usability. Changes in container size can also affect logistics and warehousing. In some cases, larger formats improve efficiency; in others, they reduce pallet density, increase transport weight, or add handling complexity.

- Consumer and retail dynamics: Large-format packaging typically suits households with higher consumption or businesses purchasing in bulk. However, it can be less practical for smaller households or for products where freshness and storage space are concerns. Larger formats can sometimes result in less accessible formats or less ergonomic consumer handling if not addressed correctly. The higher upfront cost of large-format products can also be a barrier for some consumers, as it may not align with the cash flow or shopping habits of all households. Clear communication of cost-per-use and environmental benefit can help drive consumer adoption.
- Integration with reuse and refill models: Large-format products are often most effective when paired with reuse systems at the retail or consumer level, allowing the same bulk format to serve multiple replenishment cycles.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Larger containers can be heavy and difficult to manage, especially for people in small apartments, for older adults, and for those with disabilities. Some community engagement participants pointed out that access to larger packaging often requires warehouse memberships and vehicles, which excludes lower-income households, smaller families, and people who rely on transit.

Community engagement survey results found that buying large format/bulk packaging was viewed as one of the easiest plastic reduction behaviors compared to buying package-free, declining single-use plastic food service ware, or bringing personal containers to refill stations. Many participants strongly associated larger packaging with saving money in the long run and reducing plastic simultaneously. At the same time, participants emphasized that the higher upfront price is a barrier for families living paycheck-to-paycheck.

Material Substitution (Plastic to Nonplastic)

Strategy Overview

Material substitution involves substituting plastic components or plastic covered material formats with nonplastic alternatives. The objective is to reduce plastic use by switching to materials such as paper, fiber, metal, or glass while maintaining equivalent functionality. Material substitution can deliver measurable single-use plastic reductions when the new material fully replaces plastic, rather than being added as an extra layer or component. This strategy is increasingly used across food, home care, and personal care categories. Examples include switching rigid plastic trays to molded fiber or aluminum, replacing plastic jars and bottles with glass for sauces and condiments, and using paper-based packaging for dry goods or refills that do not require high moisture barriers. Aluminum bottles can replace plastic bottles in pump or trigger formats. Material substitution also applies to secondary and tertiary packaging, such as substituting pallet stretch film or plastic impact-resistant inserts with paper-based wraps and corrugated board.

Considerations to Inform Actions, Costs and Investments, and Adoption

- Material R&D and qualification: Research and testing to identify viable alternative materials that meet barrier, strength, and sealing requirements. This includes migration and safety testing for food contact applications.
- Covered material design and engineering: Redesign may be required to account for differences in how alternative materials can be shaped and processed. These forming differences influence the achievable geometry, wall thickness, seal or closure areas, and overall structural performance. Fiber, paper, glass, metal, and other substitutes behave differently from conventional plastics, so certain features may need adjustment to maintain function across both packaging and food service ware.
- Tooling and equipment: New or adapted molds, or sealing heads are often required when transitioning to new materials. Existing production lines designed for plastics may require modification to accommodate different forming pressures, sealing temperatures, or cutting tools. In some cases, entirely new production lines are needed, particularly when switching from plastic to glass, metal, or molded fiber, as these materials demand different forming, filling, and sealing technologies.
- Third-party production and outsourcing: To avoid interrupting existing production or to test new formats before scaling, some businesses choose to use third-party fillers or co-manufacturers. This approach can reduce operational disruption and accelerate learning but introduces additional logistics coordination and typically higher short-term costs.
- Infrastructure and safety upgrades: Handling heavier or more fragile materials such as glass and metal may require changes to conveyors, palletizing systems, and filling lines, as well as investment in protective equipment to minimize breakage and operator injury. Factories with plastic-only lines may also need to install specialized cleaning systems to manage dust, shards, or corrosion associated with new materials.
- Training and upskilling: Operators, engineers, and maintenance teams often need training to safely and efficiently manage new materials, adjust sealing or forming parameters, and maintain quality control under different process conditions.
- Filling and process validation: Production line trials to test compatibility between new materials and existing filling conditions, particularly where alternative

substrates are more rigid or less heat tolerant. Validation ensures sealing integrity, run speed, and good protection remain consistent.

- Good protection and logistics testing: Distribution and storage trials to verify that the new material maintains durability, moisture and grease resistance, and shelf life performance equal to the original format.
- Supply chain and procurement: Establishing new supplier relationships and securing material supply at scale. New materials may require different storage or handling conditions, adding to initial setup costs.
- Marketing and communication updates: Revised artwork and messaging to clearly communicate recyclability and material change to consumers, ensuring expectations are managed around differences in look, feel, or weight.

General Timelines and Other Implementation Considerations

- Indicative timelines: Transitions within an existing format (for example, switching a plastic film to paper laminate) can typically be implemented in nine to 15 months. More complex format changes, such as rigid plastic to fiber, glass, or metal, often take 18 to 36 months or more due to tooling lead times, new production line installation, validation, and regulatory approvals.
- Technical and operational considerations: Alternative materials vary significantly in behavior, weight, and process demands. Paper and fiber generally offer lower moisture and grease resistance, while glass is brittle and presents a higher risk of breakage during filling and transport.
- Handling glass within plastic: Handling glass within plastic-oriented factories is often discouraged for safety reasons, as breakage can lead to contamination and production line downtime. Metal alternatives introduce challenges around corrosion and forming precision, requiring different temperature and pressure control. Unlike many plastic packaging formats that are converted directly at the point of filling, materials such as glass and metal are usually supplied as pre-formed containers. This increases logistics complexity and transport costs, as empty containers must be delivered, stored, and handled on-site before filling. Each material also affects equipment wear differently, influencing maintenance schedules and long-term operating costs. Upskill teams to manage these new handling, safety, and maintenance requirements.
- Economic factors: Replacement materials can be more expensive per ton and can reduce production speeds. Heavier materials such as glass and metal can increase transport costs and emissions associated with transport. Capital expenditure can be significant where new forming, filling, or sealing lines are required, especially for high-volume products.
- Consumer perception: Consumers generally respond positively to visible material changes when the environmental benefit is clear. However, shifts in material can alter the sensory and functional experience of the product. Paper and metal-based packaging, for instance, can eliminate product visibility, which can affect

perceptions of freshness, color, or fill level. This can be particularly challenging for food, beauty, and household products where seeing the product reinforces trust and value. Differences in weight, rigidity, and surface feel can also influence how consumers handle and store the product. Clear on-packaging messaging can help maintain reassurance and support continued acceptance of new materials.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Consumers expressed general support for paper, glass, and metal packaging, with some caveats around weight or bulkiness, and if they perceive that the packaging compromises the viability of the goods. During the community engagement process, participants cited higher costs and heavier weight of glass and metal packaging compared to plastic.

Glass jars and metal containers were described as heavier to carry and store, which felt inconvenient for people who rely on public transit, walk or bike to shop, have stairs at home, are older, and have disabilities. Participants cited the removal of flexible plastic straws as an example that failed to consider accessibility needs for people with disabilities.

Interviewed companies noted that material substitution faces various technical challenges, including that some materials are currently unable to meet operational requirements, such as scanning compatibility, durability, or performance in existing conveyor and distribution systems. Some interviewed businesses also expressed concern of potential environmental tradeoffs from material substitutions.

Cross Cutting Considerations for Source Reduction Strategies to Maximize Successful Adoption

Generally, other source reduction strategies, including reuse and refill strategies that do not require infrastructure investments, operate within existing linear supply chains and can be implemented directly by brands and material converters without requiring system wide shifts in business models.

While each strategy differs in scope and impact, they share common technical, operational, and communication enablers that impact how they can scale efficiently across California. Insights from the Current State of Source Reduction report highlight that successful adoption depends on robust technical validation, predictable supply chains, coordinated supplier engagement, and clear communication that preserves consumer trust and protects priority populations.

The following are cross-cutting considerations regarding shared infrastructure, technical, and consumer-facing conditions to scale strategies such as lightweighting, elimination, right-sizing, concentration, large-format packaging, and material substitution.

Infrastructure Requirements

Changes to plastic covered material that reduce the amount of plastic depend on reliable testing frameworks, proven materials, and production line capability. Although many strategies can be implemented within existing supply chain assets, others may require investment in new tooling, new equipment, or in some cases completely new production lines. Successful adoption relies on structured upgrades, thorough validation, and close coordination between brands, packaging converters, and suppliers to ensure that revised formats run efficiently, maintain product protection, and meet regulatory requirements. The following sections outline the core infrastructure needs that support the implementation of these source reduction strategies.

Standardized Testing and Validation Protocols

Why it matters: Strategies that reduce the amount of plastic in plastic covered material or change format require assurance that the packaging still protects the good, meets regulatory requirements, and performs through handling, transport, and storage.

Current State of Source Reduction report insight: Some interviewed interested parties noted that materials such as paper and fiber offer lower moisture and grease resistance and may require additional testing to confirm durability and barrier performance. Additionally, heavier or more fragile materials such as glass and metal can increase the risk of breakage or leakage during distribution, requiring careful verification of performance under load and transport conditions.

Actions that may be most effective include:

- Use industry standard test protocols for top load, drop, barrier, torque, seal strength, shelf life, and distribution stress.
- Establish shared test criteria across suppliers to reduce duplication.
- Apply small-scale pilots before multi-region rollout.

Potential barriers include:

- Limited availability of modelling tools for alternative materials.
- Restrictions where food safety or tamper evidence are tied to specific packaging thickness, material types, or components.

Cost considerations:

- Moderate per SKU costs for laboratory testing, line trials, and distribution validation. Costs rise when multiple rounds of testing are needed to resolve performance issues.

Timing:

- Three to 12 months depending on the extent of the change, with shorter timelines for minor thickness or geometry adjustments that require limited validation.

- More extensive testing cycles, including barrier, migration, shelf life, or distribution trials may be needed.
- Products regulated under stricter food contact or tamper evidence requirements may require sequential testing rounds, adding additional time before approval.

Supply Chain Readiness and Material Availability

Why it matters: Consistent access to needed materials is a precondition for lightweighting and substitution, though this is not a challenge specific to source reduction strategies. Without a predictable supply, producers may face delays, performance variation, and inconsistent product appearance.

Current State of Source Reduction report insight: In some cases, transitioning to new materials may require establishing new supplier relationships to secure consistent quality and supply at scale.

Actions that may be most effective include:

- Secure supply contracts with converters.
- Build multi-supplier redundancy for formats sensitive to raw material variation and to mitigate supply risk.

Potential barriers include:

- Paper and fiber alternatives that potentially cannot run at full line speed or meet barrier requirements.
- The need for new suppliers or converters equipped to handle nonplastic covered materials.

Cost considerations:

- Some cost recovery is possible through reduced material use or redesigned formats.

Timing:

- Six to 24 months depending on the material or resin type and the level of qualification required.
- Shifts to nonplastic materials can take longer due to additional validation of barrier performance, durability, and run speeds.
- Timelines extend when new converters or resin suppliers must be qualified through sampling, pilot runs, and consistency checks.

Tooling, Equipment, and Line Adaptation

Why it matters: Many source reduction strategies can be implemented by modifying existing tooling, such as new molds, forming parts, and seal jaws. However, more significant transitions, including format changes, concentrated products, or shifts to new material types such as aluminum or fiber, often require investment in entirely new equipment or even new production lines. These upgrades ensure that revised packaging runs safely, efficiently, and at commercial line speeds. Even small dimensional or material changes can require recalibration, adjustments to fill accuracy, and updates to line functions such as inspection and torque systems.

Current State of Source Reduction report insight: Findings showed that transitions to new materials or product formats often require modifications to existing equipment or the installation of new line components. Materials such as paper, fiber, glass, and metal behave differently to plastics and may require adjustments to forming, sealing, and handling conditions to maintain packaging integrity. Some interviewed interested parties also highlighted that heavier or more fragile materials such as glass and metal can require changes to conveyors, palletizing systems, or line guarding to manage breakage risks. In addition, the introduction of new formats, including concentrated liquids or solid formats, can necessitate revised filling, dosing, or handling approaches to ensure products run efficiently on manufacturing lines.

Actions that may be most effective include:

- Plan for new molds and change parts when right-sizing, eliminating components, or adjusting geometry.
- Assess whether format changes or material substitutions require new filling, forming, or sealing equipment.
- Adapt line parameters to maintain sealing integrity, fill accuracy, and run speed for thinner walls or alternative substrates.
- Use modular tooling platforms when appropriate to reduce long-term cost and increase flexibility across SKUs.

Potential barriers include:

- Long lead times for high-cavity injection molds, custom forming tools, and specialized equipment.
- Reduced line speeds or increased downtime when new materials introduce different thermal, mechanical, or handling characteristics.
- Limited compatibility between existing lines and certain new formats or materials, increasing the need for new equipment or line redesign.

Cost considerations:

- Tooling and equipment investments range from moderate for simple profile or thickness changes to very high where full-format changes, new materials, or new production lines are required.

Timing:

- Six to 36 months depending on the scope of change. Minor adjustments to molds or change parts sit at the lower end.

- New molds, forming tools, or sealing equipment typically require several months for design, fabrication, installation, and validation.
- Format changes or shifts to new material types usually fall toward the upper range because they require new equipment, revised line parameters, and full commissioning.

Distribution and Logistics Testing

Why it matters: Many source reduction strategies reduce weight and change dimensions, potentially introducing new structural weaknesses. Distribution failures can negate environmental benefits and increase waste.

Current State of Source Reduction report insight: Findings showed that shifts to downgauged or alternative materials raised concerns among some about product damage during transport and storage. Some businesses noted that materials such as paper and fiber may offer lower moisture resistance and reduced structural durability, requiring additional validation to ensure packs withstand handling and distribution stresses. The research also highlighted that heavier or more fragile materials such as glass and metal can increase breakage or leakage risk during logistics.

Actions that may be most effective include:

- Conduct pallet stability, stacking, vibration, and humidity testing for all new designs.
- Validate that alternative materials resist moisture and mechanical stress.
- Reoptimize case count and pallet load where right sizing or concentration alters dimensions.

Potential barriers include:

- Paper and fiber packs collapsing under high-humidity or previous design pallet counts.
- Lightweighted bottles deforming during transport.

Cost considerations:

- Low to moderate.
- Savings achieved through improved cube efficiency and reduced materials.

Timing:

- Three to six months for most formats, allowing time for pallet stability, vibration, compression, and environmental testing.
- Alternative materials such as paper, fiber, or lightweighted rigid plastics may require additional testing cycles to confirm moisture resistance, stacking strength, and durability, which can extend timelines toward the upper end of the range.

- Multi SKU portfolios or formats with multiple packaging sizes may need staggered distribution trials to ensure consistent performance across all variations.
- Where distribution issues emerge during testing, redesign and retesting can add further time before full rollout.

Technical and Operational Enablers

These strategies depend less on business model shifts and more on the technical capability of brands, R&D teams, and packaging suppliers to redesign, validate, and scale new packaging formats without causing operational disruption. Adoption may be most successful with alignment across formulation, tooling, processing, and quality assurance, along with the ability to adapt existing lines or install new equipment where needed. Close coordination with converters, material suppliers, and co-manufacturers will enable redesigned packs to run reliably at commercial speeds, maintain product protection, and meet regulatory and performance requirements. The following technical enablers support the consistent and scalable implementation of these strategies across a range of product categories and manufacturing environments.

R&D and Formulation Capability

Why it matters: Concentration, format change, and some material substitutions require reformulating the good to ensure it remains stable, safe, and effective in its new form. These changes often involve new mixing processes, viscosity profiles, and dosing behavior, which may require investment in new formulation or processing equipment, such as mixers, dissolvers, or drying systems. Reformulated goods must also be compatible with the revised packaging format, whether that means a smaller bottle, powder packaging, or a solid bar. Robust formulation capability is critical to maintaining product performance and avoiding operational disruption.

Current State of Source Reduction report insight: Findings showed that concentrated and reformulated products often require additional stability and performance testing, which can extend development timelines. Some interviewed interested parties noted that changes in viscosity, appearance, or sensory characteristics must be assessed to ensure that product performance and consumer confidence are maintained. The research also indicated that transitions to new formats such as powders or solid bars require consumers to adjust to new dosage sizes and usage behaviors, highlighting the importance of clear, intuitive instructions to support correct use.

Actions that may be most effective include:

- Develop R&D protocols for stability testing, sensory assessment, and compatibility between new formulations and new packaging formats.
- Assess whether new formulation or processing equipment is needed to support liquid to solid transitions, higher concentration levels, or new material handling requirements.

- Pilot concentrated or reformulated products with third party manufacturers to reduce disruption to existing lines and accelerate learning.

Potential barriers include:

- Compatibility issues between new formulations and existing filling or dosing equipment.
- Longer validation cycles when new formulations require extended stability, shelf life, or performance testing.
- Operational complexity when shifting to formats that require different handling, mixing, or dosing characteristics.
- Consumer acceptance challenges, particularly when new formats require dilution or dosing, or when product appearance or sensory characteristics change.

Cost considerations:

- Higher costs for format changes or transitions requiring new formulation equipment, moderate costs for concentration within existing process capabilities.
- Potential long-term logistics efficiencies from strategies like concentration and format change, which reduce transport weight and volume and may offset formulation and equipment costs over time.

Timing:

- 12 to 36 months depending on the level of reformulation required. Simpler concentration within existing liquid formats tends to sit at the lower end, while new formats such as powders, tablets, or bars require longer development and validation.
- Timelines extend when new formulation or processing equipment is needed, or when products require longer stability, shelf life, or performance testing cycles.

Supplier Coordination and Packaging Converter Alignment

Why it matters: Reliable supply of lighter components, new materials, and new formats to packaging converters and suppliers will allow for source reduction at scale.

Current State of Source Reduction report insight: Findings showed that supplier and converter capability varies across material types, as alternative substrates such as paper, fiber, glass, and metal have different forming, sealing, and handling requirements. Some interviewed parties reported that transitions to these materials often require establishing new supplier relationships and securing reliable material supply at scale.

Actions that may be most effective include:

- Early engagement with packaging converters and material suppliers on feasibility.
- Joint trials to confirm run speeds and quality stability.

Potential barriers include:

- Misalignment between converter capability and brand expectations.
- Limited converter availability for currently niche materials such as paper barriers or molded fiber.

Cost considerations:

- Mostly related to trial runs and scheduling.

Timing:

- Timelines run in parallel with tooling and material qualification and typically span six to 18 months depending on supplier readiness and capacity.
- New suppliers or alternative material partners often require additional time for qualification, sampling, line trials, and quality verification.

Quality Assurance, Compliance, and Regulatory Assurance

Why it matters: Changes in thickness, formulation, or material type may require updated quality assurance checks and compliance documentation to ensure the packaging and product continue to meet food contact, safety, labeling, and tamper evidence requirements. Reformulated or newly packaged products may also need updated shelf-life validation, hazard classification, and documentation to demonstrate continued conformity with state and federal regulations.

Current State of Source Reduction report insight: Findings showed that material and formulation changes often require additional validation to confirm product safety, durability, and performance. Some interviewed parties noted that alternative material types such as paper, fiber, glass, and metal may compromise protection or increase risks of breakage or leakage, requiring further barrier and durability testing before approval. The research also highlighted that concentrated or reformulated products need extended stability and performance testing, which can add significant time to implementation.

Actions that may be most effective include:

- Update compliance records for all reformulated or substituted packs.
- Validate that new formats still meet tamper evidence or hygiene regulations.
- Use accredited labs for food contact and barrier testing.

Potential barriers include:

- Extended stability, shelf life, and performance testing cycles are needed when formulations or materials change, which lengthen overall timelines.
- Additional compliance review if material changes affect food contact status, migration potential, or safety classification.

- Additional redesign may be necessary to meet existing tamper evidence, hygiene, or durability requirements.

Cost considerations:

- Moderate, depending on product category

Timing:

- Six to 18 months depending on the scope of change. Shorter timelines apply to minor thickness adjustments, while formulation or material changes requiring stability, migration, or shelf-life testing typically fall toward the upper end.
- New formats or new material types may require multiple testing cycles, which can extend timelines further.

Consumer Acceptance and Communication Needs

While other source reduction strategies generally require less behavioral change than reuse and refill, they still affect appearance, usability, and perceived value. The following considerations outline the communication and user experience factors that support successful and equitable adoption of these source reduction strategies.

Managing Perceptions of Value, Quality, and Safety

Why it matters: Changes in size, weight, color, or structural features can alter how consumers perceive value, quality, and safety. Smaller or lighter packaging may be interpreted as offering less of the good, and visible differences such as reduced headspace, simpler structures, or different coloration can be mistaken for defects or lower quality. These perceptions can undermine trust, even when technical performance is unchanged. Clear communication is essential to help consumers understand the reason for visible changes and to maintain confidence in the product and brand.

Current State of Source Reduction report insight: Findings showed that consumers often interpret smaller or lighter packaging as offering less value, even when volume is unchanged. In addition, the removal of structural elements such as over-lids, inner seals, or sleeves reduced the sense of hygiene or product protection for some users.

Actions that may be most effective include:

- Clear on-packaging statements about volume, performance, and environmental benefit.

Protecting Priority Populations and Accessibility

Why it matters: Priority populations include a diverse range of individuals including: those living in disadvantaged communities, low income, rural areas, and Tribes. Because of this, certain strategies that overwhelmingly benefit one group may not be as beneficial to others. For example, many low-income large families appreciate the opportunity to purchase items in large format packaging, while individuals with disabilities may need lighter weight items. Overall, utilizing a wide array of source reduction strategies ensures the right fit to meet the needs of each individual.

Packaging have the ability to create or remove barriers for priority populations. Eliminating certain components, such as bendable straws, can remove features that some users rely on for safe and independent use. Material substitutions, including shifts to glass or metal, can increase packaging weight, fragility, or handling difficulty, which poses challenges for older adults, people with disabilities, and those who walk or use public transit. Larger or heavier formats can also increase strain or spill risk. However, other strategies such as concentration and lightweighting may offer benefits of lighter weight goods for these groups.

Current State of Source Reduction report insight: Findings showed that some source reduction strategies can create usability challenges for priority populations when weight, handling effort, or storage needs increase, while other strategies provide benefits of lighter weight products. Larger or heavier packs were reported to create strain and storage difficulties for older adults, people with limited strength, and households with constrained space. Shifts to heavier or more fragile materials such as glass or metal were also noted as less convenient to carry and store, limiting uptake among some of these user groups. Other findings found that transitions to new formats may require behavioral adjustments, which can pose barriers if instructions or usage expectations are not clear. These findings and considerations underscore the importance of incorporating the perspectives and needs of priority populations and vulnerable communities.

Actions that may be most effective include:

- Conduct consumer research and usability testing that includes priority populations to ensure redesigned packaging meets diverse accessibility needs.
- Avoid eliminating accessibility features without alternatives.
- Offer smaller formats alongside large formats where possible.

Clear Usage Instructions for Concentrated and Reformulated Formats

Why it matters: Concentrated and reformulated products often require consumers to adopt new usage habits, such as diluting, dosing, mixing, or handling unfamiliar product forms like powders, tablets, bars, or refills. If instructions are unclear or unintuitive, users may underdose, overuse, or misuse the product, which can reduce performance, increase cost, or create safety concerns. Well-designed instructions help maintain product performance, support equitable access, and prevent confusion during the transition to source reduced alternatives.

Current State of Source Reduction report insight: Findings showed that concentrated products often require consumers to dilute, dose, or mix at home, and that successful adoption depends on intuitive, easy to follow instructions to avoid misuse or overuse. The research also found that smaller or lighter concentrated packaging can be perceived as lower value if not clearly communicated, making clear labelling and shelf messaging essential for uptake. With clear labeling and messaging, concentrated products present an appealing solution, as findings show consumers are most receptive to strategies that align with existing habits, including purchasing concentrated items. Additionally, community engagement also found that the lighter weight and smaller physical presence of concentrated items provide benefits for people who rely on public transit or reduce strain on older adults or people with limited strength.

Actions that may be most effective include:

- Provide simple, multilingual dosing and dilution guidance that is easy to follow across literacy levels and language groups.
- Use clear visual icons, diagrams, or step by step cues to support correct use, especially for new formats such as powders, tablets, bars, or refill concentrates.
- Include on packaging statements such as “makes X servings” or “equivalent to X standard bottles” to reinforce value and prevent perceptions of reduced product.
- Ensure instructions are placed prominently on packaging and repeated at key points in the user journey, including outer packaging, inserts, or digital resources where appropriate.
- Test instructions with consumers to confirm usability, clarity, and accessibility before scaling new formats.

Timeline for Scaling

Near term (0 to 12 months)

These strategies require limited redesign and can often be implemented using existing equipment or minor production line adjustments. They offer quick wins while longer term actions are being developed.

- Lightweighting through downgauging, small reductions in thickness or headspace adjustments.
- Elimination of redundant or nonessential components where no new tooling is required.
- Minor right-sizing that uses existing packaging platforms.

Medium term (1 to 3 years)

These strategies involve more significant engineering, supplier coordination, or formulation changes. They typically require new tooling, updated material specifications, or additional validation cycles.

- New tooling for right sizing, more involved lightweighting, including revised molds, forming tools, or sealing jaws.
- Partial material substitution where production line speeds, barrier needs, or product protection requirements must be revalidated.
- Concentration within existing product ranges, including stability testing and packaging updates.

Long term (3+ years)

These strategies require major capital investment, new production lines, or extensive formulation and process changes. They involve the highest level of testing, validation, and cross supply chain coordination.

- Full transitions to alternative materials such as glass, metal, or molded fiber that need new handling, forming, or filling capability.
- Format changes that require new equipment or new formulation processes, such as shifts from liquids to powders, gels, or solids.
- Large format redesigns with reinforced structures, new ergonomics, or significant changes to transport, palletization, or merchandising systems.

Together, these timelines reflect the coordinated technical, operational, and supply chain activities needed to scale source reduction strategies.

Alternative Compliance

Post-Consumer Recycled (PCR) Plastic

Strategy Overview

The Act allows the PRO to propose an alternative compliance formula to achieve source reduction of plastic covered material sold, offered for sale, or distributed in the state. No more than 8% of plastic covered material sourced reduction may be obtained through alternative compliance (based on the ratio of virgin plastic to PCR plastic).

Using PCR plastic involves replacing a portion or all of the virgin plastic resin used in packaging with material recovered from recycling streams. The approach reduces the demand for new plastic production and lowers the overall lifecycle carbon impact of packaging,[3] while maintaining the same overall format or functionality.

PCR content is widely used in rigid bottles, trays, and closures made from PET, HDPE, and PP, as well as in some flexible films. Common examples include detergent and personal care bottles with 25% to 100% recycled content, thermoformed food trays containing recycled polyethylene terephthalate (rPET), and flexible pouches incorporating recycled PE layers. In some cases, PCR adoption is combined with lightweighting or design simplification to achieve a single round of material efficiency and circularity benefits.

Considerations to Inform Actions, Costs and Investments, and Adoption

- Material qualification and testing: Extensive testing is required to ensure that PCR resins meet clarity, color, odor, and mechanical strength requirements comparable to virgin resin. This may include migration and food contact testing for applications with direct good exposure.
- Packaging design and engineering: Some adjustments to wall thickness, barrier layers, or color specifications may be necessary to account for the different mechanical and visual characteristics of PCR materials.

- Equipment and process adaptation: Molding, extrusion, or sealing parameters often need to be recalibrated to manage variation in melt flow and material stability. Equipment upgrades may also be needed to improve filtration or manage potential contamination.
- Supply chain and procurement: Reliable sourcing of high-quality PCR resins remains a challenge, particularly within the U.S. where availability varies by polymer type. Food safe grades of PCR are widely accessible for rigid PET but remain limited for HDPE, PP, and especially for flexible film structures. Establishing long-term supply contracts, qualifying new suppliers, and verifying chain-of-custody certification all add to initial costs and can extend timelines.
- Quality assurance and compliance: Additional inline monitoring and quality control are often introduced to ensure batch consistency and compliance with regulatory standards, particularly for food contact and cosmetic packaging.
- Marketing and communication updates: Artwork and labeling often require updates to communicate recycled content levels and reassure consumers about safety and performance.

General Timelines and Other Implementation Considerations

- Indicative timelines: Integrating PCR plastic into existing packaging typically takes six to 18 months, depending on resin availability, product compatibility, and testing requirements. Food contact or high-clarity applications usually require longer lead times due to stricter qualification and approval processes.
- Technical and operational considerations: PCR resin quality can vary depending on feedstock source and recycling technology. Maintaining consistent appearance, mechanical strength, and barrier performance can be challenging, particularly for transparent packaging. Within the U.S., supply constraints and variability in food grade recycled polymers, particularly in flexible films, can further limit implementation or require partial blends of virgin and recycled resin. Grey or tinted appearances are common at higher PCR content levels and may require design adaptation to manage consumer expectations.
- Economic considerations: PCR resin often costs more than virgin material due to limited supply and higher processing requirements. However, costs would be expected to decrease if recycling infrastructure expands and demand stabilizes. Incorporating PCR plastic can also help businesses meet state mandated recycled content requirements and sustainability commitments, offsetting some of the financial impact through brand value and compliance benefits.
- Consumer perception: When well communicated, PCR-plastic packaging is generally viewed positively, with consumers associating visible recycled content with environmental responsibility. However, reduced clarity or color variation can sometimes be perceived as lower quality if not supported by clear on-packaging messaging explaining the material’s origin and benefits.

- Strategic value: Integrating PCR plastic is often an entry point into broader circularity strategies and can be combined with lightweighting, elimination, or replacement initiatives to achieve deeper and more resilient reductions in virgin plastic use.

Learnings from Current State of Source Reduction Report and Potential Impact on Priority Populations

Some solutions create differences in appearance, such as a change in coloration (e.g., plastic with a higher percentage of PCR can appear gray), texture, or visible imperfections, according to businesses interviewed. Businesses felt consumers may incorrectly associate this with lower quality, safety risks, or reduced product value.

While many consumers expressed support for recycled content in principle, the contractor found through analysis that they may be reluctant to pay a premium for it. This gap between stated preference and actual purchasing behavior underscores the role of perception and price sensitivity as barriers.

4.0 Further Analysis of Source Reduction Baseline

Introduction

The objective of this section is to describe the methods used to conduct further analysis on the published source reduction baseline (SRB) for the purposes of this study. CalRecycle published the SRB, which estimated the total weight and total number of plastic components of plastic covered material that was sold, offered for sale, or distributed in the state in the 2023 calendar year. The SRB established that 2.86 million tons of plastic covered material and 170 billion plastic components of plastic covered material were sold, offered for sale, or distributed into California in 2023.

The contractor conducted further analysis on the SRB to break it down into granular information (e.g., different types of packaging and food service ware, or sales channels). This approach was necessary to inform the reuse, refill, and other source reduction strategies and pathways.

This study used the scope of plastic covered material as defined in PRC section 42041(e)(2). Packaging associated with medical products and products defined as devices or prescription drugs, animal medicines, infant formula, fortified oral nutritional supplements, insecticides, hazardous materials, and paint as well as beverage containers subject to California Redemption Value (CRV) and long-term storage packaging were excluded from the scope of the study.

Categorizing Plastic Covered Material

To prioritize source reduction strategies, where and how plastic covered material is used, such as the type of good packaged or whether the plastic covered material is used in B2C or B2B contexts are key factors. To meet the objectives of this study and to effectively evaluate the different source reduction strategies, the contractor conducted further analysis of the 2023 SRB. The total weight of plastic covered material and number of plastic components reported in the SRB remain constant in this adapted baseline, but the breakdown of contributions from different plastic uses (e.g., B2C versus B2B) were recalculated according to the categorizations described here, and the methods described in the following subsections.

Covered Material Categories

Covered material is categorized according to covered material categories (CMC). This report relies upon the CMC list published on December 31, 2024, which has 94 CMCs, of which 68 are plastic covered material, meaning they have a plastic component. It is the 68 CMCs for plastic covered material which are subject to the source reduction requirements. For covered material containing plastic and nonplastic components, the weight is specific to the weight of the plastic material (i.e., excludes the weight of the nonplastic material).

The definitions of these CMCs alone do not provide enough information about the use of the plastic covered material within those categories to effectively consider source reduction. For example, both a plastic jar containing a cooking sauce and a plastic spray bottle containing shampoo for dogs could fall into the CMC with code 25_P1P for PET (#1) bottles, jugs, and jars (clear/natural). In practice, these products have very different characteristics and approaches to source reduction are likely to differ. The cooking sauce jar needs to meet food contact standards while the spray bottle does not in this example.

The contractor determined that there were both insufficient data available to break down the SRB at the level of granularity of CMCs and that CMCs were not granular enough for this analysis. To overcome this challenge, the contractor developed clusters of covered material (and associated goods) as the basis for this analysis. These clusters are defined in the following subsections. To enable readers to understand how clusters relate to CMCs, two crosswalk tables are provided in Appendix G, Table G-70 and Table G-71. Table G-70 shows, for each CMC, which format clusters are expected to contribute plastic covered material. Table G-71 shows, for each format cluster, which CMCs are expected to contribute plastic covered material.

Categorization to Assess Source Reduction Strategies

To identify the most appropriate source reduction strategy for specific types of plastic covered material, the contractor evaluated three main characteristics: format, function, and item journey (see Table 4-1).

Table 4-1: Characteristics Affecting Appropriate Source Reduction Strategies

Characteristic	Definition	Effect on Source Reduction
Format	The physical properties of the plastic covered material such as shape, rigidity, size, and weight.	Informs which other source reduction strategies are appropriate for all uses of covered plastic material.
Function	The good being contained by primary/secondary packaging (e.g., shampoo, kibble for dogs).	Informs which reuse source reduction strategies are appropriate for primary and secondary packaging.
Item Journey	This encompasses the goods sales channels (i.e., B2B, and B2C) and, for food service ware, the item's point of use (on premises or off premises).	Informs which reuse source reduction strategies are appropriate for tertiary packaging and food service ware.

The following subsections describe each characteristic and why it affects the choice of source reduction strategy.

Format

The format of the plastic covered material refers to the physical shape and properties of the plastic, like its rigidity, size, and weight.

For any given plastic covered material item, the most appropriate source reduction strategies (not including reuse and refill) are typically determined by the format of the material. This is true for primary, secondary and tertiary packaging as well as food service ware. For example, lightweighting is typically more appropriate for rigid plastic bottles than for flexible films, while elimination of components is mainly possible in formats with multiple components.

Therefore, as part of the further analysis of the SRB, the contractor categorized all plastic covered material types by format. To this end, the contractor grouped all types of plastic covered material into 35 format clusters. These format clusters are based on the contractor's expertise and were developed over the course of several internal workshops focusing on:

- Product technical requirements across 23 parameters.
- Available packaging formats.
- Consumer requirements such as accessibility (e.g., the ability for the packaging to meet ADA Accessibility Guidelines).

These format clusters group together all uses of plastic covered material that are identical, or functionally similar in packaging formats or food service ware use. The 35 format clusters are shown and defined in Appendix A, Table A-2 and include the following examples:

- Flexible bag – low barrier (food).
- Clamshell (food).
- Nonfast moving consumer goods primary/secondary – flexible.
- B2B transport packaging.

Function

For any given item of single-use plastic primary or secondary packaging, the most appropriate reuse and refill strategies are generally dependent on the function of the packaging, defined here as the properties of the good being contained. For example, refill in-store reuse models are not typically appropriate for high-viscosity liquids, as it is difficult to maintain hygiene in stores. This is the case regardless of the current packaging. Importantly, the appropriate reuse strategies for tertiary packaging and plastic food service ware are dependent on the item journey and the format cluster, and not generally on function as defined here.

The contractor grouped similar goods into function clusters. These clusters help in the evaluation of primary and secondary packaging reuse strategies by simplifying the number of categories that need to be considered. The method used by the contractor to group together goods is described in the following two subsections. The 42 function clusters (41 fast-moving consumer goods clusters and one durable cluster) are shown and defined in Appendix A, Table A-1.

Fast-Moving Consumer Goods (FMCG)

Fast-moving consumer goods are goods usually purchased many times a year and are typically less expensive compared to other types of consumer goods such as electronics. FMCGs include things like food (e.g., pasta), beverages (e.g., milk), cleaning products (e.g., laundry detergent), and personal care products (e.g., shampoo).

A list of FMCG categories was taken from GlobalData's packaging market analyzer.[4] GlobalData is a market intelligence platform that provides data and insights across various industries. Its Packaging Market Analyzer offers data and forecasts on packaging volumes, materials, and trends.

The Packaging Market Analyzer categorizes all goods typically sold in supermarkets into 430 market segments. The contractor grouped these segments to identify the minimum number of clusters such that meaningful differences between types of goods (e.g., liquid versus solid goods) are maintained, as is necessary for evaluating reuse strategies. Similar market segments are categorized into clusters as follows. All goods within a cluster:

- Have similar applications (e.g., wet cat food and wet dog food are assigned to the same cluster, but human food is not included in that cluster).

- Are physically similar (e.g., liquid oils and solid fats are placed in different clusters).
- Have similar storage, display and transportation requirements (e.g., frozen goods are not clustered with nonfrozen goods).
- Are purchased a similar number of times each year (e.g., shampoo is not clustered with hair dyes, which are typically purchased much less frequently).

Based on this analysis, the 430 market segments were grouped into 40 FMCG function clusters.

GlobalData covers all types of FMCG, with the notable exception of fresh fruit and vegetables. A function cluster for fresh fruits and vegetables was created and analyzed using other data sources described in a subsequent subsection.

The 40 clusters using GlobalData and the single cluster for fresh fruits and vegetables resulted in a total of 41 FMCG function clusters.

Durable Goods

Durable goods are goods typically kept and used by consumers for a longer time than FMCGs and are purchased less frequently. Durable goods include electronics, toys, and furniture. According to some sources, significantly less plastic is used for primary and secondary packaging of durable goods than FMCGs.[5] [6]

Because they are purchased less frequently, the suitability of durable goods for reuse is inherently different to FMCGs. It is therefore important to distinguish between these two categories of goods, and they were therefore considered separately in this analysis.

All durable goods were assigned to one single cluster by the contractor, for the following reasons:

1. The function of the packaging is largely the same (i.e., durable goods typically do not have special storage requirements like refrigeration).
2. The properties of durable goods are largely similar, specifically that the goods are usually solid and shelf-stable.
3. There is little data on durable goods consumption, and estimation methods involve considerable uncertainty. Because it is difficult to estimate the amount of plastic-covered material within various durable goods packaging types, creating separate durable goods clusters offers little, if any, benefit.

Item Journey

The item journey for plastic-covered material refers to the sales channel of the goods being packaged (i.e., B2B or B2C), as well as whether food service ware is used in on-premises dining or off-premises consumption like carryout. These considerations drive which source reduction strategies are available, and how these strategies can be implemented.

Packaging

As discussed in Section 3.0, different reuse strategies are applicable when the end user of the packaging is a business compared to when the end user is a consumer. Packaging used in a B2B context includes:

- Primary and secondary packaging of goods sold to businesses (e.g., packaged ingredients sold to restaurants).
- Tertiary packaging, when the intended user of the packaging is someone at a business (e.g., pallet wrap).

Packaging used in a B2C context typically includes primary/secondary packaging of consumer goods that are ultimately used by an individual. E-commerce mailers were also included in this analysis as B2C tertiary packaging. Pallet wrap was only included in the B2B context.

As part of the further analysis of the SRB, additional data were collected and calculations performed to categorize all primary, secondary, and tertiary packaging such as B2B or B2C. These calculations are described in Primary and Secondary Packaging within this section.

Food Service Ware

Different reuse strategies are available when food service ware is used on premises (e.g., in a restaurant) versus off premises (e.g., takeout consumed at home or on the go).

When the food service ware is used on premises (i.e., in a closed-loop system), the business (e.g., in a stadium or at a restaurant) providing the food service ware has more influence over how that food service ware is managed after use.

Meanwhile, when food service ware is used off premises (e.g., on the go or at home as part of a takeout delivery as part of open-loop systems), the consumer has greater control over what happens to it.

As discussed in Section 3.0, reusable food service ware strategies are typically easier to implement in closed-loop systems than in open-loop systems. Therefore, as part of further analysis of the baseline, calculations (described later in this section) were performed to categorize all food service ware use into open-loop or closed-loop systems.

Further Quantitative Analysis of Plastic Covered Material

This section describes the calculations used to quantify the amount of plastic covered material (in terms of weight and number of plastic components) within each function cluster, item journey, and format cluster.

A unique set of calculations were performed for each of the categories in the bulleted list, with more information on the specific calculations in the following subsections:

- Packaging
    - Primary and secondary packaging
        - Fast moving consumer goods (excluding fresh fruit and vegetables)
            - B2C
            - B2B
        - Fresh fruit and vegetables
        - Durable goods
    - Tertiary packaging
- Food service ware

The methods used by the contractor to apportion the SRB into these categories were partly a function of data availability. Estimates made in this report are reported to two significant figures, meaning totals may not exactly match between tables.

Primary and Secondary Packaging

Primary packaging directly packages a good, while secondary packaging is used to package multiple goods together for handling or display. The following subsections consider both primary and secondary packaging combined, estimating the weight and number of plastic components of plastic covered material used in terms of the 42 function clusters shown in Appendix A, Table A-1.

Both this study and the SRB estimate plastic covered material used in primary/secondary packaging based upon estimates of the number of units of the product sold. The SRB estimates the number of goods sold based on manufacturing economic trade/sales data and the average value of representative goods. This study largely uses sales data, allowing a more granular understanding of how much plastic single-use packaging is used for different types of goods.

For the purposes of this study, the contractor assumed that any inventory of covered material categorized as offered for sale, imported, or distributed in the state but not sold in 2023 was small compared to total annual sales. This is demonstrated by the relatively small average inventory size in the retail sector, for example.[7] Further, the contractor assumes that unsold covered material inventory in 2023 is offset by sales carried forward from the previous year. Therefore, this study uses sales as a proxy.

Fast-Moving Consumer Goods – Excluding Fresh Fruit and Vegetables (B2C)

The number of B2C FMCG goods bought in the U.S. was derived from GlobalData's Packaging Market Analyzer and applied to California on a per capita basis.[8] This section focuses on goods that are sold in packaging that is majority plastic (i.e., it excludes any packaging that would fall into the material classes other than plastic). Plastic Covered Material in Nonplastic Material Classes (also referred to as " Non-

Dominant Plastic Packaging with Plastic Component") are assessed separately within this section.

The data in the Packaging Market Analyzer is based on retail audits that collect data on sales of goods at the point of sale (e.g., in supermarkets). These audits cover major U.S. retailers including supermarkets, convenience stores, and e-commerce platforms, and provide granular insights into sales at the goods level.

GlobalData also integrates data from market research organizations. These datasets cover sales volumes, revenues, and prices at a more aggregated level. Finally, GlobalData uses information released by companies such as U.S. Securities and Exchange Commission filings and earnings reports, to further refine estimates of unit sales of different goods.

GlobalData estimates the sales of every type of FMCG sold in the U.S. with the exception of resh fruits and vegetables. The platform categorizes all sales into one of 430 market segments (i.e., categories of goods), 24 packaging formats, and various size categories.

These unit sales were categorized into function clusters according to the method described earlier in this section and Appendix A, Table A-3.

Appendix A, Table A-4, Table A-5, and Table A-6 show the estimated unit sales by GlobalData packaging format, grouped by the contractor into function clusters for California in 2023. [9] Note that these tables show some packaging formats defined by GlobalData as majority plastic but that are not majority plastic according to the CMCs relevant to the Act (e.g., Foil – Aluminum and Tube - Flexible Aluminum). Because this analysis focused only on majority-plastic formats, these units were excluded.

The packaging formats provided by GlobalData are different from the format clusters defined and used in this study. Unit sales were mapped from GlobalData format types onto format clusters using the mapping shown in Appendix A, Table A-7 and Table A-8.

These mappings were formulated by the contractor's expertise in packaging design. For instance, the GlobalData packaging format category 'Bag/sachet - Aluminum/Plastic' is a multi-layer flexible packaging type which is used to provide a medium barrier in nonfood applications, and a high barrier in food applications. The units categorized by GlobalData as 'Bag/sachet - Aluminum/Plastic' can thus be categorized into the format clusters, 'Flexible Bag medium barrier (nonfood)' and 'Flexible bag high barrier (food),' accordingly, based on consumption of food and nonfood units in that category.

The result of this mapping estimated unit sales of all FMCG goods (excluding fresh fruit and vegetables) in terms of format clusters and function clusters. The following paragraphs describe how these unit sales were used to estimate the weight and number of plastic components of plastic covered material within this category.

The contractor team identified representative examples of goods for each format cluster, falling into small, medium, and large categories based on product size. Small, medium, and large were defined according to the definitions in Appendix A, Table A-10. These size bands shown in Appendix Table A-10 were created by the contractor to capture and represent the available array of packaging sizes while reducing the amount of packaging needing to be purchased and weighed. The goods were identified by the contractor team as being representative examples of those format types, based on significant experience in designing packaging.

These representative goods were purchased, and the weight of plastic in their packaging was measured. This data is shown in Appendix A, Table A-11, Table A-12, and Table A-13. An average unit packaging weight across small, medium and large was derived for each format cluster based on the proportion of units sold in different sizes from GlobalData.

The unit packaging weight was multiplied by the quantity of units placed on market, to calculate the weight (tons) of plastic covered material sold in the B2C FMCG category in 2023, by format cluster and by function cluster.

The same process was performed to estimate the number of plastic components, according to the average number of plastic components found in each packaging cluster (Appendix A, Table A-15).

Worked Example – Calculating B2C Unit Consumption of Suncare Function Cluster

This suncare function cluster includes the following goods segments (as labeled by GlobalData data; “mass” in the names refers to mass market): Mass After-Sun, Mass Self-Tan, Mass Sun Protection, Premium After-Sun, Premium Self-Tan, Premium Sun Protection.

The total number of units sold in each of these six goods segments in the U.S. in 2023 is provided by GlobalData, across 28 types of packaging. For each of these packaging types, these units were summed across the six categories of good, to get a total number of units sold in the suncare function cluster. The units sold in the U.S. was scaled to California on a per capita basis, assuming California represents 11.8% of the population of the U.S. The results of this step are shown in Table 4-2; in total there were an estimated 27 million units sold in the suncare cluster in 2023 in California. All values in this report are rounded to two significant figures, meaning totals may not match due to rounding.

Table 4-2: Estimated Number of Baseline Units in the Suncare Function Cluster, by GlobalData Packaging Category (B2C)

GlobalData Packaging Category	Suncare Units Sold
Bag/Sachet - Flexible Plastic	100,000
Bottle – HDPE	5,600,000
Bottle - Other Plastic	1,400,000
Bottle – PET	27,000
Tub – Plastic	82,000
Tube - Flexible Plastic	20,000,000
Tube - Rigid Plastic	210,000
Total	27,000,000

GlobalData's packaging format categories were mapped onto the format clusters defined in this study according to Appendix A, Table A-7 and Table A-8, using the method described earlier in this subsection. This calculation provides the number of units in the suncare function cluster, distributed into the applicable format clusters (Table 4-3).

Table 4-3: Estimated Number of Baseline Units in the Suncare Function cluster, by Format Cluster (B2C)

Format Cluster	Suncare Units Sold
Flexible Bag - Medium Barrier	100,000
Tub and Lid - Higher Weight	81,000
Bottle and Cap	5,000,000
Bottle and Cap - High Function	860,000
Bottle and Pump/Trigger	1,100,000
Tube and Cap	20,000,000
Total	27,000,000

The average weight of plastic in the single-use plastic packaging and number of plastic components in each format cluster was estimated as described earlier in this subsection and is shown in Appendix A, Table A-11, Table A-12, and Table A-13. This is summarized for the relevant format clusters, in Table 4-4.

Table 4-4: Unit Properties of Format Clusters Relevant to Suncare (B2C)

Format Cluster (Nonfood)	Average Weight of Plastic (lb./unit)	Average Number of Plastic Components per Unit
Flexible Bag - Medium Barrier	0.057	1
Tub and Lid - Higher Weight	0.13	4
Bottle and Cap	0.12	3
Bottle and Cap - High Function	0.084	5
Bottle and Pump/Trigger	0.11	9
Tube and Cap	0.049	2

These estimated per unit weights of plastic covered material and numbers of plastic components were applied to the number of units placed on market to obtain the total weight of single-use plastic packaging (weight of plastic only) and number of plastic components in the suncare function cluster, distributed into the applicable format clusters Table 4-5.

Table 4-5: Estimated Baseline Weight of Plastic Covered Material and Number of Plastic Components in the Suncare Function Cluster, by Format Cluster (B2C)

Format Cluster	Weight of Single-Use Plastic Primary/Secondary Packaging (tons)	Number of Plastic Components
Flexible bag - medium barrier	3.4	170,000
Tub and lid - higher weight	6.3	270,000
Bottle and cap	390	14,000,000
Bottle and cap - high function	45	3,700,000
Bottle and pump/trigger	23	2,600,000
Tube and cap	570	33,000,000
Total	1,000	54,000,000

Fresh Fruit and Vegetables (B2C)

GlobalData's packaging market analyzer does not include fresh fruit and vegetable items. The contractor built a separate model to determine the weight and components of plastic covered material for these goods.

According to a Freedonia Group industry report (2024), roughly 47 billion units[10] of single-use plastic packaging were used for fresh fruit and vegetables in the U.S. in 2023. On a per capita basis, this equates to roughly 5.5 billion units sold per year in California in 2023. In terms of the value of packaging, the same source states that rigid formats account for 70% of sales while flexibles account for 30%, and that, per unit, rigid formats cost approximately 50% more than flexibles. This means rigids account for approximately 47% of unit sales for fresh fruit and vegetables and flexibles 53% of unit sales.

In lieu of sales data, 50% of fresh fruit and vegetables in rigid formats were assumed to be sold in clamshells and 50% in tray and film formats based on best professional judgement.[11] It was assumed that all fresh fruit and vegetables sold in flexible plastic formats are sold in 'flexible bags - low barrier.' These units are assigned into the appropriate format clusters based on these assumptions.

These tons and components all fall, by definition, into the fresh fruit and vegetables function cluster.

Fast-Moving Consumer Goods (B2B)

The number of units sold in the B2B channel were estimated for each unit in each function cluster, as follows:

1. Appendix A, Table A-14 shows the sales value breakdown between B2C and B2B for the four FMCG categories (food and beverage, household care and cleaning, personal care, and pet food). By categorizing each of the function clusters into one of these four categories, the B2B sales value of the good was calculated as a percentage of the B2C sales value. For example, the suncare function cluster is categorized as personal care, which data suggests is 81% B2C by value.
2. The contractor assumed the price of one unit of consumption is the same across B2B and B2C. For example, one pound of rice is assumed to cost the same in B2B and B2C channels.
3. The contractor assumed that packaged items contain, on average, four times as much good in B2B channels as in B2C channels. There is no data regarding the average size of goods sold in B2B versus B2C channels, or how the packaging to product ratio varies across these channels. The value used was chosen as a proxy value chosen based on professional judgement. Therefore, it was important to assess the impact of this assumption on the amount of packaging split between B2B and B2C channels. Modeling shows that this assumption does not have an impact on the total weight of plastic split between B2B and B2C, but it does have a small impact on the number of plastic components assigned into B2B and B2C categories. The potential impact of this assumption is discussed in Data Sources, Limitations and Assumptions.
4. The number of B2B FMCG units in each function cluster was derived by multiplying the three data points by the number of B2C units in that function cluster.
5. Within each function cluster, the breakdown of packaging into each format cluster is assumed to be the same in B2C and B2B. This mapped the FMCG B2B number of units sold into format clusters.

Table 4-6: Estimated Number of Units, Weight of Plastic Covered Material and Number of Plastic Components in the Suncare Function Cluster, by Format Cluster (B2B)

Format Cluster	Units Sold	Weight of Single-Use Plastic Primary/Secondary Packaging (tons)	Number of Plastic Components
Flexible bag - medium barrier	5,900	0.78	9,700
Tub and lid - higher weight	4,600	1.4	15,000
Bottle and cap	320,000	88	800,000
Bottle and cap - high function	52,000	10	210,000
Bottle and pump/trigger	20,000	5.3	150,000
Tube and cap	1,100,000	130	1,900,000
Total	1,500,000	240	3,100,000

The contractor assumed that one item of packaging weighs, on average, four times as much in the B2B channel as in the B2C channel but has the same number of plastic components. As such, the weight of plastic covered material and number of plastic components of primary FMCG packaging sold B2B were calculated for each format cluster and each function cluster (Table 4-6).

The potential impact of this assumption is discussed in Data Sources, Limitations and Assumptions at the end of this section.

Durable Goods Packaging

Durable goods are typically kept for a longer time than FMCGs and purchased less frequently, like electronics, toys and furniture Durable goods are considered here in terms of a single function cluster and two format clusters: non-FMCG primary/secondary (rigid) or non-FMCG primary/secondary (flexible). This section focuses on goods that are sold in single-use plastic packaging in the plastic material class.

The bottom-up modeling approach used to estimate weight of plastic covered material and number of plastic components in FMCG clusters was not possible here, as data on unit consumption of durable goods and the typical packaging types used are not readily available.

Instead, the contractor applied a high-level model to estimate this single-use plastic packaging use. Appendix A, Table A-16 shows the weight of single-use plastic packaging used for durable goods as a proportion of the weight of single-use plastic packaging used for food, in terms of rigid and flexible packaging.

The weight of plastic used for food packaging was calculated according to the method described in the previous sections (see Primary and Secondary Packaging earlier in this section). This was broken into flexible and rigid packaging types based on the definition of each format cluster.

By multiplying these weights by the ratios in Appendix A, Table A-16, the weight of plastic packaging in the format clusters non-FMCG primary/secondary (rigid) and non-FMCG primary/secondary (flexible) was estimated.

In lieu of more robust data, the findings of the SRB were adopted for the number of plastic components used to package durable goods across single-use plastic rigid and flexible formats. The SRB categorizes uses of single-use plastic primary and secondary packaging into one of the following categories:

- Apparel and accessories*
- Beverage (liquid)
- Business*
- Commercial apparel*
- Commercial food
- Computer and consumer electronics*
- Construction
- Consumer good*
- Consumer transport
- Fabrics and leather*
- Frozen food
- Home appliance or good*
- Industrial
- Large animal food
- Mixed construction
- N/A
- Nonfrozen food
- Office equipment and supplies*
- Personal care
- Pet food

- Toys and hobby*
- Mixed chemicals
- Mixed auto

Those with an asterisk were categorized by the contractor as a durable good. The average weight and number of plastic components per sales unit found in the SRB were estimated for durable goods using this categorization. This was done separately for packaging in rigid and flexible formats. The results of this are shown in Appendix A, Table A-16.

The number of sales units of durable goods was estimated by dividing the weight of durable goods packaging by the average unit weight. The number of plastic components non-FMCG primary/secondary (rigid) and non-FMCG primary/secondary (flexible) was estimated by multiplying these unit sales quantities by the average number of plastic components per unit.

Data from the 2025 material characterization study, which measured how much single-use packaging and plastic food service ware disposal reaches California landfills, was used to approximate how much durable goods packaging comes from B2C channels versus B2B channels.[12] The study estimated the proportion of covered material discarded through franchised commercial, franchised residential, self-haul, and mixed waste sectors. The proportion of franchised commercial to franchised residential was used to approximate the proportion of B2B to B2C material.

Plastic Covered Material in Nonplastic Material Classes

This section focuses on uses of plastic covered material in primary and secondary packaging that is not a majority plastic (also referred to as “Non-Dominant Plastic Packaging with Plastic Component”). This includes covered material that falls within the ceramic, glass, metal, paper and fiber, or wood and other organics material classes and have a plastic component. Covered material without a plastic component is not subject to the source reduction requirements.

Single-use plastic packaging that falls within a nonplastic material class includes lids, closures, labels and barrier linings for packaging that is majority paper, metal, glass, or another material. Examples include paperboard boxes with a plastic window and metal containers with a nondetachable plastic wrap label.

Plastic components integrated into covered material in nonplastic material classes are wide ranging and there is insufficient data to reliably estimate the tonnage or number of plastic components used in any detail. The contractor assumes that the total contribution of plastic weight from this category in the baseline is likely to be low, as the plastic components are usually light compared to majority plastic packaging.

The contractor instead developed a high-level method to estimate the weight and number of plastic components used for plastic covered material in nonplastic material classes, based on its experience of packaging design over a range of types of goods.

The total number of units of FMCG goods sold in plastic covered material in nonplastic material classes was derived from GlobalData's Packaging Market Analyzer. The number of plastic components associated with those units of FMCG goods were estimated as follows. The total number of unit sales of FMCG goods sold in plastic covered material in nonplastic material classes were summed from GlobalData, and categorized as either metal with plastic, paper with plastic or glass with plastic. It was assumed that these three categories account for the vast majority of covered primary and secondary nondominant plastic packaging. For each of these three categories, a representative single-use packaging type was considered, based on the sales data in the GlobalData database:

- Paper with plastic component was assumed to be a carton (representing 98% of unit sales of this category). This representative packaging format was assumed to have three plastic components, based on professional packaging design expertise: a plastic cap, plastic neck, and plastic barrier layer.
- Metal with plastic component was assumed to be a can (cans account for 75% of unit sales of metal packaging in FMCGs). This representative can is assumed to have a plastic layer.
- Glass with a plastic component is assumed to be a jar (jars account for 80% of glass packaging uses in FMCGs). The representative glass jar is assumed to have one plastic component: a label.

The total number of plastic components in plastic covered material in nonplastic material classes was estimated by multiplying the estimated number of units sold in paper-with-plastic, metal-with-plastic and glass-with-plastic packaging (from GlobalData) by the respective number of plastic components per representative product in the list.

The total weight of plastic was estimated using data breaking down sales of plastic resin by end use. The source lists sales of resin by application and high-level format (e.g., plastic for stretch film versus labels). The total proportion of plastic used in plastic covered material in nonplastic material classes was derived from this source, and multiplied by the total estimated weight of plastic covered material in plastic material class to obtain the estimated weight.[13]

Tertiary Packaging

Tertiary packaging is typically the outer layer of packaging used during the transporting and handling of goods. Single-use plastic tertiary packaging includes plastic pallet wrap, dunnage (e.g., packing peanuts), straps, e-commerce envelopes, drums, and other containers.

All single-use tertiary packaging was categorized as either B2B or B2C according to the following steps. SRB analysis suggests that the weight of pallet wrap is by far the dominant B2B tertiary single-use plastic packaging format, and all other types of B2B plastic tertiary packaging are assumed to be negligible by weight.

B2B Transport Tertiary Packaging

The adapted baseline weight of B2B tertiary packaging was estimated using nonbag commercial and industrial packaging film estimated in California's 2021 waste characterization disposal facility-based waste characterization study.[14]

The weight of pallet wrap was estimated by assuming that each pallet uses 0.5 pounds of plastic (an approximate midpoint of this range), and that each of these accounts for just one component. The actual weight of shrink wrap per pallet varies significantly: The SRB estimates pallets use roughly 0.3-0.4 pounds per pallet (a number likely to align with highly efficient, machine-wrapping), while other sources such as the following pallet wrap calculator,[15] suggest hand-wrapped pallets require 0.6-0.7 pounds per pallet.

B2C E-Commerce Tertiary Packaging

The adapted baseline weight of e-commerce packaging was adopted from 2024 SB 54 Material Characterization Study.[16] The contractor summed the weight of material disposed as estimated in that study falling into the following CMCs:

- 24_P29P - PS (#6) - Flexible and Film Items.
- 24_P46P – Plastic Multi-Material Laminate - Pouches and Envelopes.

The number of plastic components in e-commerce envelopes used was estimated by estimating the number of units of B2C FMCGs that are sold through e-commerce channels (by summing the number of units as calculated in the previous sections), assigning each purchase into one of the categories shown in Appendix A, Table A-9 and assuming each e-commerce envelope has one plastic component. Two key simplifications are made here: various formats of e-commerce envelopes have more than one component, while some goods sold through e-commerce channels will not have their own unique envelope (i.e., some units will be packaged together). These simplifications will therefore offset each other to some extent. There is a particularly high degree of uncertainty associated with plastic used in B2C tertiary channels. Two CalRecycle landfill waste characterization studies (using data collected in 2021 and 2024) suggest total e-commerce envelope plastic weight may vary by a factor of five, however, a comparison is not possible due to the changes in categories between the two studies. This uncertainty is not critical to this study's analysis of source reduction strategies as there has been, since the baseline year of 2023, a significant market shift away from plastic for e-commerce envelopes.

Food Service Ware

Single-use plastic food service ware includes:

- Trays, plates, bowls.
- Food containers such as clamshells, lids, hinged or lidded containers.
- Cups (both for hot and cold beverages).
- Utensils and accessories such as cutlery, straws, and stirrers.

- Flexible packaging like wraps or wrappers used in the packaging of food offered for sale or provided to customers by food service establishments.
- Bags used in the packaging of food offered for sale or provided to customers by food service establishments.

The contribution of single-use plastic food service ware to the baseline was adopted from the SRB. As with single-use plastic packaging, different types of single-use plastic food service ware were grouped into format clusters to facilitate source reduction evaluation. These food service ware format clusters group together similar applications of plastic covered material that were assessed by the contractor to have similar potential for source reduction.

Table 4-7: Categorizing SRB Food Service Ware Applications into Format Clusters

SRB Food Service Ware Category	Format Cluster
Plastic Cutlery	Food Service Ware: Utensil
Clamshell	Food Service Ware: Container - majority plastic
Plastic Cups	Food Service Ware: Cups
Plastic Cup Lids	Food Service Ware: Lids
Plastic Cups for Hot Products	Food Service Ware: Cups
Plastic Cup Lids for Hot Products	Food Service Ware: Lids
Straws	Food Service Ware: Utensil
Plastic Containers	Food Service Ware: Container - majority plastic
Plastic Container Lids	Food Service Ware: Lids
Condiment Cups and Lids	Food Service Ware: Utensil
Stirrers	Food Service Ware: Utensil
Plates	Food Service Ware: Container - majority plastic
Bowls	Food Service Ware: Container - majority plastic
Food trays	Food Service Ware: Container - majority plastic
Sandwich box/ stable packaging	Food Service Ware: Container - majority plastic
Wraps or Wrappers	Food Service Ware: Film
Bags	Food Service Ware: Film

The proportion of food service ware consumed on premises (i.e., within restaurants/canteens) versus off premises (e.g., takeout) is an important factor in analyzing different reuse source reduction strategies. This is because it informs the weight of single-use plastic food service ware and number of plastic components available to be reduced by closed-loop and open-loop food service ware reuse models, respectively.

For the purpose of this analysis, on-premises consumption is labeled B2B (as businesses are heavily involved in food service ware material choices and disposal), while off-premises consumption is assumed to be B2C.

The SRB analysis, which is grounded in data and assumptions regarding where meals are consumed, suggests that 53% by weight of single-use plastic food service ware is consumed off-premises.

Summary: Format and Function Clusters

The main goal of assigning plastic covered material into clusters is to simplify analysis and assess source reduction potential between groups of plastic covered material at a manageable granularity (as opposed to, for example, evaluating spoons, forks, and knives as separate categories of plastic food service ware).

Understanding the physical properties of the plastic covered material enables evaluation of nonreuse source reduction strategies. Therefore, the contractor team assigned all plastic covered material into one of 35 format clusters. These format clusters group together uses of plastic covered material that are in identical or functionally similar in packaging/food service ware formats. The 35 format clusters are shown and defined in Appendix A, Table A-2 and include the following examples:

- Flexible bag – low barrier (food).
- Cutlery.
- B2B transport packaging.

To assess suitable reuse and refill source reduction strategies, both the good and the packaging were evaluated. The contractor determined that the format of tertiary packaging and food service ware was the best indicator for assessing the feasibility of specific reuse and refill strategies. In contrast, identifying the most appropriate source reduction strategies for primary and secondary packaging required additional context, which was informed by the function of the good contained within the packaging.

Therefore, all uses of primary/secondary packaging have also been assigned by the contractor into one of 42 function clusters, which are shown in Appendix A, Table A-1 and include the following examples:

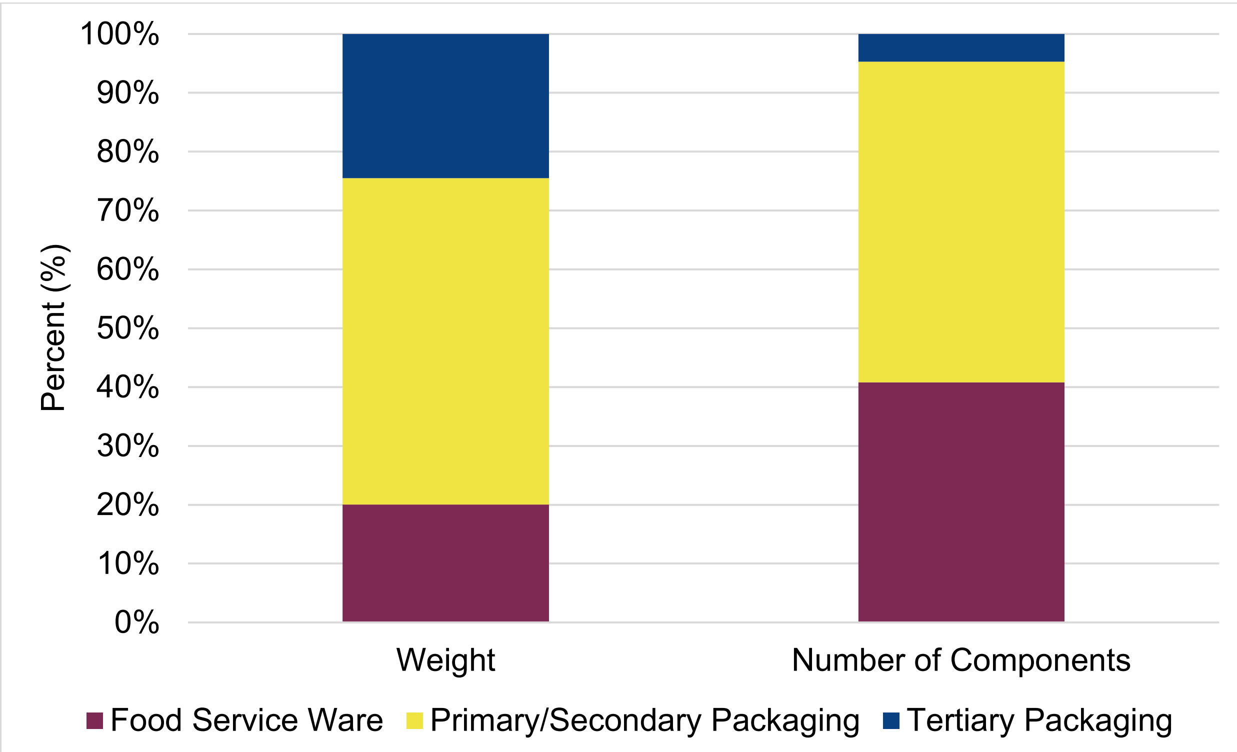
- Ice cream.
- Dry pet food.
- Skincare.

Adapted Baseline Results

The total weight of plastic covered material and number of plastic components according to the SRB is approximately 2.9 million tons and 171.4 billion plastic components of plastic covered material.

According to the contractor's analysis, Figure 41 compares the distribution of plastic covered material in terms of weight and number of plastic components, across the three main plastic covered material types: food service ware, primary/secondary packaging, and tertiary packaging.

Figure 4-1: Breakdown of Plastic Covered Material Weight and Number of Plastic Components by Plastic Covered Material Type (% of total)



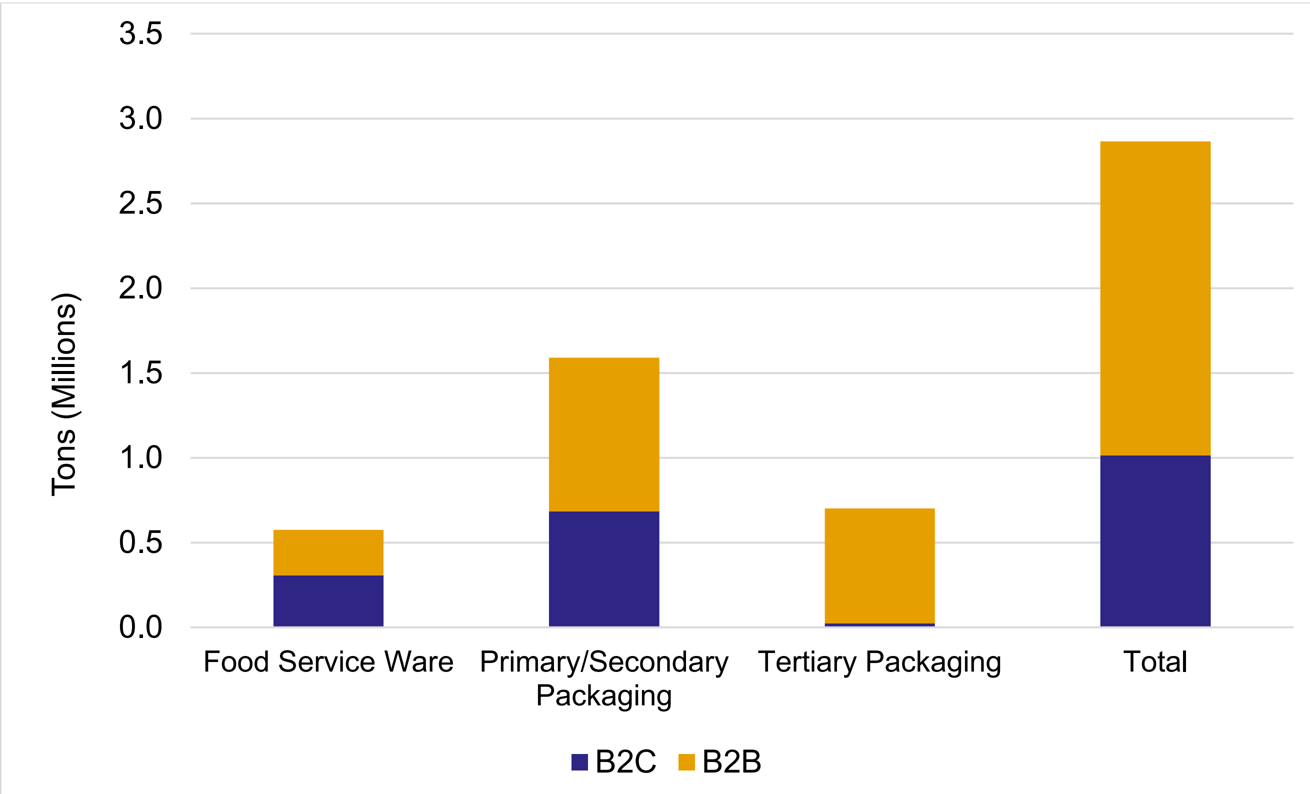
Single-use plastic primary and secondary packaging are estimated to account for a similar proportion of both the total weight and number of plastic components estimated in the SRB. Conversely, single-use plastic food service ware accounts for about 20% of the baseline weight, but approximately twice the share of plastic components. Tertiary packaging accounts for nearly one-third of the estimated baseline weight but less than 10% of all plastic components.

These findings indicate that not all strategies by type of plastic covered material that have an impact on plastic weight will have a significant impact on the number of plastic components (e.g., those targeting tertiary packaging).

Figure 42 breaks the adapted baseline packaging weight into primary/secondary packaging, tertiary packaging, and food service ware, and by sales channel (B2C versus B2B). Overall, the contractor estimated that more plastic by weight is used in B2B channels than B2C. This result is driven by pallet wrap (all of which is used in the B2B context for this study).

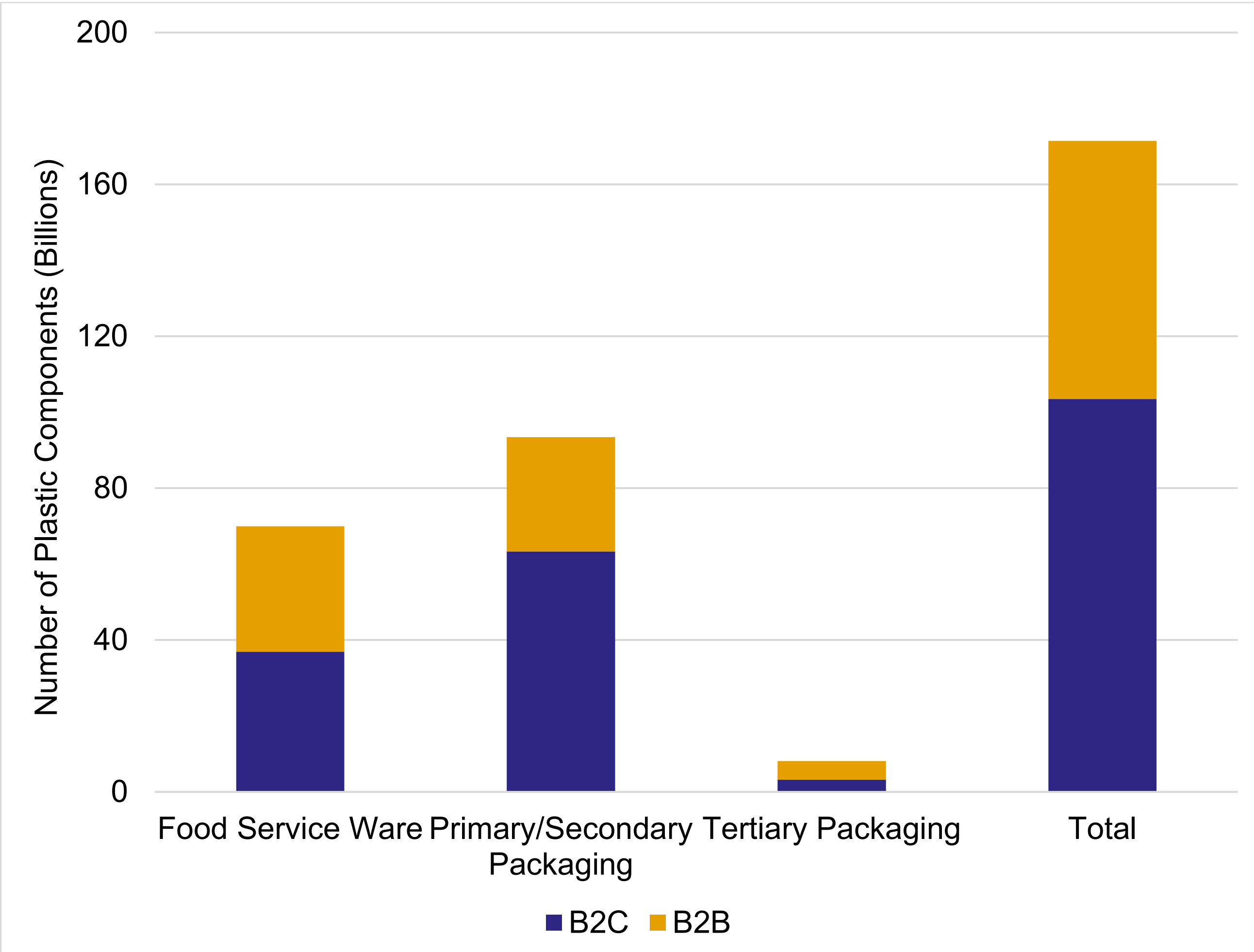
The contractor estimated that there is an approximately even split between B2B and B2C uses of plastic covered material for single-use plastic food service ware and single-use plastic primary/secondary packaging.

Figure 4-2: Estimated Plastic Covered Material Weight by Plastic Covered Material Type and Sales Channel (million tons)



Based on the contractor's analysis, Figure 4-3 shows that, unlike plastic weight, more plastic components are used in B2C channels than in B2B. This result is driven by the high number of components used for B2C single-use plastic primary/secondary packaging. The figure also reiterates the minimal contribution of tertiary packaging to total number of plastic components.

Figure 4-3: Estimated Number of Plastic Components by Plastic Covered Material Type and Sales Channel (billion components)



By examining Figure 41, Figure 42 and Figure 43, an important dynamic emerges: single-use plastic packaging (driven by B2B) accounts for the majority of plastic weight, while single-use food service ware applications account for a much higher portion of plastic components. This implies that different source reduction strategies may be needed to achieve the weight reduction requirements and the plastic component reduction requirements. This dynamic is explored in detail in Section 6.0.

Appendix A, Table A-17 breaks down the adapted baseline primary/secondary plastic packaging use by function cluster. This table only includes function clusters covering consumer goods. In later analysis, format clusters covering nonconsumer goods are also treated as function clusters, to inform reuse/refill source reduction strategies. Key results are highlighted in the following list:

- The fruit and vegetables function cluster has the highest total estimated weight of plastic covered material at 300,000 tons. This function cluster also accounts for the highest share of plastic components (an estimated 13 billion plastic components per year).

- Other dairy/soy products (i.e., nonmilk dairy/soy foods), bakery and cereals, milk (liquid dairy and soy milk products), meat, confectionery, savory snacks, and other household care products are also estimated to account for large shares of plastic covered material by weight.
- Bakery and cereals, all other dairy/soy products, milk (liquid dairy and soy milk products), prepared meals and savory snacks are estimated to account for large shares of plastic components.
- Single-use plastic packaging used for foods are estimated to account for the largest share of weight and number of plastic components.

Appendix A, Table A-18 shows the weight and number of plastic components by format cluster. Key results are highlighted in the following list:

- Pallet wrap, assessed only in the B2B context for this study, was estimated to have the highest total estimated weight among all format clusters, at 670,000 tons. This is the largest format cluster in terms of weight but represents a relatively small number of plastic components (~1 billion).
- Tray and film (TF) low barrier (food) (250,000 tons), bottle and cap (food) – (250,000 tons) and food service ware: container - majority plastic (240,000 tons) are estimated to account for large portions of plastic covered material weight.
- Single-use plastic food service ware utensils (which in this study groups together cutlery, condiment cups, straws, and other small items) accounted for an estimated 39 billion plastic components in 2023.
- Flexible bag - medium barrier (food) (17 billion plastic components), TF low barrier (food) (15 billion plastic components) and food service ware: Lids (11 billion plastic components) are estimated to contribute large amounts of plastic components. There are also a significant number of plastic components (approximately 7 billion) estimated in nonmajority plastic packaging (e.g., plastic labels on glass bottles).

Data Sources, Limitations and Assumptions

The amount of plastic sold, offered for sale, or distributed in California in the 2023 calendar year is not systematically tracked. Areas contributing to uncertainty include:

- The basis of estimates for primary and secondary packaging in this analysis is unit sales in California. As described, GlobalData's Packaging Market Analyzer uses audits and agglomerated data. This source was used to provide insight into which types of goods are sold in single-use plastic packaging. However, while GlobalData performs extensive primary data collection, its process also involves significant modeling and assumptions. The source tends to focus on larger companies and brands may underestimate packaging used for smaller brands. GlobalData also follows a process of aggregation to account for variations between brands, stores and locations in how packaging is used and defined. There is therefore limited confidence in the total proportion of plastic covered material that is used for primary/secondary packaging, across both B2C and B2B applications.

- For each primary and secondary packaging format cluster, average unit weights are applied to convert from unit sales to weight. Although these are based on primary research conducted by the contractor, they cannot perfectly reflect the weights of packaging in each category.
- Data on the amount of B2B consumer goods, and the amount of non-FMCG consumer goods sold in California was not identified. Instead, estimates based on the values of the goods (rather than the actual amounts) are used.
- In lieu of available data, the contractor assumed that there is no change in the average packaging to product weight ratio between goods sold in B2C and B2B. There is little evidence to either support or contradict this statement – while professional experience suggests that larger units (e.g., units typically sold in B2B channels) need less packaging per unit of good, there is no data on the typical weight of goods per unit of packaging sold in B2B versus B2C. It is likely that the method employed here is overestimating the weight of FMCG packaging used in B2B, and underestimating the amount used in B2C.
- The SRB was used as the basis for estimating the weight and number of plastic components for single-use plastic food service ware in this study. The SRB followed a logical, bottom-up approach to calculating these estimates, however there is very little data available to corroborate its findings.

While it is difficult to verify the breakdown of the adapted baseline into different format and function clusters, the contractor compared the total adapted baseline values for weight of plastic covered material and number of plastic components to the following.

- The SRB.
- CalRecycle material characterization study data.
- The tonnage of flexible films sold in the U.S.[17]
- Eunomia's detailed packaging analysis performed in the 50 States of Recycling report.[18]

Each of these sources agrees on total weight of plastic consumed within California is roughly 15%, suggesting the methods used in this study are robust.

5.0 Strategy Evaluation and Impact Potential

Introduction

The objective of this section is to identify and evaluate the types of goods most suitable for reuse and refill strategies, and the types of packaging formats and food service ware most suitable for implementing other source reduction strategies. The results of this evaluation and the prioritized strategies are then used as part of the pathway development (Section 6.0). Strategies identified by the contractor as more suitable based on the established feasibility criteria are included in the subsequent pathways. A "pathway" represents a potential mix of source reduction approaches, including reuse, refill, and design-based strategies, deployed across product categories to meet the statutory requirements for 2027, 2030, and 2032.

The contractor developed a set of criteria that reflect the suitability of the strategies, assessed against format clusters and function clusters as appropriate (see Summary: Format and Function Clusters in Section 4.0 to understand the goal of clusters). Separate criteria were developed by the contractor to assess reuse/refill strategies independently from other source reduction strategies. As previously discussed, generally whether packaging could switch to reuse/refill depends on the purpose of the packaging (i.e., in the case of consumer goods, the good being packaged), while the opportunity for other source reduction typically depends on the packaging format and the characteristics it provides with respect to the good.

Reuse and Refill Strategy Prioritization Method

Refill in store, Prefill B2C, and Prefill B2B were evaluated against the 43 primary/secondary packaging function clusters. Closed-loop and open-loop food service ware strategies were evaluated against the food service ware format clusters. B2C e-commerce transport packaging and B2B transport packaging were evaluated against the transport packaging format clusters.

Technical Feasibility for Refill in Store

The first stage of the evaluation of the refill in store strategy was to determine, from a technical perspective, which goods have characteristics that limit applicability and which have characteristics that make them good candidates for refill in store. If a function cluster met the following criteria, then it was determined that the good was less likely to be delivered through a refill in store model. The contractor determined if the function cluster met these criteria based on its team’s expertise in packaging and product supply chains and its experience assisting the design of reuse and refill systems.

- **Criterion 1: Does the good contain harsh or reactive chemicals?** Harsh chemicals require special handling and refill systems may create safety hazards for these goods. For example, fragrances and some household care products have chemicals limiting their technical feasibility for refill in store.

- **Criterion 2: Does the good require high functionality packaging such as an aerosol spray, squeeze tube, content preservation (ultra-high temperature, canned items), or cook-in-package?** Refill in store generally cannot replicate high functional packaging such as a pressurized aerosol spray. For example, many types of makeup and sprayed antiperspirants and deodorants have high functional packaging limiting their ability to be dispensed or scooped into a consumer owned container.
- **Criterion 3: Does the good require special conditions for handling and storage such as perishable/frozen goods, sanitary/sterile product, or a controlled substance (e.g., tobacco)?** Special handling and storage requirements such as frozen goods do not currently have equivalent delivery methods for refill in store systems. For example, ice cream needs to be kept frozen and prepared meals need to be apportioned correctly therefore these special conditions for handling limit these clusters' technical feasibility for refill in store.
- **Criterion 4: Does the good have physical characteristics that limit dispensing or scooping such as thick creams/spreads, pressed powders, or solid fats**? Refill in store systems for goods with these characteristics are more difficult to develop. For example, nut-based spreads might be too sticky to be easily scooped, powders may be hard to dispense or can create a mess, and solid fats are difficult to apportion for effective purchasing.

This evaluation found that 34 applicable clusters had characteristics that potentially limit their technical ability to be delivered in a refill in store model. See Table B-19 in Appendix B for the full list of clusters and the evaluation.

Technical Feasibility for Prefill Packaging, Reusable Food Service Ware and Transport Packaging

For prefill B2B, prefill B2C, closed-loop and open-loop reusable food service ware, and reusable transport packaging, the contractor took a more holistic approach to the technical evaluation. As these strategies generally have not been applied at scale, there are opportunities to design systems to be able to overcome technical challenges currently presented by the characteristics of the goods. Therefore, the contractor reviewed each cluster against criteria 1 through 3 for refill in store but found that even if the cluster has these characteristics, a prefill system, reusable food service ware, or reusable transport packaging would still be likely feasible.

The only characteristic that the contractor found to limit the technical feasibility of the prefill B2C strategy is if the good requires highly specialized packaging such as an aerosol spray or needs to be microwavable like some popcorn packaging. No cluster had a majority of goods that required specialized packaging; therefore, all other clusters were determined technically feasible for prefill B2B, prefill B2C, reusable food service ware, and reusable transport packaging where relevant.

Implementation and Impact Feasibility Method

Beyond technical feasibility, there are other considerations for whether a reuse or refill strategy is appropriate and effective in reducing plastic covered materials. For each reuse strategy, the contractor scored each relevant cluster against three further criteria.

- **Criterion 1: Proportion of adapted baseline** This criterion represents the estimated proportion of total baseline weight and number of plastic components in the cluster. Clusters with a higher proportion of the total weight or number of plastic components have greater opportunity to contribute toward the source reduction requirements. High proportion clusters are also more likely to be able to achieve economies of scale to create an efficient reuse system. Finally, targeting plastic uses with higher volume reduces the number of strategies that need to be implemented, reducing the overall complexity and cost of reusable packaging systems. This criterion was given a weighting value of 1. Overall weight and number of components help prioritize clusters to meet the source reduction requirements but have less influence on strategy feasibility.
- **Criterion 2: Operational readiness** This criterion considers the extent to which there is precedent for this type of reuse model as applied to each cluster. Overall, if a strategy is already utilized for a cluster, then there is greater opportunity to scale. This criterion was given a weighting value of 3. Strategies that are operationally ready to be implemented are assumed to be most effective to meet the short term (i.e., 2027) source reduction requirements. This considers the following questions:
    - Does the strategy make use of pre-existing standardized packaging formats? This allows multiple products to use the same reusable packaging design, optimizing inventory management, transportation, washing and collection operations.
    - Can the strategy leverage existing back-of-house reuse infrastructure, regional suppliers or regional co-packing sites?
    - Would the strategy allow for packaging to be washed, sanitized, quality assured, refilled and redistributed for reuse without large disruptions to existing supply chains?
- This criterion was given a weighting value of 3. Strategies that are operationally ready to be implemented are necessary to meet the short term (i.e., 2027) source reduction requirements.
- **Criterion 3: User Acceptance** This criterion considers whether the strategy in question requires significant change on behalf of the user, whether the user is a business for B2B packaging/food service ware or consumer for B2C packaging/food service ware. If a system does not require significant change from the user, then the strategy is assumed to be able to scale faster to help contribute toward the source reduction requirement. This criterion was given a

weighting value of 3. User acceptance is very important as the goods need to be accepted by the user for them to be purchased and used.

Each cluster is given a score against each criterion and weighted according to assumptions made by the contractor on how important each additional criteria was to the feasibility of the strategy. The contractor assumed that operational readiness and end-user acceptance are more relevant to the ultimate success of reuse systems. Overall weight and number of components help prioritize clusters to meet the source reduction requirements but have less influence on strategy feasibility.

Only clusters which were relevant for the given strategy and passed the technical feasibility criteria were evaluated for implementation and impact feasibility. These scores (i.e., one final score for each cluster in each applicable reuse strategy) were used to qualitatively inform pathway development. Table 5-1 shows how scores were applied, based on the contractor's experience of reuse systems and the adapted baseline. For all scores, see Appendix B, Tables B-21 and B-22.

Table 5-1: Scoring Method Used to Prioritize Reuse Strategies

Score	1	2	3	Weighting
Criterion 1a: Proportion of adapted baseline (weight)	Less than 2,700 tons	Between 2,700 and 27,000 tons	More than 27,000 tons	1
Criterion 1b: Proportion of adapted baseline (components)	Less than 500 million plastic components	Between 500 million and 4.1 billion plastic components	More than 4.1 billion plastic components	1

Score	1	2	3	Weighting
Criterion 2: Operational readiness	No examples and significant barriers to implementation e.g., curbside collection	Some small examples of system functioning e.g., refill in store or for similar products	Systems already in place and functioning well e.g., B2B reverse logistics	3
Criterion 3: User Acceptance	Significant change to user experience e.g., bringing own packaging to store	Small, surmountable change to user experience e.g., giving packaging to delivery person from home	Improves or no change to individual user experience e.g., restaurant returning food packaging	3

Three detailed examples of how the criteria were scored are provided in Table 5-2. The liquid oils cluster is evaluated against the prefill B2B strategy, food service ware utensils clusters are evaluated against the closed-loop reusable food service ware strategy, and pasta and noodles cluster is evaluated against the refill in store strategy.

- Criterion 1:
    - Liquid oils:15,000 tons and 440 million plastic components received a score of 2.
    - Utensils: 160,000 tons and 40 billion plastic components received a score of 3.
    - Pasta and noodles: 5,700 tons and 560 million plastic components received a score of 2.
- Criterion 2:
    - Liquid oils: Prefill B2B
    - Utensils: Closed-loop reusable food service ware receive a score of 3 as there are systems already in place utilizing these strategies that could be scaled.

    - Pasta and noodles: Refill in store receives a score of 2 as there are some small local stores utilizing this strategy, but it is assumed to require significant changes for large scale adoption.
- Criterion 3:
    - Liquid oils: Prefill B2B receives a score of 3 as it is assumed that business users would not require significant change in operation. They would be able to use the reusable containers as they currently do now and in the assumed system will be able to send back the reusable containers when their next shipment of oil is received.
    - Utensils: Received a score of 2 as there are reusable utensil systems currently in use, but in some circumstances, consumers may be less willing to switch to a reusable format.
    - Pasta and noodles: Refill in store received a score of 1 as this was assumed to require significant consumer change as consumers would carry a reusable container to the store and operate a refill station rather than purchasing a prepackaged container.

For these three examples liquid oils B2B and utensils closed loop reusable food service ware are considered to have high suitability for the source reduction strategy, while pasta and noodles refill in store is considered low suitability for the source reduction strategy.

Table 5-2: Example Scores for Three Clusters Against Three Strategies (Score in Parenthesis is Weighted Score)

Criteria	Criterion Weight	Liquid Oils (Prefill B2B)	Utensils (Closed-Loop Reusable Food Service Ware)	Pasta and Noodles (Refill in Store)
Criteria 1: Proportion of adapted baseline	1	2 (2)	3 (3)	2 (2)
Criteria 2: Operational readiness	3	3 (9)	3 (9)	2 (6)
Criteria 3: User Acceptance	3	3 (9)	2 (6)	1 (3)
Total Score	blank	8 (20)	8 (18)	5 (11)

Appendix B, Table B-21 includes the scores for all relevant function clusters against each reuse and refill strategy. The scores are not absolute in determining clusters that should implement reusable and refillable strategies but were used by the contractor to inform the strategies and clusters for the source reduction pathways. The highest score a cluster could receive for a strategy is 21 (3 maximum points from criteria 1, and 9 maximum points from each criterion 2 and 3). To help inform the pathways, clusters with a score of 18-21 were considered to have high suitability for that strategy, 14-17 were considered medium suitability, and under 14 was considered low suitability.

Implementation and Impact Feasibility Results

Prefill B2B Strategy

For prefill B2B, 10 clusters were found to have high suitability for weight reduction. In total these clusters make up 860,000 tons and 22 billion plastic components of single-use plastic packaging representing an estimated 30% total baseline weight and 13% of total plastic components. This strategy has the highest number and total weight of clusters to be considered high suitability. The high suitability clusters include:

- Fruit and vegetables.
- Milk - Liquid dairy and soy milk products.
- Liquid oils.
- All other seasonings, dressings and sauces.
- Non-FMCG primary/secondary (rigid).
- Meat.
- Prepared meals.
- All other dairy/soy products.
- Confectionery.
- Bakery and cereals.

Thirty-three clusters were determined to have medium suitability for weight reduction and one cluster had low suitability. The low suitability cluster is solid fats. In terms of plastic component reduction three clusters had high suitability, thirty-nine had medium suitability, and one had low suitability. Less clusters received high suitability for plastic component reduction compared to weight reduction as these clusters had a higher proportion of weight compared to components.

These results are in line with the findings outlined in Section 3.0. There were two prefill B2B solutions identified in California and additional examples found outside of California showing potential for scale. B2B systems were identified as a promising near term opportunity for scale. They do not require the same level of consumer behavior change but do require the user to be trained to ensure containers can be returned. This strategy benefits from being able to more easily be integrated into existing logistics and procurement systems.

Closed-Loop Reusable Food Service Ware Strategy

For closed-loop reusable food service ware, three clusters (utensils, cups, and containers) were found to have high suitability for both weight and number of plastic components reduction. These clusters account for 469,000 tons and 56 billion components, 6.2% and 12% of the total respectively. Furthermore, one cluster (lids) had medium suitability, and one cluster (film) had low suitability.

As discussed in Section 3.0, there are active pilots in stadiums and university campuses using on site or nearby washing facilities. This shows that there are operational readiness and opportunities to scale. Furthermore, the Current State of Source Reduction report found that there was strong public support for closed-loop systems in high-traffic venues, citing convenience and environmental benefits.

B2C E-commerce Transport Packaging and B2B Tertiary Transport Packaging

Pallet wrap and e-commerce envelopes were found to be medium suitability clusters for the reusable B2B transport packaging and reusable e-commerce packaging. These clusters are estimated to represent a combined 700,000 tons (25% of the baseline) and 4.6 billion plastic components (2.7%). There are some examples of reusable transport packaging systems in operation showing potential for scaling, but overall, the contractor found that user acceptance is likely to be lower compared to other strategies.

Prefill B2C Strategy

Prefill B2C included one cluster (Milk – liquid dairy and soy milk products) which was evaluated to be high suitability for this strategy. This cluster represents an estimated 24,000 tons and 4.7 billion plastic components. Milk has a long history of being sold in reusable containers with some businesses currently selling their products in reusable containers.

Ten clusters were identified as medium suitability. These clusters, representing 270,000 and 18 billion plastic components, include the following:

- All other dairy/soy products.
- Other household care products.
- Prepared meals.
- Confectionery.
- Non-FMCG primary/secondary (flexible).
- Herbs, spices and seasonings.
- Skincare.
- Make-up.
- Dishwashing and laundry products.

- Personal bathing products.

Thirty-two clusters were identified as low suitability and as such not discussed here.

As discussed in Section 3.0 prefill systems are currently niche in California, with only a few examples identified in the Current State of Source Reduction report. International models demonstrate scalability when supported by standardized packaging and financial incentives. This standardized packaging would require more medium- or long-term actions to align peer companies on a design. The Current State of Source Reduction report also identified that potential deposit costs and access to convenient return locations as key factors to consider. Building out a convenient return infrastructure to ensure consumer acceptance and adoption is likely only feasible in the medium or long term limiting this strategy's opportunity to support near term source reduction requirements.

Open-Loop Reusable Food Service Ware Strategy

All food service ware clusters (containers, utensils, cups, lids, and film) were identified as low suitability for this strategy. Very limited scale pilots were identified in California and only in urban areas. Although there was interest from the community engagement as part of the Current State of Source Reduction report, there was also concerns on convenience for returns and hygiene limiting potential user acceptance.

Refill in Store Strategy

One cluster (fruit and vegetables) was identified as high suitability, one cluster (confectionery) was identified as medium suitability with 16 clusters identified as low suitability. Systems currently do exist, but only 1% of the California population have access to a full refill store as discussed in the Current State of Source Reduction report. Furthermore, 62% of participants found refill stations challenging due to time and convenience, showing that consumer acceptance may be a challenge for this strategy. Finally, the Current State of Source Reduction report found that this strategy is less favored by businesses among other reuse and refill strategies due to hygiene and operational concerns.

Priority Reuse and Refill Strategies

Based on this evaluation the prefill B2B and closed-loop reusable food service ware strategies had the highest share of plastic covered material within clusters evaluated as high suitability for the evaluated reuse and refill strategies.

Prefill B2B shows strong potential to contribute to weight-based reductions of plastic covered material and can operationally scale to contribute to medium term source reduction requirements. Focusing on B2B minimizes may be most effective in the shorter term.

Closed-loop reusable Food Service Ware demonstrates significant potential to contribute to plastic component-based reductions of plastic covered material due to the large volumes involved. Food service ware accounts for an estimated 20% of the total weight of plastic covered material but about 40% of plastic components. These systems can be implemented relatively easily within the food service industry and require minimal consumer behavior change.

These two strategies and the high suitability clusters evaluated against them are used as the priority strategies for developing the overall source reduction pathway described further in Section 6.0.

Depending on the pathway, some medium suitability clusters may be integrated into the pathway for these strategies to meet the overall requirement. Expanding the clusters within these two strategies rather than implementing additional strategies may be most effective as the high suitability clusters will help develop the foundational infrastructure and educate users to support user acceptance.

Other Source Reduction Strategy and Alternative Compliance Strategy Prioritization Method

The most effective other source reduction strategies are influenced by the format of the plastic covered material and the properties it provides (rather than the good contained). For example, the contractor assumed that the same strategies will be effective in source reducing a high-barrier flexible bag, regardless of whether that packaging contains a savory snack or a nut-based spread.

The following source reduction strategies (described in detail in Section 3.0) were evaluated against the 35 format clusters:

- Lightweighting.
- Elimination.
- Right sizing.
- Concentration.
- Large format.
- Material substitution.

The alternative compliance formula for PCR plastic was also evaluated against the clusters. Alternative compliance is not considered a source reduction strategy; however, the PRO may propose an alternative compliance formula through which no more than 8% of source reduction can be counted toward the requirements.

While there are recognized relationships between certain source reduction strategies (such as lightweighting and right sizing), each cluster was evaluated against distinct criteria related to each individual strategy. A single criterion of overall suitability for source reduction was then established for each cluster.

Technical Feasibility

Twenty-three technical criteria were developed to evaluate the potential for other source reduction across each format cluster. The full list of criteria and details on how each criterion was scored are in Appendix C, Table C-23. The criteria fall into one of five categories:

- Composition: These criteria reflect the amount of plastic (weight and number of plastic components) used in the cluster and the overall complexity of the single-use plastic packaging (in terms of the typical number of plastic components per unit). Clusters such as tertiary packaging, different types of bottles, and jars that tend to use more plastic by weight, but fewer plastic components show strong opportunities for lightweighting.
- Structure/design: These criteria reflect the amount of headspace typically found in the packaging and the amount of protection typically required. Excessive headspace and/or minimal protection requirements indicate strong opportunities for source reduction, including certain bottles, jars, and rigid cases.
- Manufacture and logistics: These criteria reflect whether the typical processes involved in manufacturing the cluster create barriers/limitations to design changes and source reduction.
- User and market: These criteria evaluate the features and functionality (and their necessity) the packaging provides for the user, such as the ability to microwave the packaging with the good or the ability to reseal the packaging.
- Regulatory: These criteria reflect the regulatory requirements typically met by the cluster, such as food grade compliance or hazardous goods compliance.

A score of -1, 0, or 1 was applied to each cluster for each criterion. A score of -1 reflects the contractor's assessment that there is a challenge to source reduction with respect to that criterion. A score of 0 reflects the contractor's assessment that features of the cluster do not affect feasibility for source reduction. A score of 1 reflects the contractor's assessment of high suitability for source reduction with respect to that criterion. All 23 scores were summed for each cluster; these are shown in Appendix C. The highest score a cluster could receive is 23 and the lowest score is -23.

Similar to the reuse and refill evaluation, these scores are not absolute and serve as guideposts to identify strategies that together can form a pathway to meet source reduction requirements. The top nine scoring clusters were categorized as high suitability for other source reduction strategies. These clusters received scores between 9 and 14. The middle 13 scoring clusters were categorized as medium suitability for other source reduction. These clusters received scores between 4 and 8. The lowest scoring 12 clusters were categorized as low suitability for other source reduction. These clusters received scores between -7 and 3.

The clusters the contractor evaluated as high suitability represent approximately 484,000 tons of plastic covered material and 8.7 billion plastic components. These clusters include nonfood bottles which are typically made from a single material/resin, are generally not subject to stringent regulatory requirements (as they do not contain food), often use excessive components that could be removed, and do not have layers that preserve the good. They also include nonfood rigid packaging such as clamshells for durable goods and rigid cases as these clusters are monomaterial and have less restrictive manufacturing requirements so they could more feasibly be source reduced. No clusters that handle food were evaluated as high-suitability clusters for other source reduction, indicating a potentially untapped area for R&D in the future.

The medium suitability clusters represent approximately 984,000 tons of plastic covered material, or about 38% of the total. These clusters include more lightweight rigid packaging and films. These clusters also include some food packaging which usually includes a barrier layer that is harder to design out. Several food service ware clusters are also evaluated as medium suitability.

The low suitability clusters represent approximately 1.1 million tons of plastic covered material, or 43% of the total. Flexible film food packaging that has either a medium or high barrier layer, high barrier trays with film, and lightweight tubs with lids were evaluated as low suitability. These packaging formats are often multi-layer as they need to fulfill various technical capacities such as air barriers. Furthermore, they are, per unit, light and there is little opportunity to further reduce the weight of plastic per unit. These functional elements of the packaging make it more complex to achieve source reduction through the other source reduction strategies.

Plastic Reduction Potential

For each strategy, the impact of potential source reduction per unit was estimated for each cluster (see Appendix D).

For example, the bottle and pump/trigger (nonfood) cluster was estimated to have the potential to reduce approximately 65% of its plastic weight through material substitution, as the bottle could be replaced with aluminum or glass, while the pump/trigger would likely remain plastic. This cluster could also achieve an estimated 15% reduction per unit through lightweighting. Each potential impact was applied to the clusters based on their ranking to understand how source reduction requirements could be met.

Priority Strategies

Right sizing and lightweighting were identified as key opportunities in the Current State of Source Reduction report for other source reduction strategies. Interested parties believe these are practical opportunities for working toward the source reduction requirements. 18% of plastic covered materials are highly suitable for these strategies and businesses interviewed indicated that the most feasible lightweight opportunities have already been achieved. A 25% reduction through lightweighting across highly suitable format clusters was estimated to reduce the overall weight by 4.5%.

Material substitution and elimination offer opportunities for plastic component reduction. These strategies were assumed to offer a one-to-one reduction for both weight and number of plastic components. Although food service ware clusters were evaluated as medium or low suitability clusters, they should still be considered for meeting the other source reduction requirements, especially for plastic component reduction. Food service ware is difficult to lightweight as it is already light and because it is used to handle food there are additional technical requirements. There are nonplastic food service ware alternatives on the market today, therefore, material substitution is a possible strategy for food service ware.

6.0 Pathways to Meet Source Reduction Requirements

Introduction

The objective of this section is to present illustrative pathways demonstrating how California's plastic covered material source reduction requirements could be achieved through different combinations of strategies. A pathway represents a potential mix of source reduction approaches — including reuse, refill, and design-based strategies — deployed across product categories to meet the statutory requirements for 2027, 2030, and 2032.

The analysis explores the interplay between strategy selection, market penetration rates, and achieving requirements, providing a framework for understanding the range of actions needed and their relative contributions to weight and plastic component reductions.

The baseline considered in this study estimates approximately 2.86 million tons of plastic covered material and 171 billion plastic components of plastic covered material were sold, offered for sale, or distributed into California in 2023. The reductions necessary to meet the requirements are summarized in Table 6-1 and Table 6-2.

Table 6-1: Source Reduction Baseline and Estimated Plastic Weight Reduction Requirements

	2023	2027	2030	2032
Estimated Amount of Plastic Covered Material (tons)	2,860,000	2,860,000	2,860,000	2,860,000
Source Reduction Requirement (%)	N/A	10%	20%	25%
Source Reduction Requirement (tons)	N/A	286,000	573,000	716,000
Minimum Reuse/Refill Reduction Requirement (%)	N/A	2%	4%	10%
Minimum Reuse/Refill Reduction Requirement (tons)	N/A	57,300	114,000	286,000

*This table is provided to three significant figures for clarity.

Table 6-2: Source Reduction Baseline and Estimated Plastic Component Reduction Requirements

	2023	2027	2030	2032
Estimated Amount of Plastic Covered Material (billion plastic components)	171	171	171	171
Source Reduction Requirement (%)	N/A	10%	20%	25%
Source Reduction Requirement (billion plastic components)	N/A	17	34	43
Minimum Reuse Refill Reduction Requirement (%)	N/A	2%	4%	10%
Minimum Reuse Refill Reduction Requirement (billion plastic components)	N/A	3.4	6.9	17

*This table is provided to three significant figures for clarity.

The modeling assumed no growth to enable the pathways to clearly illustrate the potential impacts of various strategies on reducing the weight of plastic covered material and number of plastic components.

Pathway Development Methodology

Strategy Prioritization and Modeling Approach

There are many possible combinations of strategies that could achieve the source reduction requirements. This analysis does not prescribe how requirements should be met but rather demonstrates multiple plausible scenarios and illustrates how different priorities, constraints, and implementation rates might shape industry response and outcomes.

The pathways reflect priorities identified through the scoring and prioritization process detailed in Section 5.0, which evaluated strategies based on feasibility, barriers, costs, and achievable reductions. While this process narrows the field to strategies with fewer barriers and higher likelihood of adoption, significant uncertainty remains regarding market penetration (i.e., the rate at which source reduction strategies will be adopted within each cluster).

The analysis identifies which product groups and strategies face fewer barriers but cannot predict precise adoption rates. Instead, the pathways illustrate the level of market penetration that may be most effective to meet requirements under different strategic emphases.

Certain strategies, while highly feasible, have limited applicability across goods groups or offer low impact potential when applied broadly. Examples of such source reduction strategies include concentration and right sizing.

The following nonreuse strategies shown in Table 6-3 are therefore prioritized.

Table 6-3: Prioritized Strategies

Strategy	Justification
Material Substitution	Material swapping is achievable and commonplace in many goods groups. It was assumed to offer a one-to-one source reduction potential.
Lightweighting	There remains a modest but meaningful opportunity for some goods groups to reduce weight.
Elimination	Elimination offers a one-to-one source reduction potential, with notable opportunities in food service ware.

In addition to the strategies, alternative compliance through the use of PCR plastic is also included in the pathways. This analysis assumed a one-to-one source reduction benefit from alternative compliance given that the alternative compliance formula has not yet been established.

For reuse systems, the analysis favors achieving high penetration rates within goods groups that are easier to transition, rather than spreading effort thinly across a broader market. This results in prioritizing two key groups under reuse: closed-loop reusable food service ware and prefill in B2B contexts.

- Closed-loop reusable food service ware demonstrates significant potential to contribute to plastic component-based reductions due to the large volumes involved. It is estimated to account for approximately 40% of plastic components in the baseline. These reuse systems can be implemented relatively easily within the food service industry and require minimal consumer behavior change.
- Prefill B2B shows strong potential to contribute to weight-based reductions of plastic covered material, complementing food service ware. Focusing on B2B minimizes consumer impact and avoids the need for incentivization strategies and some of the more costly return infrastructure needed for B2C contexts. It also establishes some of the core infrastructure (e.g., sorting, washing) that can later support broader B2C systems, making this a low-risk steppingstone.

Once strategies were prioritized and their potential quantified, the contractor determined potential adoption levels. Based on expert guidance from study partners, market penetration limits were established for each packaging format and strategy, creating an upper bound for their contribution toward meeting the requirements. The core pathway analysis model was then used to conduct systematic sensitivity analysis and scenario optimization. This involved varying penetration rates within plausible ranges and applying requirement-oriented parameter adjustment techniques, akin to a structured goal-seeking approach, to identify configurations that could be theoretically plausible options to achieve compliance. Through this iterative optimization process, the contractor identified implicit system constraints and developed pathways that illustrate these limitations.

Why develop multiple pathways?

The analysis process revealed a central finding: achieving the plastic component-based reduction requirements requires either substantial material substitution, significant reuse adoption, or a combination of both. This conclusion is based on the following factors*:*

1. **Impact of strategies**: Reuse and material substitution are two of the only strategies that substantially reduce both weight of plastic covered material and number of plastic components simultaneously, while also offering a one-to-one reduction potential and broad applicability across packaging formats. Other strategies (e.g., lightweighting, concentration) primarily reduce weight and/or have lower overall impact.
2. **Variation across product groups**: Product groups differ in their weight-to-plastic component ratios, meaning that the effectiveness of strategies varies depending on where they are applied.
3. **Strategic Trade-offs**: High reliance on material substitution may raise concerns about certain life-cycle impacts, whereas heavy emphasis on reuse requires significant infrastructure investment and some degree of consumer behavior change.

Therefore, this section presents two distinct pathways that explore these strategic choices and their implications:

- Pathway A: Substitution Emphasis Pathway – Relies more heavily on shifting plastic to nonplastic alternatives (paper, fiber, metal, glass) alongside incremental design strategies, whilst still meeting reuse requirements.
- Pathway B: Reuse Emphasis Pathway – Prioritizes prefill, reusable food service ware, and B2B reuse systems.

In both pathways, substantial levels of both reuse and substitution remain necessary. A singular focus on one strategy would likely result in exceeding one requirement while attempting to meet another. The pathways illustrate scenarios where one strategy is emphasized more strongly than the other.

Overall Pathway Results

The results of modeling these example pathways are shown in Figure 6-1 for Pathway A and Figure 6-2 for Pathway B.

In Pathway A, nonreuse strategies to achieve source reduction are emphasized, but their impact varies by requirement type. For example, substituting nonplastic for plastic in packaging, pallet wrap, and e-commerce envelopes significantly contributes to weight-based reductions but has a much lesser effect on plastic component reduction, which is primarily driven by food service ware in this pathway. This illustrates that a combination of strategies may be most effective to meeting both requirements concurrently. Overall, market penetration rates between 5% and 81% (averaging approximately 43%) are required across the prioritized clusters.

As modeled in pathway A, meeting the 2027 and 2030 weight-based reductions for reuse resulted in exceeding the plastic component reductions. In some years, these scenarios surpass some requirements to ensure the overall requirement is met. Exceeding the plastic component reduction can serve two purposes: contributing to overall plastic component requirement and enabling the ramp-up of prefill systems in later years, which help rebalance weight and plastic component reductions by 2032.

In Pathway A, approximately 47% of closed-loop food service ware and 25% of prioritized prefill B2B groups were estimated to transition to reuse by 2032.

Additionally, alternative compliance contributions remained below the maximum allowable threshold throughout the pathway. This is due to two factors:

1. Uncertainty regarding the availability of sufficient recycled material in the market and the need for either very high recycled content levels in nonfood applications (approximately 50% or more) or broader adoption in food applications. However, with recyclability and recycling rate requirements under the Act, the availability of post-consumer recycled content is likely to increase in the future.
2. Prioritizing recycled content in early years would result in exceeding the weight-based reduction requirement by 2032, because PCR content was not considered to contribute towards reductions in plastic components for the purposes of this study.

Pathway B, which places greater emphasis on reuse, reveals notable insights. Here, the primary driver remains the plastic component-based requirement, which, absent significant material substitution, was modeled to be achieved predominantly through food service ware adoption. In Pathway B, approximately 85% of the closed-loop food service ware market was estimated to transition to reuse by 2032, complemented by a 40% uptake among prioritized B2B prefill groups. Correspondingly, other source reduction strategies focus on lightweighting as there is less need for plastic component reductions through material substitution or elimination. Compared to Pathway A, more format clusters are selected for the lightweighting strategy and the market penetration for some of the clusters increases to 50% compared to a maximum penetration rate of 25% in Pathway A.

Given the complex interaction between plastic component-based and weight-based reductions, and the multiple ways these can be achieved in intermediate years, the pathway analysis aimed to reduce greatly exceeding the requirements to avoid cost estimates that go beyond the required reductions, however some excess may be unavoidable.

Both Pathways A and B exhibit this to varying degrees, largely due to the time required to establish and scale prefill reuse systems. During this ramp-up period in the pathways, other source reduction measures are implemented to meet earlier requirements for 2027 and 2030. A practical approach could be to increase recycled content in the early years, a strategy that can be deployed quickly and cost-effectively, provided material availability.

Figure 6-1: Pathway A for Achieving 25% Source Reduction Requirements – Substitution-Emphasis

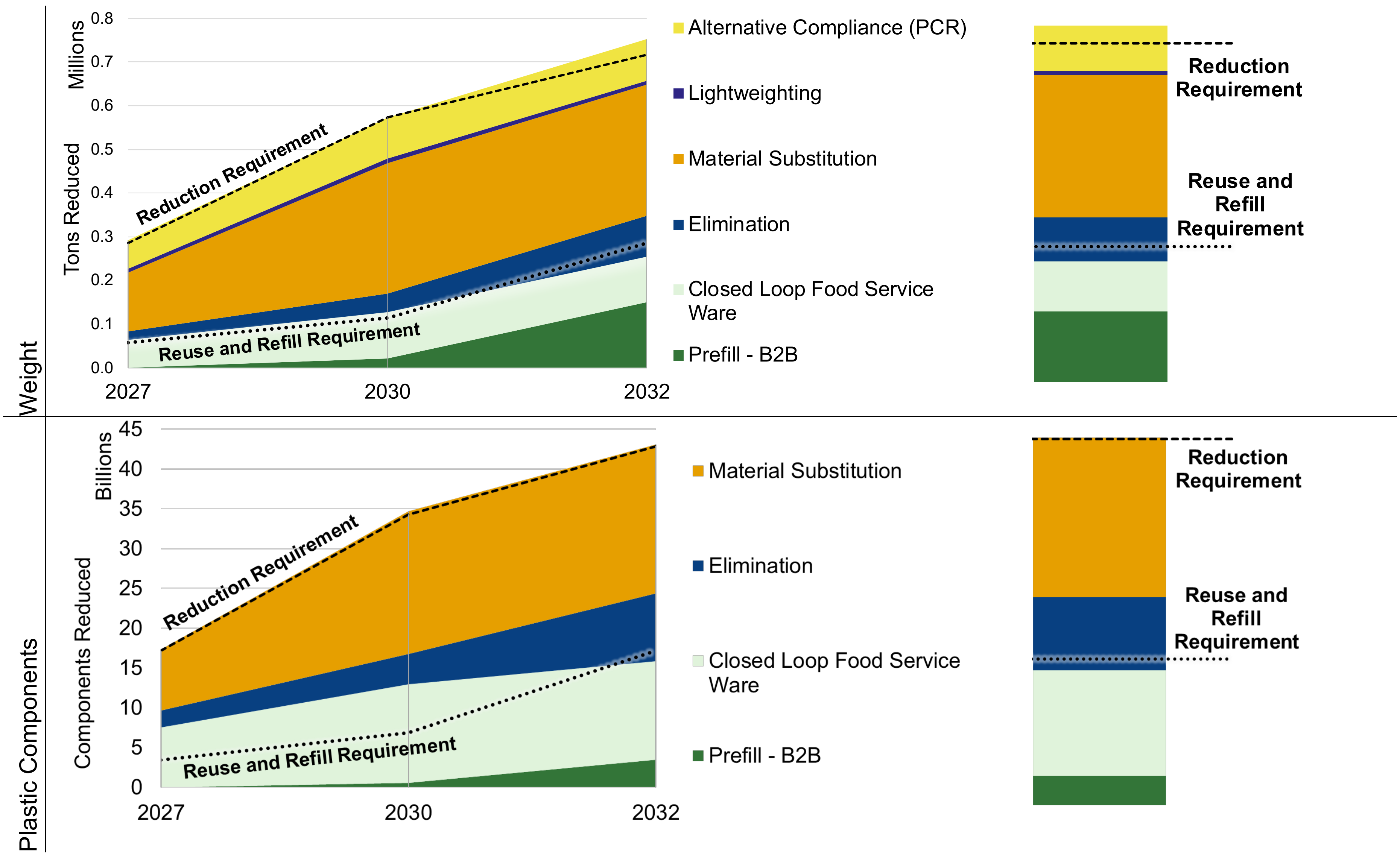
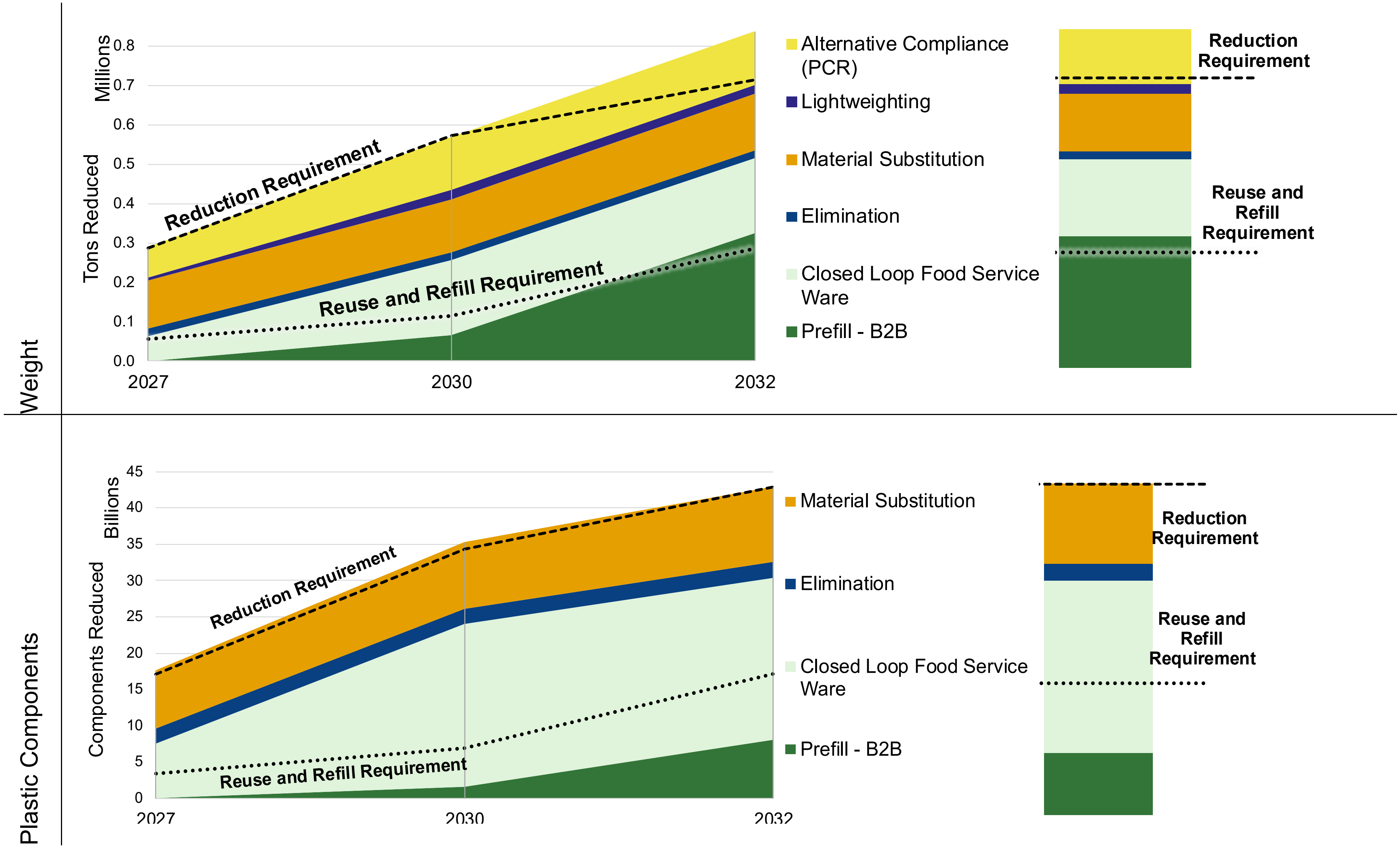


Figure 6-2: Pathway B for Achieving 25% Source Reduction Requirements – Reuse Emphasis



Detailed Pathway Results

The following section provides more detail on the results for the two pathways. These results present the weight of plastic covered material (including the weight of plastic only) and the number of plastic components estimated as reduced through each strategy and describe relative market penetration needed to meet the reductions. As previously discussed, these are not recommendations but plausible options for meeting the requirements. Detailed results showing weight, plastic component reductions and market penetration by cluster/format and strategy are provided in the accompanying Pathway Results spreadsheet. Table totals may not add up due to rounding.

Pathway A

Table 6-4 and Table 6-5 show the weight of plastic covered material and the number of plastic components reduced based on the modeling for Pathway A.

Table 6-4: Pathway A Weight Reduction of Plastic Covered Material, by Strategy (tons reduced and percent source reduction contribution; rounded to nearest 10,000)

	2027	2027	2030	2030	2032	2032
Strategy	**Tons**	**%**	**Tons**	**%**	**Tons**	**%**
Closed-Loop Reusable Food Service Ware	70,000	2%	110,000	4%	110,000	4%
Prefill B2B	0	0%	20,000	1%	150,000	5%
Elimination	20,000	1%	40,000	1%	90,000	3%
Material Substitution - Food Service Ware	50,000	2%	90,000	3%	90,000	3%
Material Substitution – Tertiary Transport Packaging	40,000	1%	80,000	3%	80,000	3%
Material Substitution – Primary/Secondary Packaging	50,000	2%	130,000	4%	130,000	4%
Lightweighting	10,000	<1%	10,000	<1%	10,000	<1%
Alternative Compliance (PCR) – Tertiary Transport Packaging	0	0%	30,000	1%	30,000	1%
Alternative Compliance (PCR) – Primary/Secondary Packaging	60,000	2%	60,000	2%	60,000	2%
Total	300,000	10%	570,000	20%	750,000	26%

Table 6-5: Pathway A Plastic Component Reduction, by Strategy (number of plastic components reduced and percent source reduction contribution)

	2027	2027	2030	2030	2032	2032
Strategy	**Million Plastic Components**	**%**	**Million Plastic Components**	**%**	**Million Plastic Components**	**%**
Closed-Loop Reusable Food Service Ware	7,600	4%	12,400	7%	12,400	7%
Prefill B2B	0	0%	600	0%	3,400	2%
Elimination	2,100	1%	4,300	3%	9,500	6%
Material Substitution - Food Service Ware	7,100	4%	15,700	9%	16,500	10%
Material Substitution – Tertiary Transport Packaging	400	0%	1,100	1%	1,100	1%
Material Substitution – Primary/Secondary Packaging	300	0%	1,100	1%	1,100	1%
Lightweighting	0	0%	0	0%	0	0%
Alternative Compliance (PCR) – Tertiary Transport Packaging	0	0%	0	0%	0	0%
Alternative Compliance (PCR) – Primary/Secondary Packaging	0	0%	0	0%	0	0%
Total	17,500	10%	35,200	20%	44,000	26%

The closed-loop reusable food service ware strategy is focused on transitioning single-use plastic containers, cups, and utensils sold in closed-loop systems such as cafeterias, restaurants, stadiums, and schools to reusable formats. As estimated in the pathway, in 2027, 29% of the units sold were estimated to shift to reusable formats, with 47% penetration required for 2030 onward. To meet 2027 and 2030 requirements respectively, this is equivalent to either the consumption of approximately:

- 19,000 and 31,000 quick service restaurants having switched or

- 8,000 and 13,500 cafeterias (including schools, care, and correctional facilities).[19]

This pathway assumes that prefill B2B will not contribute to the 2027 requirement as more time is required to set up the necessary infrastructure to implement this strategy. By 2030, 3% penetration in 20 clusters is estimated for the prefill B2B system. These clusters include the 10 identified as high suitability in Section 5.0 in addition to 10 medium suitability clusters. By 2032 the market penetration of these clusters would rise to 25%, representing approximately 14% of all B2B single-use plastic packaging by weight.

Elimination, in combination with BYO reuse and refill, is focused on plastic food service ware cups, utensils and containers sold off-premises such as takeout, quick service, or home use. By 2027, 5% of utensils and containers are eliminated or reduced through BYO refill which rises to 9% of all three categories in 2030 and 20% by 2032. Examples of these strategies could be a restaurant not providing any utensils with a takeout order, a consumer providing their own cup at a coffee shop, or a fast casual restaurant not providing small containers for sauce.

Material substitution varies across food service ware and packaging. For single-use plastic food service ware in 2027, 18% of containers and 17% of utensils are replaced with nonplastic formats. This rises to 20% and 40% by 2030 and 20% and 48% by 2032, respectively. Packaging material substitution varies across 13 format clusters, 10 of which are nonfood. Some clusters such as bottles and pump/trigger (nonfood) shift 5% to a nonplastic material such as glass or aluminum. Impact resistant packaging shifts 32% in 2027 rising to 40% in 2032. Goods in these formats could be packaged in nonplastic fiber as a material substitution, for example.

Lightweighting is primarily focused on packaging formats such as bottles, rigid cases, and higher weight tubs. Within Pathway A, eight clusters implement the lightweighting strategy. The market penetration of this strategy across these clusters ranges from 3 to26% with an average of 18%. This means, on average, 18% of the units within these clusters are lightweighted. The average amount each unit is estimated to be lightweighted ranges from 8 to15%. For example, 26% of the units sold in the bottle and pump/trigger (nonfood) format cluster are lightweighted and each of these unit is lightweighted by 15%.

Alternative compliance through the use of PCR is also primarily focused on packaging including transport packaging. Approximately eight clusters were estimated to integrate recycled content to contribute toward the alternative compliance mechanism for source reduction. Some clusters such as high weight tubs have a market penetration of approximately 26% and these units integrate 100% PCR content into their packaging. For single-use transport packaging pallet wrap there was an assumed 0% market penetration in 2027, which rises to 15% in 2032. Each unit of pallet wrap that integrates PCR content is estimated to achieve 38% PCR in this pathway.

Pathway B

Table 6-6 and Table 6-7 show the plastic weight and the number of plastic components reduced by strategy for Pathway B. Pathway B has a greater reliance on reuse, therefore the market penetration rates for these strategies are higher.

Table 6-6: Pathway B Weight Reduction of Plastic Covered Material, by Strategy (tons reduced and percent source reduction contribution; rounded to nearest 10,000)

	2027	2027	2030	2030	2032	2032
Strategy	**Tons**	**%**	**Tons**	**%**	**Tons**	**%**
Closed-Loop Reusable Food Service Ware	70,000	2%	190,000	7%	190,000	7%
Prefill B2B	0	0%	60,000	2%	320,000	11%
Elimination	20,000	1%	20,000	1%	20,000	1%
Material Substitution – Food Service Ware	50,000	2%	60,000	2%	60,000	2%
Material Substitution – Tertiary Transport Packaging	40,000	2%	40,000	2%	40,000	2%
Material Substitution – Primary/Secondary Packaging	30,000	1%	30,000	1%	30,000	1%
Lightweighting	10,000	<1%	30,000	1%	30,000	1%
Alternative Compliance (PCR) – Tertiary Transport Packaging	10,000	<1%	70,000	2%	70,000	2%
Alternative Compliance (PCR) – Primary/Secondary Packaging	70,000	2%	70,000	2%	70,000	2%
Total	300,000	10%	580,000	20%	830,000	30%

Table 6-7: Pathway B Plastic Component Reduction by Strategy (number of plastic components reduced and percent source reduction contribution)

	2027	2027	2030	2030	2032	2032
Strategy	**Million Plastic Components**	**%**	**Million Plastic Components**	**%**	**Million Plastic Components**	**%**
Closed-Loop Reusable Food Service Ware	7,600	4%	22,400	13%	22,400	13%
Prefill B2B	0	0%	1,600	1%	8,100	5%
Elimination	2,100	1%	2,100	1%	2,100	1%
Material Substitution – Food Service Ware	7,400	4%	8,500	5%	9,700	6%
Material Substitution – Tertiary Transport Packaging	400	<1%	400	<1%	400	<1%
Material Substitution – Packaging	200	<1%	300	<1%	300	<1%
Lightweighting	0	0%	0	0%	0	0%
Alternative Compliance (PCR) – Tertiary Transport Packaging	0	0%	0	0%	0	0%
Alternative Compliance (PCR) – Packaging	0	0%	0	0%	0	0%
Total	17,700	10%	35,300	21%	43,000	25%

For closed-loop reusable food service ware, Pathway B has the same transition as Pathway A for 2027 as this was considered the ceiling in the short term for this analysis (i.e. 29% of food service ware including cups, utensils, and containers would transition from single-use to reusable to contribute 2% source reduction by 2027). The reuse transition across these food service ware categories then rises to 85% by 2030 and 2032. This represents a more comprehensive transition to reusable food service ware in closed-loop systems, equivalent to the combined consumption of 48,000 schools and quick service restaurants.

For prefill B2B, Pathway B utilizes the same clusters as Pathway A, but has a market penetration rate of 8% in 2030 (compared to 3% in Pathway A) rising to 40% in 2032 (compared to 25% in Pathway A).

In 2027, Pathway B has a similar contribution of other source reduction compared to Pathway A. The main difference in Pathway B is there are more clusters implementing material substitution but the relative market penetration of each is lower.

Elimination and BYO reuse for food service ware contributes less source reduction in 2030 and 2032 compared to Pathway A. In Pathway B only 5% of containers and utensils are eliminated compared to 10% in Pathway A. Material substitution contributes less source reduction in Pathway B than Pathway A. Food service ware containers and utensils have a material substitution rate of 23% and 24%, respectively in 2032 compared to 20% and 48% in Pathway A.

Both lightweighting and the alternative compliance using PCR contribute more to the weight reduction in Pathway B compared to Pathway A. By 2032, 15 clusters are implementing lightweighting compared to 8 for Pathway A and many of these clusters have higher rates of market penetration, up to 50% compared to 26% in Pathway A. In Pathway B, a similar share of clusters implemented alternative compliance through PCR but, by 2032, 22% of pallet wrap integrates PCR compared to 15% in Pathway A. In Pathway B, 22% of e-commerce envelopes integrate PCR plastic, while this cluster does not use recycled content in Pathway A.

Timing for Various Strategies

The strategy evaluation process for different format and function clusters resulted in the contractor presenting two possible pathways to meet the requirements. Both pathways focus on strategies that minimize consumer impact and behavior change. For most reuse and refill strategies the pathways focus on developing and implementing systems within B2B supply chains and closed-loop systems.

There is the potential for the infrastructure and systems designed for these B2B and closed-loop systems to be leveraged to implement strategies focused on B2C routes, however, the time required to set up all of the required elements for significant market penetration of B2C reuse and refill is likely to take more time than B2B. Having tried and tested systems, operating models, and contracts in place from B2B reuse and refill will allow key success factors of a B2C reuse and refill system to be the focus. This would include packaging design and consumer engagement to ensure that there are few barriers to participation from either physical or economic perspectives.

7.0 Calculation Methodology for Actions, Costs and Investments

Introduction

The objective of this section is to describe how the contractor estimated the type and scale of actions, and corresponding costs and investments to achieve the source reduction pathways described in Section 6.0.

Scope of Actions and Investments Considered

This study considered actions and costs to achieve the source reduction requirements for plastic covered material. The study considers any direct system costs that are different from today's system, or net costs, but does not consider indirect costs. As such, any direct cost savings in the pathways associated with actions avoided in the single-use system are included in this study. For example, the financial savings associated with reduced virgin plastic use for single-use material are included in the final net costs as negative values.

Costs are not annualized and they are accounted for in the year in which they are incurred. Future costs are not discounted and real 2025 values are used (meaning there is no nominal adjustment for inflation, which would add additional uncertainty to the results).

The modeling and numerical results themselves make no distinction based on which actor costs fall on (either directly or indirectly), nor do they consider where costs will ultimately be borne geographically. This is because, within California, the location of the investment, and on whom it falls, are assumed not to be major factors in the size of the investment required.

However, later sections consider the distributional impacts of the actions underlying these costs by identifying the actors who may take steps to help deliver the pathways and ensuring adequate access to reuse systems, for priority populations (including people living in certain geographies, like rural areas).

Financial transfers between actors are out of scope. Only direct costs to packaging and food service ware systems resulting from the actions taken to achieve source reduction are included. This means that deposits, for example, which would be a financial transfer from business and/or consumers to the PRO, system operator, or government, are out of scope.

This section of the report presents investment costs in two categories:

- Capital Expenditure (CAPEX): the upfront investment for acquiring, upgrading, or extending the life of long-term assets within the system. These expenditures are typically one-time, high-cost investments that provide value over multiple years. In this study, it is assumed that all CAPEX (and the resulting infrastructure implemented) is spent in the years before the requirement years. For example, the total CAPEX to achieve the 2032 source reduction requirements in each pathway is assumed to be spent in the years up to and including 2031. CAPEX values presented in the report represent the cumulative total cost; they are not the new costs needed between one requirement year and the next.

- Operational Expenditure (OPEX): the recurring costs to maintain and operate the system. These are recurring expenses that are consumed within a given accounting period (this report presents annual OPEX). These are the ongoing costs to run the system in a given year; they are not cumulative.

The cost estimates described in this section are based on a variety of assumptions about how system actors will act in the future in each pathway. Without insight into how the requirements will be met, the contractor has modeled a system design it deems most likely in the context of existing reuse systems and financial constraints. The contractor has identified the most likely choice or assumption in each case based on its knowledge of packaging and reuse systems, the Act and other economic and financial constraints. The 'most likely' assumption is therefore a function of a variety of conditions which are themselves subject to significant uncertainty. The contractor uses the term 'most likely' to imply that it considers that assumption more likely than other possibilities, but not to imply that that assumption is the only way, or that there is high confidence in that choice. In using this term, the contractor is not making any definite statements about how requirements will in fact be met, or how likely any particular system design choice is.

When it has not been possible to determine the most likely system choice, the contractor has made assumptions that it deems realistic but conservative. The impacts of these more conservative assumptions are discussed, where relevant, in each of the following subsections and in the Discussion and Limitations in Section 9.0.

Costs Spanning Reuse and Other Source Reduction

Program Administration

Funding for administration and governance, legal support, and program oversight was considered. This included funding for the development and maintenance of IT systems for data collection and reporting for tracking plastic covered materials and ensuring accurate producer declarations. Compliance monitoring and audits involve verifying producer reports and conducting third-party checks to maintain program integrity.

Table 7-1: Cost Scope of Program Administration

Cost type	Cost scope
OPEX	Labor and systems required for program administration and governance
CAPEX	None

These actions were assumed to be required on an ongoing basis so all program administration costs are treated as OPEX. The contractor estimated this OPEX by referring to the administration of other similar systems globally.

In 2023, Stewardship Ontario reported administrative costs at 4.5% of total system expenses,[20] while CITEO in France spent 5% of its annual budget on support for client, local authorities, and internal operating costs.[21] The contractor applied a 5% uplift to all other system costs.

Reuse and Refill Strategy Modeling

This section describes, for the two reuse/refill source reduction strategies employed in the pathways (i.e., closed-loop reusable food service ware and prefill B2B), the processes and associated actions. It describes the key modeling assumptions made by the contractor to estimate the costs and investments associated with the pathways.

The objective is to quantify the net CAPEX and OPEX to implement these systems at scale, while excluding any activities that remain unchanged from today.

Switching from Single-Use Plastic Covered Material to Reusable Formats

The foundation of this analysis is the amount of plastic covered material (in terms of weight, number of plastic components, and number of individual units) switching from single-use formats to reusable formats. This is driven by the baseline analysis (Section4.0) and the market penetration of each strategy in each pathway (Section 6.0).

It was assumed that all goods switching to reusable packaging as part of the prefill B2B strategy are sold in reusable units of the same size/weight/volume, and where possible, remain in the same format (e.g., a good sold in a single-use bottle would switch to a reusable bottle).

All reusable packaging in the B2B context is assumed to be made from plastic and is assumed to be made from the same resin as the single-use equivalent. This assumption was made as previous contractor experience and modeling has shown that reusable plastic packaging often has lower system costs than alternative materials such as glass or steel. Furthermore, glass, ceramic or metal packaging is not often used in B2B contexts; in a system heavily reliant on plastics, the most likely transition is to other plastic choices. However, system operators may choose different materials for reusable B2B packaging. The impact of these assumptions is discussed in Limitations in Section 9.0.

All reusable food service ware used in closed-loop settings is assumed to be made of plastic, with the exception of reusable utensils, sauce pots, straws and stirrers, which are assumed to be made from stainless steel. Plastic is the likely choice for cups, plates, and other types of containers in the reusable food ware system considered in this study. Here, all food service ware is assumed to be transported off-site to centralized washing hubs, and plastic is less likely to be damaged in transport than glass and ceramic options. The majority of reusable food service ware programs identified by the contractor use containers made from plastic. As with reusable B2B packaging, other options are available and the impact of these assumptions is discussed in Limitations in Section 9.0

It was also assumed that, where possible, switching rigid packaging (ahead of flexible formats) to reusable packaging will be prioritized. There are several reasons for this assumption:

- On a per unit basis, single-use plastic rigid formats are typically significantly heavier and have more components than single-use plastic flexible formats. This means that, all else being equal, fewer units must transition to reuse to achieve the same plastic reductions.
- Reusable flexible packaging formats are less likely to be a viable option for most applications as they are difficult to wash.
- There will be less change to the end-user experience as a result (e.g., switching from a single-use film to a reusable rigid container is likely to more significantly disrupt how a consumer interacts with packaging than switching from a single-use rigid container).
- Less R&D is likely required to design new packaging types and ensure their compatibility with goods.

Simplifying Packaging Formats

The pathways involve switching plastic covered material ware to reusable formats. The contractor used packaging archetypes in the modeling. The purpose of using archetypes is to simplify modeling. Six reusable archetypes are modeled, with all reusable formats simplified as one of these archetypes:

- Reusable box/tub/tray/clamshell packaging.
- Reusable bottle/jar packaging.
- Reusable food service ware utensil.
- Reusable food service ware container.
- Reusable food service ware cup.
- Reusable tote box.

The contractor recognizes that there will be many more than six types of reusable packaging to deliver the functionality required. For example, a tub and a clamshell will both be needed, however, these are grouped for simplicity, due to the following reasons:

- It is not known exactly how reusable packaging formats will be designed. The contractor aimed to model averages representing approximations of which reusable formats will achieve certain functions for certain types of goods.
- Although the specific details of the designs of a tub and clamshell will differ (e.g., a tub will have a separable lid while a clamshell's lid is attached to the rest of the container), for the purposes of this modeling, they will flow within the reusable system in a similar way. All packaging within an archetype can use the same washing machinery and be stacked in a similar way. In other words, at the level

of granularity chosen for this modeling, there are no significant differences between a tub and a clamshell.

Grouping reusable packaging into these archetypes is not expected to have any significant impact on the results of this modeling.

Each format cluster implicated in the pathways is mapped to one of these reusable formats based on functional equivalence. For example, any goods currently contained in the format cluster 'Flexible Bag – Low Barrier (Food)' will, when switched to reusable packaging, be packaged in the Box/Tub/Tray/Clamshell archetype.

Action, Cost and Investment Model Methods

Both Pathway A and Pathway B involve closed-loop reusable food service ware and prefill B2B strategies.

The following sections describe the potential actions to achieve these pathways. Within each stage in the life cycle of reusable packaging, several actions may be considered and the scale of these actions generally depends on the market penetration of the relevant reuse strategies. The following stages are considered:

- Outreach.
- Research and development.
- Manufacturing.
- Forward transport.
- Packing/filling.
- Returns.
- Sorting.
- Washing.
- Reverse transport.
- End of life.

For each stage, the cost and investment modeling approach is described, alongside key assumptions and their potential impact on the overall cost results. Some of the estimated costs to achieve the source reduction requirements do not necessarily represent additional costs to companies, rather they represent costs that need to be strategically reallocated towards source reduction. For example, businesses are regularly updating their product lines and conducting R&D to design new types of goods and packaging. Costs associated with R&D and updating product lines specifically for source reduction could be integrated into existing budgets.

Unless otherwise stated, the general method used to calculate costs is the same for packaging and food service ware, while data and assumptions feeding into these methods vary based on the strategy in question.

Outreach

Outreach includes actions such as onboarding businesses, managing partnerships, and running campaigns to encourage consumer participation and proper return behavior.

These actions can help transition businesses using single-use plastic B2B packaging (e.g., restaurants, supermarkets) or using single-use plastic food service ware with on-premises dining to reusable or refillable alternatives.

Table 7-2: Cost Scope of Outreach Modeling

Cost type	Cost scope
OPEX	Labor associated with outreach, training
CAPEX	None

The contractor developed a simple bottom-up model to estimate the costs of outreach, based on the estimated number of businesses in California that were estimated to shift to reusables, the number of hours of outreach assumed per business, and the estimated hourly cost of this outreach.

It was assumed that these businesses are engaged every year, and therefore the extent of this action (and the associated investment costs) does not depend on the market penetration of the reuse strategies.

There are significant uncertainties in this cost associated with each of the assumptions described, meaning it is difficult to state the administrative costs of onboarding businesses for reusable food service ware and prefilled packaging with a high degree of confidence.

In particular, the success rate of outreach is not known. A high success rate – which could be driven through financial or other incentives, and high quality, targeted training – would result in fewer businesses needing engagement. This study has assumed that one in every four businesses is successfully onboarded to a reuse system, regardless of whether that business is also a producer. This assumption is not critical to overall system costs, as onboarding is estimated to account for just over 1% of overall annual costs.

Costs could be reduced by targeting certain businesses, such as chains, more centrally. For example, education, branding, procurement, and staff training in reuse systems could be organized and implemented by central management of businesses that have multiple locations, potentially reducing the outreach burden.

Research and Development (R&D)

R&D involves actions such as designing durable, attractive, and functional reusable packaging. The contractor assumed no R&D is required to produce reusable food service ware formats as these are widely available and used. Companies will conduct material selection and testing to ensure the chosen resin meets performance, barrier, and sustainability requirements. Design and prototyping may be carried out, often using computer-aided design tools and rapid molds to validate functionality and aesthetics. R&D also includes testing materials for longevity, and safety, particularly in a food-contact context. More sophisticated R&D could aim to develop tracking or smart tech for inventory and return logistics. Once approved, tooling and mold development begins, which can be costly and time-intensive for injection or blow molding processes.

Table 7-3: Cost Scope of R&D Modeling

Cost type	Cost scope
OPEX	None
CAPEX	Upfront costs of designing new packaging*

* In a formal sense, R&D does not typically fall into CAPEX accounting. It is treated as CAPEX in this analysis as, similarly to other CAPEX categories, it is an upfront cost that will not need to be incurred every year.

The contractor built a simple bottom-up model of the costs of reusable packaging R&D. This model estimates the number of new reusable packaging designs that will be created as a function of the number of goods categories switching to reuse, and the extent of pooling (or shared packaging design/infrastructure). These latter are themselves a function of the market penetration of the reuse strategies, meaning investment costs for R&D increase with increasing use of prefill B2B packaging.

The following assumptions were used:

- Twelve designs per function cluster switching to reusable formats (based on the number of bottle designs in Germany's reusable water bottle system.)
- Each new packaging design costs $100,000.[22]

The degree to which different brands in reuse systems share packaging designs is referred to as system harmonization. The greater the system harmonization, the fewer packaging designs per type of good. The system modeled here, in which each type of good (i.e., function cluster) is sold in 12 different reusable packaging formats, represents somewhere between a harmonized and fragmented system. The estimated impact of the system moving more toward either a harmonized or fragmented system could decrease or increase OPEX by 5 to10%, although this range is itself highly uncertain (see Section 9.0).

R&D cost savings through system harmonization are relatively small as a function of total system cost. Reducing the number of designs per function cluster from 12 to four is estimated to reduce total system CAPEX by less than 2%.

Beyond reducing R&D costs, system harmonization has downstream effects for the entire reuse system:

- Fewer packaging designs means less sophisticated sorting equipment may be needed, and storage space at sorting and washing hubs can be used more efficiently.
- Greater system harmonization means that a unit of packaging or food service ware can be used by more system actors. This means that forward transportation can be optimized, as units can be transported to the nearest applicable filling site or distribution center.
- Less packaging headroom may be needed. Headroom is the extra packaging and food service ware needed to compensate for seasonal variations in consumption, and the amount of time units spend with the user or in transit (see the Manufacture section). The quicker packaging is returned by the user into the system, the quicker it can be washed and reused, and therefore the fewer units are needed in reserve. Conversely, packaging which is held by the user for extended periods of time (for example, longer-lasting food goods like cooking oils) requires a greater packaging headroom. As system harmonization increases, less packaging headroom may be needed. However, headroom requirements are a function of several factors (some of which are listed), and therefore it was not possible to confidently estimate cost savings.

The impact of these assumptions is discussed in the following subsections as applicable, and in Discussion and Limitations in Section 9.0.

Manufacturing

This stage involves the production of reusable packaging units, such as containers, bottles, or wraps, designed for multiple use cycles. Actions for manufacturers may include adjusting production line configurations, including machinery settings, extrusion or molding parameters, and quality control systems. Additional steps include regulatory compliance checks for food safety or other standards, and supply chain coordination to source raw materials and integrate new packaging into distribution.

Depending on the format and resin used, various types of processes may be involved in manufacturing, which typically include:

- Extrusion.
- Injection molding.
- Extrusion blow molding.
- Thermoforming.

The cost of manufacturing both single-use plastic packaging and reusable packaging is driven by material/input, labor, and energy costs. The modeling of this step captures that less packaging and food service ware is manufactured when switching systems to reuse.

Modeling the net costs of reusable packaging and food service ware manufacturing involves comparing the costs of manufacturing reusable packaging to its single-use plastic packaging counterpart as follows:

- Calculating the number of units of single-use plastic packaging and reusable packaging of each format that are manufactured in each pathway year.
- Modeling the unit costs of manufacturing each plastic format including material, labor, energy, and transport.
- Multiplying the unit costs by the number of units of each format to get the total net cost.

Table 7-4: Cost Scope of Reusable Packaging Manufacturing Modeling

Cost type	Cost scope
OPEX	Net cost of manufacturing reusable plastic packaging and food service ware, including material, labor, and energy input costs*
CAPEX	None

* The purchase of reusable packaging by a system operator may be considered a CAPEX. However, manufacturing costs are considered an OPEX in this study as they are a function of factors more typically considered as OPEX (e.g., labor, energy, materials).

The total number of units of single-use plastic packaging and reusable packaging or food service ware that are estimated to be transitioned is a function of:

- The number of goods/meals consumed in California in closed-loop settings, adapted from the SRB.
- The proportion of closed-loop food service ware switching from single-use to reusable formats (see Switching from Single-Use Plastic Covered Material to Reusable Formats).
- The proportion of units that are lost from the system each year, the inverse of system return rates (return rate assumptions and sources are shown in Appendix F, Table F-56).
- The headroom requirements (Appendix F, Table F-57) of the system.

Trade data suggest that the majority of finished plastic products used in the US are produced domestically (about $300 billion per year of domestic manufacturing[23] versus about $80 billion of imports[24]). As imports come from dozens of countries, the contractor made the simplifying assumption that all manufacturing of plastic packaging and food service ware is done in the U.S.

This assumption is likely to have a small impact on overall cost results, as just 20% of material is imported. Further, manufacturing costs have a relatively small impact on the net costs of the system. If packaging manufacturing costs for this 20% of material per ton were doubled, final system costs would change by just 1%.

The contractor modeled single-use plastic packaging unit and reusable packaging unit manufacturing costs including feedstock costs (Appendix F, Table F-54), manufacturing energy requirements (Appendix F, Table F-55), labor costs, and transport costs.[25]

Forward Transport

New reusable packaging and food service ware must be transported to the point of consumption. Forward transportation is defined in this study as any outbound transportation from a distribution center to the point of sale.

The contractor included estimated changes in forward transport costs due to changing plastic weight only, for what is typically the final transportation leg, from the distribution center to the supermarket. No changes to transport distance, or logistics efficiency were considered as it is not possible to reliably predict the effects of switching to reuse at this point. This approach was taken due to the significant uncertainty associated with forward transport impacts. In particular, the packing and filling efficiency (which cannot feasibly be predicted) is a significant factor in the per unit costs of logistics. Additionally, route efficiency, for example, the number of deadhead (empty) miles made per journey, affects transporting costs.

This model estimates changing forward transportation OPEX as a function of the total packaging material weight, an estimated transport distance of 200 miles (based on the average transportation distance between distribution center and supermarket in the U.S.)[26] [27] and an average freight cost of $0.27 per ton-mile.[28] The contractor assumed that transportation is executed by a third party, and therefore costs to the system fall under OPEX. Alternatively, a system operator could purchase and maintain its own logistics system, which would result in higher CAPEX but lower OPEX.

Table 7-5: Cost Scope of Forward Transportation Modeling

Cost type	Cost scope
OPEX	All logistics OPEX including labor, fuel, and taxes
CAPEX	None

Packing/Filling

This step involves preparing and filling reusable packaging with goods before distribution. Note that this step is not relevant for food service ware, which does not come into contact with the product until the point of consumption. The process may include container rinsing, which is separate from the more comprehensive cleaning and sterilization covered in the washing step, automated or manual filling, sealing, and labeling.

If reusable packaging is not already compatible with existing filling equipment, systems will need to be adapted to handle reusable formats. Correct packing also ensures the integrity of the good during forward transport and enhances the user experience.

Two key assumptions were made in this modeling:

- Any goods switching from flexible single-use packaging to (rigid) reusable packaging would require the construction of a new filling line.
- Any goods switching from rigid single-use packaging to (rigid) reusable packaging are likely to stay in largely the same format. For example, liquid oils sold to restaurants in single-use bottles are assumed to be sold in reusable bottles of a similar size and shape when switching to the prefill B2B model. This means that there are significantly less new machinery and infrastructure needed to facilitate this switch.

Table 7-6: Cost Scope of Packing/Filling Modeling

Cost type	Cost scope
OPEX	Operational expenditure associated with transport, not distinguishing between any constituent factors
CAPEX	None

The contractor modeled the new filling line capacity under each pathway, based on the annual demand for each reusable archetype and the typical filling speed of a line. The typical operating efficiency (i.e., the proportion of time that the line is filling versus downtime or maintenance) is also considered, and it is assumed that the filling lines operate three shifts of eight hours, seven days per week.

A new filling line, designed for a new packaging format, is assumed to include a new filling machine ($9 per unit/hour[29]), a labeling machine ($10 per unit/hour, per the same source), a case packing machine ($32,000 per line, per the same source), and a new conveyor system ($110,000 per line[30]).

This model is conservative, as in many cases existing machinery can be repurposed for new formats, reducing the need for new machinery which reduces costs. However, this stage accounts for a very small proportion (less than 1%) of system CAPEX, so final results are not sensitive to this assumption.

Returning Packaging and Food Service Ware to the System

Infrastructure is needed to collect reusable packaging and food service ware and prepare it for transport to washing facilities. The nature of this infrastructure can vary widely depending on the system design and level of technological integration. In more advanced systems, particularly open-loop or consumer-facing models, infrastructure may include automated return technologies, such as reverse vending machines or smart bins that enable packaging to re-enter the reuse cycle.

In contrast, closed-loop reusable food service ware systems and B2B prefill models typically require less complex infrastructure. Because packaging remains within a controlled environment, such as a school, stadium, or commercial kitchen, collection is more straightforward. Items are not dispersed into the general waste stream, reducing the need for consumer-facing return points or sorting technologies.

Drawing on existing systems, the contractor assumed that reusable tertiary packaging (e.g., tote boxes) used to deliver goods can also serve as the return infrastructure. In this model, used food service ware items are placed directly into these containers after use. The tote boxes can then be loaded into vehicles for reverse transport without requiring additional capital investment in dedicated return bins or collection stations.

This approach offers operational simplicity and cost efficiency. Since the same containers are used for both delivery and collection, there is no need for separate infrastructure or handling equipment. However, it does rely on consistent user behavior and staff oversight to ensure that returned items are properly placed and not contaminated with other waste.

To maintain hygiene and system integrity, staff time is required to perform an initial sort of the returned items. This includes removing nonreusable packaging, checking for damage, and preparing units for transport. These labor costs should be included in OPEX models, alongside transport and washing costs.

Overall, the infrastructure model for closed-loop reusable food service ware systems emphasizes reuse not only of packaging but also of logistical assets. By minimizing additional CAPEX and streamlining collection, it supports scalable and cost-effective deployment of reuse systems in institutional settings.

Table 7-7: Cost Scope of Returns Modeling

Cost type	Cost scope
OPEX	Labor
CAPEX	None*

* The costs of the tote boxes and other reusable archetypes used to collect and transport reusable food service ware and packaging are included in the ‘Manufacture’ section.

The contractor estimated the staff costs required for this process based on the following process:

- Calculating the number of each reusable packaging or food service ware format that can be stored in a tote box (assuming messy, nonstacked items, which is a conservative assumption, reducing the amount of staff time required to sort at a business).
- Calculating the total number of tote boxes used for returns and reverse transport.

- Based on the contractor team’s experience advising businesses on staff training for reuse systems in restaurants, it was assumed that a staff member at each business spends three minutes on an initial sort to remove conspicuous contamination.

The amount of staff time required to prepare items for reverse transport will vary depending on the amount of contamination, particularly in a food service ware setting. One of the most effective ways to reduce contamination is through clear user guidance and signage. When users understand what can and cannot be returned, and how to do so correctly, error rates will fall. This includes visual instructions at return points, color-coded bins, and simple messaging that distinguishes reusable items from disposables. In institutional settings, like schools or stadiums, staff training and public announcements can reinforce proper return behavior.

Packaging design also plays a role. It may be most effective if reusable items are easily distinguishable from single-use alternatives, through shape, color, branding, or embedded identifiers like QR codes or RFID tags (these costs would fall into manufacturing). This helps users and staff quickly identify compliant items and reduces the likelihood of contamination. Some systems also use smart bins that scan items before accepting them, rejecting anything that doesn’t match the expected format.

Return infrastructure can be optimized to reduce contamination. For example, having separate bins for food waste and reusable items encourages proper disposal. In some systems, reusable containers are returned with lids on to prevent residual food from leaking or attracting pests. Centralized collection points with staff oversight can further reduce contamination, especially in high-volume environments.

Sorting

Packaging and food service ware is sorted, either before or after it is washed and checked, to ensure that it is returned into the correct system and back to the correct user. Sorting should also remove any contamination (i.e., food and other waste) and remove packaging and food service ware that is no longer safely reusable.

Table 7-8: Cost Scope of Sorting Infrastructure Modeling

Cost type	Cost scope
OPEX	Energy, labor, rent
CAPEX	New machinery

As described, the contractor assumed that there is an initial sorting stage performed immediately after the packaging/food service ware is used (removing contamination). The sorting stage considered here is a more sophisticated process to further remove contamination and separate different items into appropriate streams.

The contractor estimated sorting infrastructure needs, CAPEX and OPEX via the following key assumptions:

- All sorting capacity is new and additional to today's system.
- Each sorting line requires roughly 220,000 square feet of space (the majority of which is for storage at the front and back ends)[31].
- Sorting takes place in rented industrial space, which does not require significant mechanical, electrical, or plumbing upgrades, and therefore fit out costs are minimal.
- A sorting line can sort 10,000 units per hour.[32] Sorting lines can operate more quickly than this, but the contractor reduced this value to account for a mixture of larger B2B packaging, which cannot be fed through the lines as quickly.
- The operating efficiency (i.e., the proportion of time that the line is sorting versus downtime, or maintenance) is 90%,[33] and it is assumed that the sorting lines operate three shifts of eight hours, seven days per week.
- Each sorting line always requires one person for loading and one for unloading. One FTE is also required for management, administrative, and ancillary roles.

Table 7-9: CAPEX and OPEX Per Sorting Line[34]

Cost Category	CAPEX ($)	OPEX ($/year)
Conveyor system	$110,000	
Sorting machine	$190,000	
Rent		$276,676
Staff		$2,407,861
Total	$300,000	$2,684,536

Washing

Packaging and food service ware must be appropriately washed, sanitized, and inspected. This is especially critical in a food-contact setting. The process typically includes prerinsing, washing, sanitizing, and drying stages, with quality control checks to ensure cleanliness and integrity.

Table 7-10: Cost Scope of Washing Infrastructure Modeling

Cost type	Cost scope
OPEX	Energy, labor, rent, water, caustic solution
CAPEX	Washing and drying machinery, industrial space refit

Washing facilities are designed to handle high volumes of items with varying shapes and materials, using automated systems that combine water, detergents, and sanitizers to meet health standards.

The contractor assumed that, in both prefill B2B and closed-loop reusable food service ware systems, washing happens centrally at a wash hub and not at the location where the packaging or food service ware is used (the logistics implications of this are covered in Reverse Transport).

This is a conservative assumption in terms of closed-loop reusable food service ware OPEX, as washing is more likely to happen on-site for closed-loop systems.

This service model is attractive to businesses without the space for dishwashing equipment and means businesses do not have to purchase any food service ware up front. Nonetheless, there are likely to be businesses that choose to wash food service ware on-site as this may save costs in the long run. It is difficult to predict the effect of this assumption on total costs, as while reverse logistics costs may be overstated, a more distributed system in which individual businesses wash their own equipment is likely to be less efficient, requiring more equipment, energy, and staff resource per unit washed.

Washing is assumed to be collocated with sorting, at sorting and washing hubs. There is interplay here between the number of hubs built in California and the typical transport distance:

- At one end of the spectrum, the system could rely on a small number (e.g., 1-10) of large sorting and washing locations in the state. The average reverse transport distance will be higher, but fewer construction projects would be needed. Larger industrial spaces tend to be cheaper per unit than smaller ones, meaning this is a lower CAPEX/higher OPEX system.
- Conversely, there could be many smaller sorting/washing hubs, which would mean that the average distance from the point of use to the washing hub is lower but, all else being equal, probably require greater CAPEX. There are also complexities related to financial risk of many small wash hubs versus fewer large wash hubs. These considerations are outside the scope of this study.

Costs are modeled based on the total number of units of packaging and food service ware washed each year and the typical capacity of an industrial washing line. The following key assumptions are made:

- Each sorting line requires roughly 220,000 square feet of space (the majority of which is for storage at the front- and back-ends).[35]
- Each washing line requires a washing machine, a loading machine, and an unloading machine (each requires one human operator). The contractor obtained this information in interviews with packaging wash hub operators outside the scope of this study.
- The capacity of each line is 8,000 containers (including packaging and food service ware cups, trays, and containers), or 16,000 units of food service ware such as cutlery, per hour.
- There are five washing lines per site.

- Wash hubs are built in rented industrial space. As a result of the significant amount of electricity and water needed for industrial washing, upgrades to the buildings' mechanical, electrical, and plumbing systems are needed at a cost of $430 per square foot.[36]

Reverse Transport

Reverse logistics includes the collection and logistics systems to return used packaging and food service ware, so that it can be prepared for another use cycle. Where possible, it may be most effective to leverage existing delivery routes to retrieve used containers, reducing additional transport costs and emissions.

The costs and investments required for reverse logistics will vary significantly as a function of system design. As no information is currently available about how reuse requirements will likely be met, it is not possible to determine the most likely reverse transportation requirements.

Therefore, the contractor took a conservative approach in assuming that all reusable packaging and food service ware requires transportation before it is washed: a worst-case scenario in which there are more additional costs than might be incurred in a better designed, more efficient system. The contractor made this choice to understand the likely higher end of costs associated with closed-loop reusable food service ware and prefilled B2B packaging. The impact of this assumption is discussed in Discussion and Limitations in Section 9.0.

The contractor assumed that transportation is executed by a third party, and therefore the costs to the system fall under OPEX. Alternatively, a system operator could purchase and maintain its own logistics system, including trucks, which would result in higher CAPEX but lower OPEX.

Table 7-11: Cost Scope of Reverse Transportation Modeling

Cost type	Cost scope
OPEX	Operational expenditure associated with transport, not distinguishing between any constituent factors
CAPEX	None

The contractor built a reverse logistics model including the following transport stages:

- Leg 1: Transportation from the point of sale to a distribution center. This is the reverse of the journey made as part of forward transportation.
- Leg 2: Transportation from the distribution center to the local sorting and washing hub (sorting and washing are assumed to be collocated, as this is logical from an economic perspective). Any further transportation, for example from the sorting/wash hub to the filling site, falls under forward transportation.

For Leg 1, the same assumptions are used to calculate forward transport costs. A 200-mile average distance between point of consumption and distribution center.

Leg 2 follows a more sophisticated logistics model. This model estimates the average distance that each unit of food service ware or packaging must be transported by:

1. Estimating how many sorting/washing hubs are needed as a function of the market penetration of reusable food service ware and prefill B2B packaging, and a set capacity for a sorting/washing hub (see the Washing section).
2. Placing each sorting/washing hub into one of California's Combined Statistical Areas (CSA, see Appendix F, Table F-59) as a function of the proportion of the state's population in that CSA. No assumption is made about where specifically within the CSA the sorting/washing hub is.
3. Assuming that packaging/food service ware leaving a distribution center will be transported to a sorting/washing hub in the same CSA. This is possible because there is at least one sorting/washing hub in each CSA.
4. Calculating the maximum possible distance between two points within a CSA. This is the maximum distance that packaging or food service ware could be transported between a distribution center and a sorting/washing hub in this model and is therefore a conservative assumption.

The contractor applied the same $0.27 per ton-mile assumption to the Leg 1 and Leg 2 reverse logistics distances to calculate total OPEX for reverse logistics.

End of Life

Reusable packaging and food service ware reaches the end of its life through two main channels:

- Once it has been inspected (either manually or automatically) and deemed to be incapable of being reused.
- Through leakage, i.e., when it is incorrectly removed from the system through disposal. Littering is a common problem in open loop and B2C systems but is not considered here as items will not generally leave the closed loop environment.

In both cases, there are costs associated with end-of-life treatment. The contractor built a model of these costs that includes transportation, tipping fees, landfills, and recycling costs. California-wide 2023 recycling rates are assumed.[37]

Other Source Reduction Strategy Modeling

This section describes the actions to implement source reduction strategies and the modeling carried out to establish costs and investments focused on delivery of the pathways presented in Section 6. The source reduction strategies included in the pathways presented include lightweighting, material substitution, and elimination.

Action and Investment Model Methods

Investments for other source reduction strategies depend on actions implemented, which are in turn a function of the strategy itself. For example, lightweighting costs include both the cost of adapting production lines and the financial savings from reduced material use.

Pathway costs associated with investment in other source reduction strategies are driven by four main actions:

1. Packaging redesign.
2. Tooling equipment.
3. Marketing and commercial.
4. Material and feedstock.

Each of these actions is required under each nonreuse source reduction strategy, but the extent to which they are required, and the associated costs, vary. Each action's cost modeling is described in the following subsections.

Packaging Redesign

Each strategy requires design and engineering work to validate the structure, performance, and usability of the new packaging or food service ware, after the strategy has been applied. Lightweighting and right sizing mainly involve geometric changes, so redesign costs are lower, while concentration and material substitution demand full-format redevelopment.

Redesign costs for each format cluster scale with the degree of redesign and testing required to ensure durability and regulatory compliance.

Table 7-12: Cost Scope of Packaging Redesign Modeling

Cost type	Cost scope
OPEX	None
CAPEX	R&D, staff, sourcing, testing, and agency costs associated with producing and rolling out new packaging design. Packaging design will typically be included in an organizations OPEX accounting. However, redesign in the context of these pathways are one-off, upfront cost requirements and are therefore treated as CAPEX here.

The methodology for estimating packaging redesign costs relied on expert judgment informed by previous projects across a wide range of format clusters. Cost ranges were developed for three packaging manufacturer sizes, small, medium, and large, reflecting typical redesign tasks such as structural adjustments, artwork and label updates, performance validation, and compliance reviews. These per-company estimates captured expected levels of effort based on realistic implementation patterns, drawing on evidence from past redesign activities rather than theoretical benchmarks.

To generate system-level cost estimates, the analysis applied a proportional allocation based on the distribution of tonnage changes across packaging manufacturer sizes. Because large manufacturers account for most of the packaging tonnage within each format cluster, they were assigned the greatest share of redesign activity and associated expense. Medium manufacturers contributed a smaller proportion, and small manufacturers contributed the least. Cost estimates for each manufacturer category were then calculated according to this distribution, so that total redesign investment reflects both the underlying cost ranges and the relative influence of each group on material throughput.

Tooling and Equipment

Tooling refers to the equipment needed to manufacture and fill (if relevant) the packaging/food service ware. Tooling CAPEX investments vary by strategy. Lightweighting and right sizing generally need modified molds. Elimination and large-format packaging may require new filling or capping tools. Material substitution and concentration can necessitate new lines. Equipment upgrades represent major CAPEX, but unlock longer-term material and efficiency savings.

Table 7-13: Cost Scope of Tooling and Equipment Modeling

Cost type	Cost scope
OPEX	None*
CAPEX	Changes to filling lines, molds, tooling for new packaging; in some cases, entirely new packaging lines.

* OPEX may change as a function of production speed, energy requirements and labor. However, these changes are extremely hard to predict and are not modeled here.

Cost estimation for tooling and equipment changes followed a structured process grounded in expert insight from past capital and line-modification projects across different format clusters. Experts defined indicative cost ranges for small, medium, and large manufacturers covering common activities such as mold or die modifications, tooling replacements, line adjustments, trial runs, and commissioning. These estimates reflected typical upgrade pathways, often incremental rather than full equipment replacement, and were informed by real project data from various manufacturing environments.

To translate these per-manufacturer costs into market-level outcomes, the analysis used a proportional tonnage-based allocation. Large manufacturers, responsible for most of the packaging tonnage within format clusters, were assigned the largest share of activity and cost. Medium manufacturers comprised a smaller share, and small manufacturers represented the smallest portion of total tonnage affected. This allocation ensured that system-wide tooling and equipment costs align with how material flows are distributed across the producer base. The resulting estimates combine manufacturer-specific cost ranges with a realistic weighting of each group’s contribution to total tonnage changes.

Marketing and Commercial

Packaging changes affect branding, on-shelf communication, and perceived value. Strategies like elimination or right sizing require messaging to preserve trust. Concentration and material substitution demand education around new formats or materials. Marketing costs cover artwork, claims substantiation, and campaigns supporting consumer transition to plastic source reduced products. These costs were assumed to require ongoing expenditure and are therefore OPEX.

Table 7-14: Cost Scope of Marketing and Commercial Modeling

Cost type	Cost scope
OPEX	Cost of advertising, especially where the product appearance has changed (right -sizing, concentration, material substitution)
CAPEX	None

Marketing and commercial cost estimates were developed using expert opinion derived from previous packaging transitions and product-line changes across format clusters. Experts provided cost ranges for small, medium, and large manufacturers covering tasks such as label revisions, product-line communication, retailer coordination, SKU management, and updates to promotional or commercial materials. The ranges also incorporated typical downstream adjustments, including price-file updates, customer notifications, and changes to distribution or logistics documentation. These estimates reflect established industry practices and the expected scale of effort for different manufacturer sizes.

To produce system-level estimates, the methodology distributed activity and cost in proportion to the share of tonnage changes attributed to each manufacturer size. Large manufacturers, responsible for the majority of packaging tonnage, accounted for the greatest share of marketing and commercial adjustment. Medium manufacturers accounted for a smaller proportion, followed by small manufacturers with the lowest share. The proportional approach ensured that total cost calculations reflect both the size-specific cost differences and the concentration of tonnage changes among larger manufacturers. This provides a realistic estimate of overall marketing and commercial impacts across format clusters.

Material and Feedstock

Source reduction strategies change the total weight and type of different materials being used for single-use plastic covered material. Feedstock OPEX reflects the related financial changes of purchasing input material.

Lightweighting, right sizing, concentration, large format packaging, and elimination all lower total plastic use per unit of consumption, and therefore net feedstock OPEX under these strategies is negative. Material substitution will reduce the feedstock OPEX spent on plastic, but net OPEX may increase due to expenditure on other materials.

Table 7-15: Cost Scope of Material and Feedstock Modeling

Cost type	Cost scope
OPEX	Changes in material costs
CAPEX	None

The methodology for assessing material and feedstock costs relied on expert evaluation of procurement and reformulation activities associated with source reduction strategies across format clusters. Experts identified typical cost ranges for small, medium, and large producers undertaking changes such as resin substitution, lightweighting, barrier adjustments, supplier qualification, and specification testing. These ranges incorporated the expected level of technical support, quality validation, and trialing required for each producer size, drawing from experience with previous material-change projects.

To develop market-wide estimates, the analysis allocated costs in proportion to the tonnage changes attributed to each manufacturer category. Large manufacturer, representing the majority of packaging tonnage across format clusters, carried the largest share of activity and cost. Medium manufacturers accounted for a smaller share, and small manufacturers the least. This allocation ensured that total material and feedstock-related costs reflect the true distribution of affected tonnage rather than treating all manufacturers equally. The resulting estimates combine manufacturer-level cost structures with realistic weighting across the manufacturer population.

8.0 Actions and Investments to Achieve Source Reduction Pathways

Introduction

The objective of this section is to present the actions and the related system-wide investments associated with Pathway A and Pathway B. The first subsection compares overall pathway CAPEX and OPEX results, summed across all source reduction strategies. The following subsections then describe the detailed actions and investment for reuse and other source reduction strategies, respectively.

As described in Calculation Methodology for Actions, Costs and Investments in Section 7.0, the contractor has made assumptions reflecting the ways that source reduction requirements will be met. However, it is not possible in every case to anticipate how reuse and other source reduction strategies will be met. In these cases, the contractor has made assumptions that it considers to be realistic but conservative. The impact of the assumptions on the cost results is discussed in Discussion and Limitations.

As described in Section 7.0, the costs presented here are overall system costs. They do not reflect costs to any particular producer or other system actor. The investments that are likely required can spur innovation, resulting in new or existing companies making investments due to profitability of their implementation. For example, current co-packing facilities could upgrade their facilities to include washing operations to allow for new business opportunities for those facilities. Individual producers could also generate financial savings by switching to reuse systems and avoiding EPR fees for that material, however, those savings are not considered.

Additionally, the estimated costs to achieve the source reduction requirements do not necessarily represent additional costs to companies, rather they represent costs that need to be strategically reallocated towards source reduction. For example, businesses are regularly updating their product lines and conducting R&D to identify new formats for goods and packaging. Costs associated with R&D and updating product lines specifically for source reduction could be integrated into existing budgets.

Summary of Investments

This section presents the overall investment requirement profiles for Pathway A and Pathway B. The estimated cumulative investments were estimated to be $8.2 billion in Pathway A and $15.4 billion in Pathway B. OPEX spending is the dominant factor in both pathways, with OPEX accounting for roughly 90% of costs in Pathway A and 89% in Pathway B.

This section also shows combined cumulative CAPEX and OPEX for each pathway and compares the costs of the two pathways. The CAPEX are cumulative, up to (and not including) the dates shown. This is because CAPEX must be spent before the start of the year for the requirement to be achieved. Conversely, OPEX spending is shown on an annual basis, because OPEX is spent in the year of the requirement.

Pathway A and Pathway B share some similar characteristics:

- Reuse strategies dominate CAPEX.
- OPEX dominates cumulative costs.

Pathway A

Pathway A focuses on:

- Closed-loop reusable food service ware and prefill B2B packaging to reach reuse requirements.
- Material substitution and lightweighting for other source reduction requirements.
- Recycled content via the alternative compliance mechanism.

Figure 8-1 shows cumulative CAPEX investment required in Pathway A from 2025 to 2031, to meet reuse and other source reduction requirements. Pathway A has estimated cumulative CAPEX investment of $390 million before 2027, $670 million before 2030, and $980 million before 2032. Note, all costs in this section are linearly interpolated between requirement years.

Reuse strategies dominate the CAPEX requirement in Pathway A, accounting for two-thirds of cumulative CAPEX to achieve the 2032 requirement. Pathway A relies largely on closed-loop reusable food service ware to achieve the 2027 and 2030 reuse requirements, requiring $190 million and $340 million cumulative CAPEX, respectively.

It was modeled that relatively little CAPEX is spent on the prefill B2B strategy before 2030, at which point $340 million is required jointly across 2030 and 2031. The remaining investments are needed across material substitution, lightweighting and alternative compliance through PCR.

Material substitution and lightweighting dominate other source reduction CAPEX, combining for a required $200 million investment before 2032. Alternative compliance through PCR is estimated to require $25 million.

Pathway A requires rapid investment of CAPEX during 2026 to achieve the 2027 requirement.

Figure 8-1: Cumulative CAPEX Investment Profile in Pathway A (Cumulative Spend Up to And Including the Year Shown)

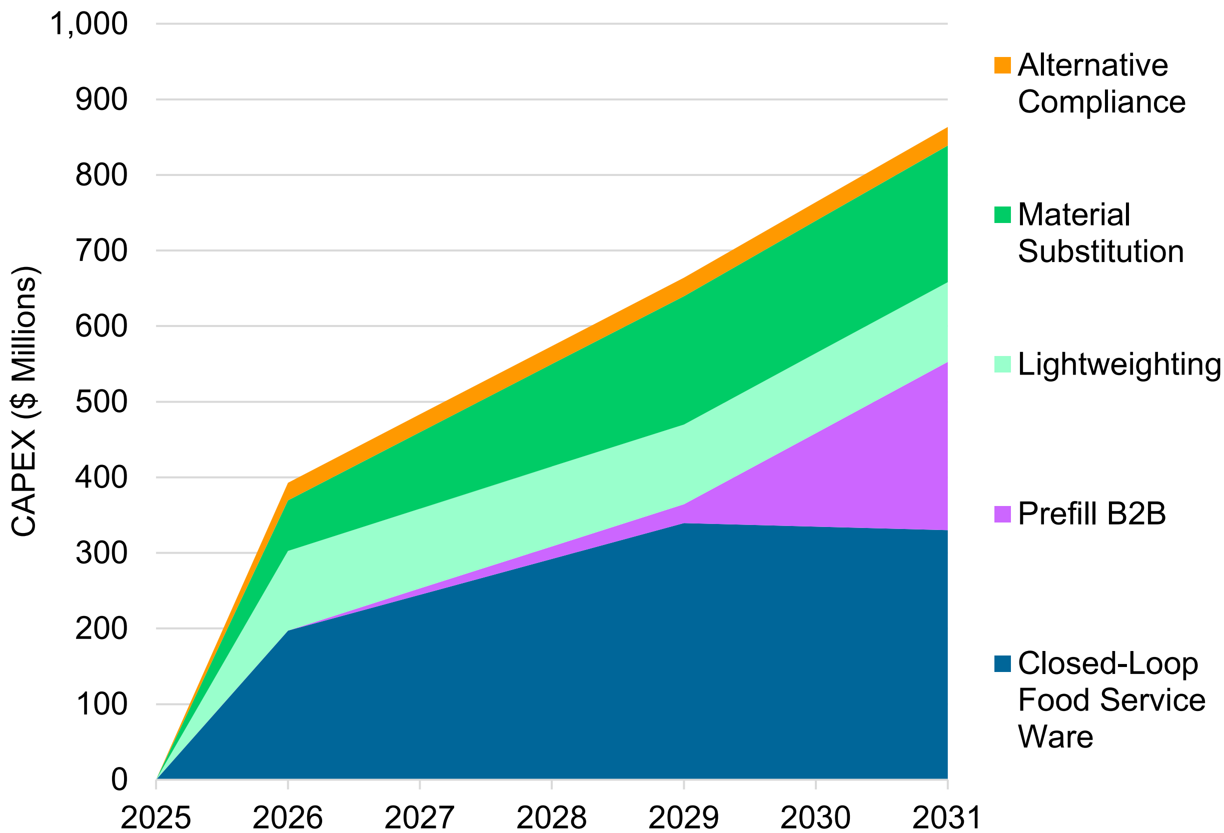
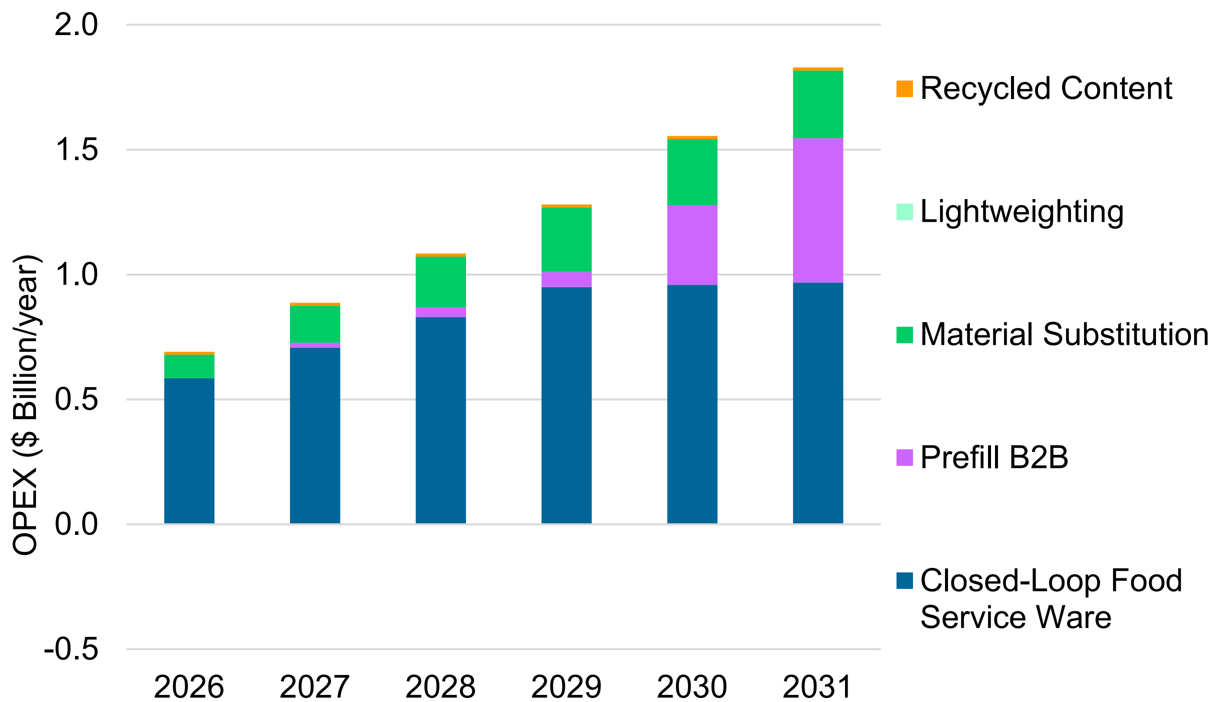


Figure 8-2 shows net system OPEX in Pathway A, with $690 million of OPEX estimated during 2026, $1.3 billion during 2029, and $2.3 billion in 2031.

As with CAPEX, OPEX in Pathway A is dominated by reuse strategies. Closed-loop reusable food service ware was modeled to ramp up rapidly, requiring $590 million to be spent in 2026. The rollout of closed-loop reusable food service ware then slows, requiring $970 million per year to be spent in 2031. Conversely, OPEX spending for prefill B2B packaging starts slowly but increases rapidly, requiring $1.1 billion per year to be spent in 2031. While these operational costs increase with the expansion of reuse and refill infrastructure, this will be accompanied by increases in local job opportunities given that washing and other collection infrastructure will likely be located close to where the items are reused. Additionally, as infrastructure, there may be opportunities for costs to be further minimized through further economies of scale.

Other source reduction costs are relatively small compared to reuse strategies. OPEX spending on material substitution dominates over the use of lightweighting and alternative compliance through PCR plastic.

Figure 8-2: Annual OPEX Spend in Pathway A (Spend in Year Shown)



Pathway B

Pathway B focuses on:

- Much higher reliance on closed-loop reusable food service ware and prefill B2B packaging to reach source reduction requirements.
- Material substitution and lightweighting for other source reduction requirements. Material substitution is utilized to a lesser extent than Pathway A.
- Recycled content via the alternative compliance mechanism.

Figure 8-3, shows cumulative CAPEX investment required in Pathway B from 2025 to 2031, to meet reuse and other source reduction requirements.

Reuse strategies dominate CAPEX in Pathway B, accounting for three-quarters of cumulative CAPEX. Pathway B relies largely on closed-loop reusable food service ware to achieve the 2027 and 2030 requirements, requiring $190 million and $590 million cumulative CAPEX, respectively. Relatively little CAPEX is spent on the prefill B2B strategy before 2030 ($110 million), at which point $700 million is required jointly across 2030 and 2031. The rest of the CAPEX is associated with lightweighting, material substitution, and alternative compliance through PCR.

Pathway B requires rapid investment of CAPEX during 2026 to achieve the 2027 requirement.

Figure 8-3: Cumulative CAPEX Investment Profile in Pathway B (Cumulative Spend Up to the Date Shown)

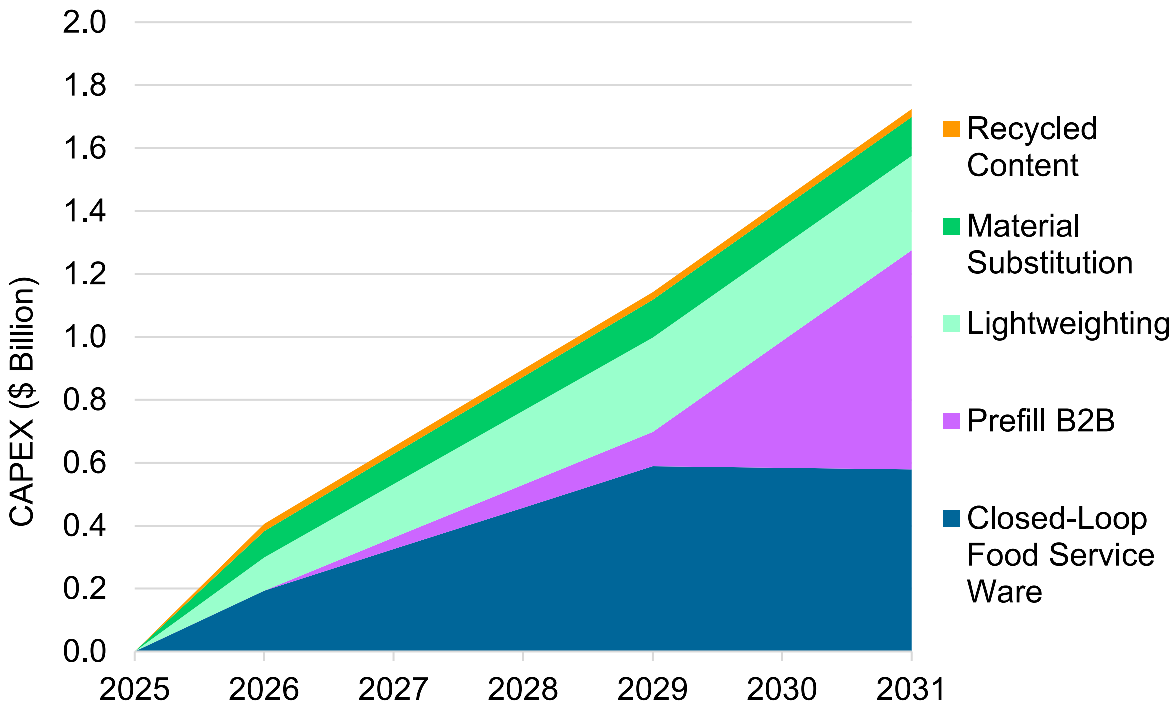
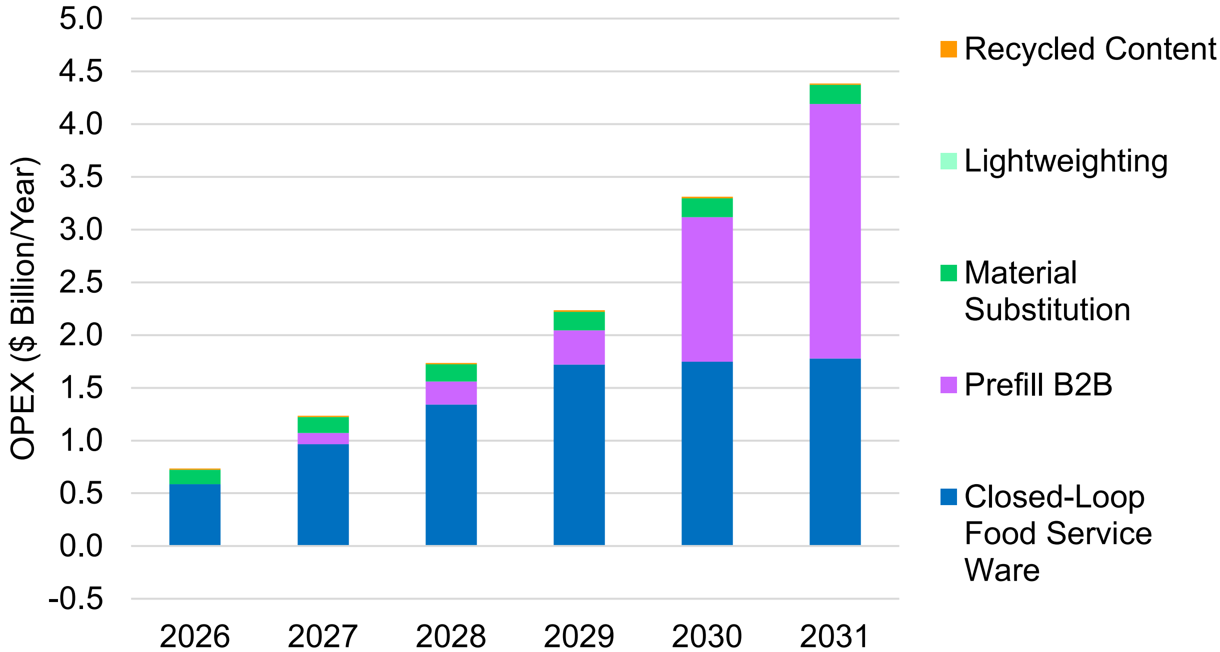


Figure 8-4 shows net system OPEX in Pathway B with $730 million OPEX estimated during 2026, $2.2 billion during 2029, and $4.4 billion in 2031.

As with CAPEX, OPEX in Pathway B is dominated by reuse strategies. Closed-loop reusable food service ware was modeled to ramp up rapidly, requiring an estimated $590 million to be spent in 2026. The rollout of closed-loop reusable food service ware continues rapidly, with the strategy associated with an estimated $1.7 billion per year in OPEX starting in 2030. OPEX spending for prefill B2B packaging was modeled to start slowly but increase rapidly, requiring $2.4 billion per year to be spent in 2032.

Pathway B explores the maximization of reuse strategies, leading to much less use of other source reduction strategies. This pathway relies largely on material substitution to achieve source reduction requirements, with OPEX spending on this strategy reaching $190 million per year in 2032.

Figure 8-4: Annual OPEX Spend in Pathway B (Spend in Year Shown)



Comparing Investment in Pathway A and Pathway B

Pathway A and Pathway B explore two different potential pathways for achieving the source, suggesting that, from a system-wide perspective, other source reduction strategies generally a less costly option based on current infrastructure. Reuse and refill strategies that do not require significant infrastructure investments (e.g., where the consumer manages the container) are also likely to be less costly.

When comparing the total cumulative CAPEX investment, Pathway A and Pathway B are both estimated to have costs in early years, however Pathway B is estimated to require nearly twice as much CAPEX as Pathway A. The findings are similar for OPEX.

Detailed Actions and Investments

The following subsections describe the detailed actions and investments modeled within each pathway. They show specific results underpinning the investment summaries shown in the previous section, broken out into reuse strategies and other source reduction strategies. The results and associated assumptions provide insight into the type of investments that are most likely to drive costs as well as opportunities, such as harmonization and standardization, to further reduce costs from what was modeled.

CAPEX results are cumulative and are modeled to be spent before the requirement year. For example, 2032 CAPEX values are assumed to be spent by the end of 2031. OPEX values are annual and are assumed to be spent in the year in which the requirements are achieved. Therefore, for example, the OPEX relating to the 2030 requirements must be spent in 2029.

Reuse Strategies

Outreach

The model included outreach and education to the businesses in California to encourage them to switch to either prefill packaging or reusable food service ware to ensure sufficient market penetration for reusable or refillable alternatives This includes any business involved in the use, sale, distribution, or importing of plastic covered material, and is not assumed to be limited to producers obligated under the Act.

Table 8-1 shows the estimated number of businesses that the contractor modeled would be contacted per year to encourage a shift to reusable and refillable alternatives with an assumed conversion rate of 25%. The actual number of businesses to be engaged is dependent on both the penetration of reuse, and the rate at which businesses convert to reusable or refillable alternatives.

Table 8-1: Estimated Number of Businesses Contacted Per Year in Modeled Pathways

Pathway	2026	2029	2031
Pathway A	23,000	42,000	46,000
Pathway B	23,000	78,000	89,000

Without knowing which tools and levers will be used to incentivize businesses, it is difficult to evaluate whether the 25% conversion rate is conservative. Greater uptake rates would mean fewer businesses need to be engaged and trained. However, outreach is not estimated to be a major driver of cost.

According to the assumptions and modeling, the onboarding of businesses as part of Pathway A would require between $10 million and $19 million per year and Pathway B would require $10 million and $35 million per year. Pathway B has higher costs due to higher modeled penetration of reuse and refill strategies.

The outreach strategies considered in these pathways are equally applicable to all businesses in the state regardless of location or other social factors. Outreach should ensure that opportunities to join reuse systems are therefore available to all relevant businesses (i.e., training should be available in multiple languages).

Research and Development

A key research and development action related to shifting to reusable or refillable alternative is designing new reusable packaging and food service ware items. Some types of covered material already have widely accepted alternatives (e.g., durable utensils to replace single-use utensils), while others will require further R&D.

The modeling estimated that both Pathways A and B would lead to the design of approximately 36 types of reusable packaging and food service ware in 2027, rising to 288 types in 2030. The cumulative estimated costs for this research and development were $4 million to meet the 2027 requirements, and $28 million to meet the 2030 and 2032 requirements.

One of the simplifying assumptions made in this study is that the number of designs needed is not a function of reuse penetration for any given type of good switching to reuse. The model depends not on the number of brands active in a reuse system (which is extremely difficult to estimate), but rather the number of clusters with some reuse market penetration.

The number of designs, and associated R&D CAPEX required, is likely to track with reuse market penetration. However, as R&D costs are relatively low, this uncertainty is not a key study limitation.

Manufacture

Reuse systems, especially when delivered at scale with high return rates, will significantly reduce the amount of plastic covered materials that need to be manufactured each year. The modeling estimated that overall need for manufactured plastic decreases as a result of source reduction strategies by as much as 105,000 tons per year in 2031 if the reusable alternatives are made of plastic or stainless steel (for some food service ware). If reusable alternatives are not made of plastic, this reduction would further increase.

In early years, the modeling estimated the annual OPEX costs could be as high as $100 million per year in 2029 for Pathway A and $150 million for Pathway B to manufacture reusable alternatives. However, as reuse and refill market penetration increases and systems start to mature, the reduction in plastic used drives OPEX savings, even when considering the high unit costs of reusable packaging. When 25% of plastic covered material has been replaced by reuse source reduction strategies, net OPEX savings in manufacturing (i.e., accounting for the costs of reusable packaging) could total nearly $100 million per year.

Manufacturing OPEX is not directly proportional to plastic savings, as this study has assumed some switching between plastic and stainless steel (for food service ware). It is hard to quantify the specific actions that must be taken to achieve this change, but they include changes to tooling, line design, and ensuring compliance.

Forward Transport

The modeling estimated the costs associated with forward transport of the reusable and refillable alternatives for both Pathway A and B. Both pathways start out with an estimated OPEX cost of $24 million in 2026, which increases to $72 million in 2031 for Pathway A and $190 million for Pathway B.

Packing/Filling

The key action modeled was developing new packing/filling lines (i.e., where a good is put into its packaging) for reusable and refillable alternatives. CAPEX is required for new packing/filling lines, when prefill goods are sold in different packaging formats from their single-use plastic alternatives. The modeling estimated that 39 new filling lines would be needed in Pathway A and 129 would be needed for Pathway B by 2031. For reference, there are approximately 600 beverage filling lines in California.[38]

Table 8-2: Estimated Cumulative Number of New Filling Lines (Up to and Including Year Shown)

Pathway	2026	2029	2031
Pathway A	0	1	39
Pathway B	0	12	129

The modeled CAPEX requirements are directly proportional to the penetration of prefill in the B2B sector in the pathways. Neither pathway modeled that prefill packaging would help achieve the 2027 requirements, thus no new filling lines (or CAPEX) are estimated in 2026. Prefill packaging was modeled to contribute a relatively small amount in 2030, requiring a single new filling line in 2029 for about $0.2 million cumulative CAPEX in Pathway A and 12 new filling lines at about $2.2 million. In 2032, prefill packaging is modeled to contribute much more in each pathway, with about 39 new filling lines in 2031 with an estimated cumulative CAPEX of $7.4 million in Pathway A. Pathway B, which has higher penetration of prefill packaging modeled, is estimated to require 129 new filling lines at a cumulative CAPEX of $24 million.

The results here are based on a model assuming a set of annual capacity for each filling line. In reality, demand could be met by a greater number of smaller filling lines, or vice versa, in response to the market demand for different format designs.

Brands could choose, particularly at lower volumes, to contract out filling of their products to copackers, who are typically more flexible in response to packaging format changes. This would serve to reduce the number of new filling lines that need to be built and minimize the associated filling infrastructure CAPEX. While this could increase system OPEX, it could facilitate faster rollout of reuse. Given the relatively small contribution of filling processes to CAPEX, this is not considered a key study limitation.

Returns

This study has assumed a simplified returns system requiring staff time at businesses to properly package returned packaging and food service ware before reverse transport. In Pathway A, OPEX was estimated to be $90 million for returns in 2026, increasing to $580 million in 2031 as the amount of reuse and refill increases. In Pathway B, OPEX was estimated to be $90 million for returns in 2026, increasing to $1.2 billion in 2031.

The results of the modeling reflect just one of many ways of dealing with returns. This could vary greatly because:

- The amount of staff time needed to ensure used items are correctly packaged and to remove excessive contamination is dependent on user behavior, which in turn is dependent on how easy the system is to interact with and how much guidance there is.

- The system could rely on more technologically advanced returns systems, which would require greater upfront investment, but less staff time and therefore less OPEX.

Given that the costs estimated here are very large, efforts should be made to estimate the costs in more detail in the future, when further details are available regarding reuse system designs. This is discussed further in Discussion and Limitations.

Sorting

The key action modeled was adding automated sorting lines to sort the millions of units of reusable packaging and food service ware before washing. The estimated number of sorting lines for each pathway (which are assumed to be collocated at wash hubs) is shown in Table 8-3. It was estimated that Pathway A would need 190 sorting lines in 2031 and Pathway B would need 360. The scale of these sorting lines can be contrasted with Quebec's goal to have 200 reusable beverage container return and sorting locations throughout the province, processing 5 billion containers per year.

Table 8-3: Cumulative Number of Sorting Lines (Up to and Including Year Shown)

Pathway	2026	2029	2031
Pathway A	100	170	190
Pathway B	100	310	360

Sorting items and removing contamination is estimated to be $59 million in cumulative CAPEX for Pathway A by 2031 and $110 million for Pathway B by 2031. Sorting OPEX, driven by staff costs, is one of the main drivers of overall system OPEX. Estimated OPEX in Pathway A is $99 million in 2026 and increases to $190 million in 2031. For Pathway B, estimated OPEX is $99 million in 2026 and $350 million in 2031.

Washing

A key action modeled is to build washing lines at collocated sorting/washing hubs. These could be built throughout the state, but locating them near population centers will help to minimize transport distances. The number of washing lines and washing hubs (assuming each hub contains four to six washing lines) needed to achieve the reuse pathways is shown in Table 8-4 and Table 8-5.

Table 8-4: Cumulative Number of Washing Lines (Up to and Including Year Shown)

Pathway	2026	2029	2031
Pathway A	78	130	130
Pathway B	78	230	230

Table 8-5: Cumulative Number of Sorting/Washing Hubs to be Developed (Up to and Including Year Shown)

Pathway	2026	2029	2031
Pathway A	19	30	30
Pathway B	19	47	47

The CAPEX (machinery and refit/construction costs) and OPEX (staff and utilities) associated with washing equipment was estimated to be one of the main drivers of cost in the reuse system. The contractor estimated that about $580 million in cumulative CAPEX by 2032 is needed for Pathway A and about $1.1 billion for Pathway B. Prior to 2029, cumulative CAPEX is estimated to be $290 million for Pathway A and $580 million for Pathway B.OPEX costs associated with washing hubs in Pathway A is estimated to increase from $190 million per year in 2026 to $900 million in 2031. For Pathway B, it was estimated to increase from $100 million per year to $1.8 billion in 2031.

Reverse Transport

As reuse strategy implementation scales over time from 2026 to 2032, the volume of reverse logistics operations was modeled and expected to increase. This escalation is reflected in the rising net annual OPEX figures for reverse transport increasing from $62 million in 2026 to $250 million in 2031 for Pathway A and from $62 million to $490 million in Pathway B.

End of Life

Net waste system costs (haulage, tipping fees, and recycling costs) are negative in all scenarios, reflecting significantly reduced waste tonnages. The reduction in costs ranges from $0.5 million in 2026 to $21 million in 2031 in Pathway A. Pathway B ranges from a reduction of $0.5 million to $28 million.

Other Source Reduction Strategies

The source reduction strategies included as part of the pathways included in Section 6.0 are lightweighting and material substitution. This strategy also includes alternative compliance via the use of PCR plastic. The actions to implement these strategies are included in Section 3.0 and summarized here:

- Packaging redesign: design and engineering work to validate the structure, performance, and usability of the new packaging/food service ware.
- Tooling and equipment: the equipment needed to manufacture and fill (if relevant) the packaging/food service ware.
- Marketing and commercial: artwork, claims substantiation, and campaigns supporting consumer transition to reduced-plastic products.

- Material and feedstock: the financial changes in purchasing input material.

Typical timeframes for implementing the source reduction strategies included in the pathways are between six months and three years, based on the contractor's extensive experience designing packaging. If these strategies are to play a significant part in meeting early requirements, as indicated in Section 6.0, actions and investments to implement the strategies should start soon.

Lightweighting

The model estimated the investments associated with lightweighting plastic covered material in each pathway. In Pathway A, the contractor estimated that approximately $110 million in cumulative CAPEX was associated with lightweighting strategies. The contractor modeled that all CAPEX associated with lightweighting was expended by 2026 as lightweighting is likely to be able to be implemented more quickly to achieve source reduction in earlier years. No further CAPEX is estimated after 2026 for Pathway A.

Pathway B is also estimated to need about $110 million in cumulative CAPEX for lightweighting by 2026, with an additional $190 million in cumulative CAPEX in 2029. No additional CAPEX is estimated after 2029, for a total cumulative CAPEX of $300 million.

The impact of lightweighting strategies on net OPEX is negative, meaning there are estimated cost savings, because less plastic material is used manufacturing plastic covered material. These savings are relatively minor in both pathways, peaking at $20,000 per year in Pathway A in 2031 and $60,000 in Pathway B.

Material Substitution

The model estimated the investments associated with material substitution, or switching from plastic to nonplastic covered material. Material substitution was modeled to achieve source reduction in earlier years. In both pathways, the majority of material substitution is modeled to be implemented before 2030, with only minor additional investment required beyond this for the 2032 target. In Pathway A, $67 million in cumulative CAPEX is estimated to be needed by 2026, $170 million by 2029, and $180 million by 2031. In Pathway B, which relies less heavily on material substitution, $83 million in cumulative CAPEX is estimated to be needed by 2026, $120 million by 2029, and no further expenditures after that.

Modeled OPEX costs follow the same pattern, with most of the estimated expenditure happening in 2029 or earlier, with small additional costs beyond that to 2031. In Pathway A, $93 million per year in OPEX is estimated in 2026, $260 million in 2029, and $270 million in 2031. In Pathway B, which relies less heavily on material substitution, $140 million per year in OPEX is estimated in 2026, $180 million in 2029, and $180 million in 2031.

Alternative Compliance Through Post-Consumer Recycled Content

The model estimated the investments associated with alternative compliance through the use of PCR plastic. For both Pathway A and Pathway B, cumulative CAPEX costs are estimated to be $25 million by 2031, with $23 million of that modeled to be spent by 2026.

The annual net OPEX requirements for using PCR plastic were estimated to be between $12 and $13 million per year in both Pathway A and Pathway B.

Economic Development Potential

A robust reuse system for packaging presents a significant opportunity for economic development. Unlike single-use packaging, which is often manufactured overseas, reusable packaging systems require local infrastructure for production, cleaning, logistics, and redistribution. This shift means that a substantial portion of the additional costs associated with reuse systems are reinvested locally, supporting California-based businesses and creating jobs across the value chain.

One of the key indicators of local economic development potential is the number of additional, long-term jobs supported by a reuse system. As shown in Table 8-6, the number of new jobs that could be created in the reuse pathways by 2032 was estimated to be over 2,700 full-time jobs for Pathway A and almost 5,500 full-time jobs for Pathway B.

Table 8-6: Estimated Number of New Full-Time Jobs Associated with Reuse

Job Categories	Pathway A	Pathway B
Admin and Outreach	93	180
Sorting	1,800	3,400
Washing	840	1,900
Total Estimated Jobs	2,733	5,480

Other source reduction strategies create potential job benefits from packaging R&D, packaging design, and manufacturing. There is limited data to assess what additional jobs could be possible from these strategies.

Impact of Pathways on Priority Populations

While implementation of reuse strategies can offer opportunities for priority populations, certain factors should be considered throughout implementation to mitigate negative impacts of implementation while maximizing benefits for communities. Additionally, ensuring the reuse system is accessible for Californians will help reach sufficient market penetration to achieve the source reduction requirements of the Act. The Current State of Source Reduction report found that while these systems are already operating in California, access remains limited, especially in rural and low-income areas.

Equity and Accessibility Considerations

The Current State of Source Reduction report shows that unclear instructions, a limited choice of brands (i.e., in instances where no 'household' brands are available in reuse), and lack of education/awareness can undermine adoption. Reuse systems can help overcome these challenges by having:

- Signage written in the language(s) as required spoken by local populations.
- Infrastructure that is ADA-compliant.
- Access for people of all income levels. Reuse systems should also be compatible assistance systems, such as SNAP benefits.

Access to Jobs

Reuse strategies, including prefill B2B and B2C reusable food service ware, as included in Pathway A and Pathway B, offer significant employment opportunities for California's priority populations. These strategies require staff for washing, logistics, inspection, and container management. As noted in the Current State of Source Reduction report, centralized washing hubs and logistics facilities could be located in priority population areas (e.g., where unemployment is high), providing stable employment and contributing to local economic development.

Reduced Impact from Waste

Landfills and other types of waste disposal often present significant health impacts to surrounding communities. Landfills produce landfill gas that contains methane, carbon dioxide, ammonia, and sulfides, as well as toxic "forever chemicals" like PFAS.

These contaminants have been linked to a range of respiratory illnesses, asthma, cardiovascular disease, cancer, and developmental disorders. PFAS contamination in groundwater near landfills frequently exceeds safe drinking water limits, creating long-term health hazards for residents who rely on local water sources.[39]

Waste facilities are often located in disadvantaged neighborhoods and litter from single-use plastics similarly impacts disadvantaged communities disproportionately. Plastic litter, and the resulting microplastics, contaminate the environment and drinking water sources, exacerbating health risks for residents.

Addressing plastic waste and litter through source reduction and reuse strategies not only improves aesthetics but also mitigates these health and infrastructure challenges.

Strategy Deployment to Meet Source Reduction Other Than Pathways Provided

If strategies are deployed that are not included in the pathways within this report that are more consumer-facing, such as prefill B2C or refill in-store refill, the following should be considered to minimize impact on priority populations, as detailed in Section 3 and the Current State of Source Reduction report:

Reuse and refill:

- Presence of trusted brands in refill format, including those at lower price points, such as store-brand products.
- Deposit or alternative financial/incentive mechanism that does not present a barrier to entry.
- Convenient return infrastructure that is accessible by public transport and which does not require additional journeys.

Other Source Reduction Strategies

- Presence of trusted brands in source reduced format, including those of lower price points, such as store-brand products.

Funding and Other Resources Required to Deliver Pathways

This section considers how funding can be used to accelerate source reduction strategies or improve system performance. As discussed previously, modeling and numerical results do not distinguish which actor bears costs (directly or indirectly) or where costs will ultimately fall geographically. For example, an entrepreneur may find private investment to open a washing plant in California, knowing that more reusable products will be sold and need washing infrastructure. Alternatively, the PRO can provide grants or investments to support washing infrastructure directly. Both of these options are considered as part of the CAPEX system costs, but for this section, only funding directed by the PRO and potential partnerships is considered.

Funding Sources, Investment Options, and Potential Partners

There are multiple avenues available to the PRO to provide investment funding to achieve pathways. This includes producer fees which can be eco-modulated fees to incentivize source reduction or certain types of packaging design.

Additionally, deposits or other charges for unreturned items from reusable packaging and food service ware systems can also provide some funding. The principal benefit of deposits or charges for unreturned items is to drive up return rates thus improving the financial and environmental performance of reuse strategies, they also provide upfront funding for certain expenditure requirements (e.g., they help cover the upfront costs of packaging). A deposit system can be designed so that deposits for containers not returned to the system are retained by the system operator. In an extremely well-performing system, this accrual will be small, but any money collected could be reinvested into the system.

How to Use Funding to Finance Source Reduction

Most of the funding needs estimated in the pathways are associated with setting up new infrastructure and new operations for certain types of reuse and refill. Other types of reuse and refill such as BYO, which were considered in this report alongside other source reduction strategies, offer opportunities to achieve reuse and refill using less costly strategies that require fewer operational changes and new infrastructure.

There are multiple ways in which the PRO and other entities can support source reduction more directly to help overcome potential barriers and catalyze action including using funds to:

- Purchase and own infrastructure and pay for system delivery on an ongoing basis. This could include building out washing and sorting infrastructure, including all logistics to manage all reusable containers.
- Procure or support contracts to deliver the infrastructure and operate the systems through third parties. Contract length would be dependent on what services are being procured, for example, if the contract was for the design, delivery, and operation of regional wash hubs, then the contract length would need to consider the depreciation period for the capital assets that the company would have invested in. Any contract with a third party can be linked to the source reduction requirements and include performance requirements, which, if not met, can link to financial penalties and contract termination. Payment terms that incentivize a system to be more optimal (e.g., achieve higher than specified return rates) could result in payment uplift.
- Direct grant funding tied to specific projects (e.g., returns, sorting, and washing infrastructure) or education. Grants could help attract more financing. For example, substantial upfront grants to offset CAPEX for a business may lead to greater investment and overall infrastructure scaling. This is an option for incentivizing source reduction in areas that require more technical assistance or in areas where actions are required from consumers or key actors who are not producers. A grant could be provided to local jurisdictions or organizations to conduct outreach to restaurants to switch to reusable or nonplastic food service ware, for example, or local campaigns could be developed to promote bring-your-own-cup programs.

9.0 Discussion and Limitations

Introduction

The objective of this section is to present the results and discussion pertaining to meeting source reduction requirements under Pathway A and Pathway B and is not intended to be universal facts about reuse and other source reduction strategies.

Actions and costs related to reuse strategies are inherently uncertain, as they are based on assumptions about how systems and actors (including both those who can enact widespread change, such as producers or supermarkets, as well as individual consumers, businesses, and their staff) behave today and in the future. Results reflect one hypothetical approach to rollout of reuse strategies, when the ways a reuse system could be delivered are far wider. Where possible, the contractor has made assumptions that it deems the most likely way that systems will be designed to meet requirements under a given pathway, based on experience with existing reuse systems and their cost modeling. However, in some cases, it is not possible to anticipate how reuse systems will be designed, and so, without insight into how the PRO will ensure that requirements are met, the contractor has made assumptions that it deems conservative and realistic. The subsections in Calculation Methodology for Actions, Costs and Investments (Section 7.0) provide specific detail on how costs may differ if different assumptions were used. These are discussed further here:

- Reusable B2B packaging is assumed to be made from plastic. Similarly, reusable food service ware is assumed to be made from plastic, except for stainless steel utensils and other small noncontainer items. These assumptions are founded on experience with existing reuse systems. Contractor experience shows that plastic is typically the cheapest material to use. However, system actors may choose to use alternative materials, like metal or glass, for B2B packaging. In particular, manufacturing and material input costs could increase by an order of magnitude or more if reusable packaging or food service ware is made from stainless steel, which costs on average two to three times more than plastic.[40] Transportation costs would also increase when stainless steel or glass is used, as these are both significantly heavier materials than plastic. However, it is difficult to estimate the size of this cost increases.
- The uptake rate of businesses taking part in reuse systems is very difficult to predict and is a function of the intensity and quality of outreach activities throughout California. Greater spending on outreach is likely to lead to greater uptake rates, improving the overall performance of reuse systems and, in turn, driving down other costs (such as costs associated with replacing reusable packaging lost from the system). The outreach costs estimated in this study are high level and could vary by a significant amount, however, it is not currently feasible to determine a realistic maximum and minimum for this action. Outreach is not anticipated to be one of the main system cost drivers.
- The return rates for packaging and food service ware are one of the main drivers of system costs. The assumptions used in this model reflect high-performing

existing systems. However, very poor-performing systems exist as well. Efforts should be made to ensure the return rate is as high as possible through education of participants (both staff and individuals), as well as technology and infrastructure (such as smart return bins). Reducing return rates by 10% (e.g., reducing the return rate of cups in closed-loop reusable food service ware systems from the assumed 88% to 78%) across all systems would increase overall annual costs by approximately 25%, highlighting the importance of maximizing return rates.[41]

- This study has assumed that the system follows a high-OPEX, low-CAPEX approach to returning reusable packaging and food service ware into the system, requiring significant staff hours at businesses to do a first contamination removal and make sure reusable items are packed for transport correctly. Different return systems could be employed, relying more heavily on automated technology, significantly altering the cost profile for these reuse systems. The impacts of this assumption have not been tested, so it is not currently possible to confidently determine the impacts of this assumption. However, advanced physical infrastructure to facilitate the returns of, for example, reusable food service ware in restaurants would likely cost hundreds of millions of dollars in CAPEX, but save significant OPEX related to staff time.

- The contractor assumed that, in both prefill B2B and closed-loop reusable food service ware systems, washing happens centrally at a wash hub and not at the location where the packaging or food service ware are used. This service model is attractive to businesses without the space or upfront cash for dishwashing equipment and means businesses do not have to purchase any food service ware up front, though the system requires greater reverse transport OPEX. Nonetheless, there are likely to be businesses that choose to wash food service ware on-site, as this may save costs in the long run. However, it is difficult to predict the effect of this assumption on total costs. While reverse logistics costs may be overstated, a more distributed system in which individual businesses wash their own equipment is likely to be less efficient, requiring more equipment, energy, and staff resource per unit washed. The extent to which washing infrastructure is centralized in these pathways is also subject to uncertainty. At one end of the spectrum, the system modeled here could operate using a higher number of smaller wash hubs distributed throughout the state, likely leading to higher CAPEX costs as construction and refitting are more expensive for smaller sites on a square footage basis. Conversely, this same approach would likely lead to lower OPEX costs as packaging and food service ware can be transported shorter distances. Alternatively, a small number of much larger wash hubs could be developed, which would probably lead to lower overall CAPEX costs but higher OPEX. However, the actual relative cost of these two ends of the spectrum is hard to assess, as larger infrastructure projects may entail greater financial risks and therefore higher costs of borrowing.

- The costs and investments required for reverse logistics are likely to vary significantly as a function of system design. The system modeled for Pathway A and Pathway B assumed that costs are incurred to transport packaging and food service ware from where it is used (i.e., at businesses) to where it is sorted (i.e., at distribution centers). This is conservative given that, in many cases, it may be possible to backhaul this material by taking advantage of journeys that would be happening anyway. The impacts of this assumption are relatively low in terms of the overall cost findings. If backhauling were employed for every journey, total system OPEX would fall by approximately 3%.

- Almost all the stages involved in a reusable packaging or food service ware system are affected by system harmonization and collaboration between actors. System harmonization is the degree to which infrastructure is shared by different system actors, driven by the standardization of packaging/food service ware designs. Standardization of designs means that the same machinery (e.g., filling and washing) can be used for all producers selling a particular good, and similarly that one unit of packaging could be used by any producer selling that good. This reduces the amount of infrastructure needed and means that sorting and transportation processes can be much more efficient, driving down costs. The system modeled here represents a midpoint between a highly collaborative, harmonized system and a highly fragmented system. It was assumed that there is significant sharing of packaging designs between brands, while recognizing there will still be a desire by certain, probably larger, brands to use their own distinct reusable packaging designs. The impacts of system harmonization across all stages of a reuse system are wide-ranging and complex, and as such have not been investigated in detail here. However, previous research by the contractor estimated that, all else being equal, moving from a fragmented to a harmonized system would reduce annual OPEX by 5 to 10% (depending on other design considerations).[42] This could be the equivalent of roughly $40 to $100 million per year difference.

- The modeling performed in this study has not incorporated any effects related to economies of scale. Economies of scale may be seen in reuse systems as they grow. As infrastructure proliferates, returns increase, transport distances decrease, and equipment and infrastructure tend to operate more efficiently. The assumptions used to model reusable packaging in this study typically relate to data adopted from systems with low economies of scale, meaning results, particularly for later years, may be conservative. Previous modeling by the contractor (demonstrated in the same source) has shown that, as economies of scale increase from 2 to 10%, the net unit cost of a reusable beverage container system could fall by as much as 25%, although it should be noted that there is a high degree of uncertainty in this reduction figure.

The findings of other source reduction modeling are also limited:

- It is extremely difficult to assess both the theoretical maximum penetration for each strategy across different strategies, and the extent to which these strategies have already been employed.

- There is limited California-specific data to inform the modeling.

- The use of cluster level modeling may oversimplify and obscure variations across different packaging and goods types.
- Cost predictions are highly sensitive to market penetration rates, and implementation timelines may render the 2027 requirements impractical, though this is not reflected in the current modeling.
- Material substitution strategies are limited by uncertainty around the choice of replacement materials.

Finally, the modeling of the alternative compliance formula currently assumes a 1:1 source reduction benefit, that is, each ton of plastic replaced with PCR material is counted as one ton toward the weight-based reduction target. The alternative compliance formula has not been released by the PRO, nor approved by CalRecycle, therefore this is only an assumption. If the actual benefit were lower, then recycled content used as part of the pathways in this analysis would deliver a smaller reduction in progress toward the requirement, resulting in an underachievement against the required percentage reduction. Alternatively, achieving the modeled reduction outcome would require a higher level of market adoption, increasing the scale of participation needed across producers and formats, as well as the associated costs, implementation effort, and risk of barriers to compliance. More recycled content would also require availability of material in the market.

10.0 Summary of Engagement

Summary of Outreach and Engagement Activities Conducted

The contractor designed the community engagement track to capture lived experience input from California residents and community-serving organizations about how plastic covered material appears in everyday life, and what factors could make reuse, refill, concentrate, and large-format alternatives workable. The objective was to collect self-reported data on prevalence, feasibility, barriers, and equity considerations across regions and populations. These inputs inform this analysis by grounding findings in consumer experience, surfacing implementation risks, and identifying the conditions and support needed for adoption.

The process began with development of a detailed community engagement plan complete with a timeline and geographic delineation of the five regions. This mapping combined CalEnviroScreen 4.0 data, SB 535 disadvantaged communities designations, census data on limited English proficiency households, and InterEthnica's proprietary database of community-based organization (CBO) partners. The resulting master list identified:

- Urban, suburban, and rural perspectives.
- Populations experiencing disproportionate environmental burdens.
- Representation across highly spoken languages: Spanish, Cantonese, and Mandarin.
- Inclusion of Tribal communities, including Tribal members living in urban areas.
- Colleges.
- Other interested parties.

The plan aligned engagement and research activities, events, locations, and potential participants for each of the five geographic regions, and detailed which groups or populations would be engaged, which engagement method would be used, and what specific outputs were expected.

The contractor conducted outreach using several formats of community engagement, including:

- Pop-up events.
- Small group discussions with Tribal communities, CBO representatives, and the disability community.
- One-on-one interviews with CBO representatives and Tribal community members.
- Focus groups with community members.

- Interviews with local jurisdictions.
- Statewide virtual public workshops.

Multiple engagement strategies were designed, with tools and materials developed and translated into Spanish and Traditional Chinese. Stipends were allocated to CBO participants, and activities were implemented across five geographic regions in California, including the Bay Area, Southern, and the Coastal, Mountain, and Valley regions. These efforts were essential to ensuring that communities historically underrepresented in statewide policy discussions could directly influence actionable reuse, refill, and source reduction strategies.

All engagement activities were documented through attendance logs, engagement boards, counters, marbles, and facilitator notes. Data were anonymized and stored in compliance with General Data Protection Regulation and California Consumer Privacy Act standards, with personally identifiable information deleted six months after project completion. Evaluation metrics tracked:

- Number of participants per activity.
- Geographic distribution across regions.
- Representation of language groups and priority populations.

The approach combined statewide coverage, region-specific tailoring, multiple engagement formats, financial compensation, and continuous integration with technical tasks. As a result, the findings reflect not only the perspectives of industry and experts but also the lived realities of priority populations, environmental justice (EJ) communities, CBOs, Tribes, college students, people experiencing disabilities, and local jurisdictions across California.

The community engagement process achieved statewide reach and depth, meeting the study's goals for inclusivity, representation, and meaningful participation. These engagement activities fulfilled the community engagement requirements under the SOW, ensuring representation across California's five regions and among urban, suburban, rural, and EJ communities. The contractor designed each method to provide actionable data for the Current State of Source Reduction report and this report, enabling the contractor to connect lived experiences and local realities with the technical analyses of reuse, refill, and other source reduction strategies.

Across all methods, the contractor engaged 994 members of the community through focus groups, small-group discussions, interviews, pop-up events, and public workshops. The contractor designed each activity to reach diverse audiences and facilitate in-depth interactions and data collection, ensuring that the voices of Californians directly informed the understanding of opportunities and barriers related to reuse, refill, and source reduction.

The breadth of engagement reflects strong participation across California's five study regions and demonstrates the contractor's success in reaching urban, rural, and suburban communities. The contractor intentionally designed activities to be accessible, multilingual, and culturally responsive, engaging participants in the settings where they live, work, and shop or inviting them to participate in focused discussions. The contractor conducted engagement in English, Spanish, Cantonese, Mandarin, Vietnamese, and Russian, ensuring that limited English proficient residents could contribute alongside English-speaking participants.

Table 10-1: Engagement Methods and Number of Participants

Engagement Method	Participants Engaged
Community Member Focus Groups	71
Small-Group Discussions/Interviews (including Tribal and Disability groups)	73
Pop-up Events	769
Public Workshops	81
Total	994

Regional Definitions and Profiles

The study uses five regions: Bay Area, Coastal, Mountain, Southern, and Valley. These regions were adopted from CalRecycle's Waste Characterization Study Regions, which group counties by shared geography, land use, and economic characteristics. The county lists in the appendix mirror CalRecycle's regional definitions. The contractor developed a community profile for each region. Appendix H, Table H-72 provides a regional overview outlining key characteristics, relevant engagement considerations, priority populations, and interested parties to ensure diverse representation reflective of each region's unique characteristics.

Pop-up Events

The contractor hosted nine in-person pop-ups in community-anchored spaces chosen for accessibility, diversity, and existing community draw. These events used interactive engagement activities to gather information on single-use plastic usage, opportunities and barriers to adopting reusable or refillable alternatives, and community perspectives on what changes would make these alternatives more accessible. The pop-ups also documented where residents currently have (or lack) access to sustainable options in their communities. One to two pop-up events took place in all regions, one of which was focused on engagement with Tribal communities.

In the Bay Area, the contractor met people where they already gather at the Fruitvale Farmers Market and Bay Area Rapid Transit (BART) stop (Oakland) and BaySpark (San Francisco Bay Area EJ event); in the Coastal region at the San Luis Obispo Farmers Market (San Luis Obispo) and Arcata Farmers Market (Arcata); in the Mountain region at the El Dorado Hills Farmers Market (El Dorado Hills); in Southern region at the Chula Vista Farmers Market (Chula Vista) and Echo Park Farmers Market

(Los Angeles); and in the Valley at Native American Day (Sacramento) and the Stone Soup Fresno Open House/Fall Harvest (Fresno). These venues connected the contractor with immigrant, bilingual, Tribal, farmworker, refugee, urban, suburban, and rural communities.

Collectively, the pop-ups engaged 769 people with on-site conversations supported in English, Spanish, Cantonese, Mandarin, Vietnamese, and Russian, demonstrating effective, multilingual access in familiar, trusted settings where communities already convene.

Table 10-2: Pop up Events by Region

Region	Pop up event	# of people engaged	Languages spoken
Bay Area	Fruitvale Farmers Market	65	English, Spanish, Mandarin
Bay Area	BaySpark	102	English, Spanish, Cantonese, Mandarin, Vietnamese
Coastal	San Luis Obispo Farmers Market	50	English, Spanish, Russian
Coastal	Arcata Farmers Market	90	English
Mountain	El Dorado Hills Farmers Market	32	English
Southern	Chula Vista Farmers Market	152	English, Spanish
Southern	Echo Park Farmers Market	78	English, Spanish
Valley	Native American Day	92	English, Spanish
Valley	Stone Soup Fresno Open House/Fall Harvest	108	English, Spanish, Mandarin

Small-Group Discussions

The contractor conducted small-group discussions with CBO leaders in each of the five study regions. For CBOs who were unable to attend, one-on-one interviews were offered to ensure their perspectives were still captured. A dedicated small-group discussion was held with members of the disability community to ensure accessibility and ADA-related concerns were explicitly captured. Participants discussed barriers related to physical access, usability of systems, and the need for product and program designs that are inclusive for individuals with diverse needs. One small-group discussion was conducted statewide with Tribal community members. This session provided insight into how single-use plastics intersect with cultural practices, environmental stewardship, and the unique challenges faced by Tribal communities, particularly around land and water protection.

CBOs and college outreach successfully engaged a broad range of organizations and institutions that reflect California's geographic, cultural, and socioeconomic diversity. In total, 83 organizations or colleges received invites to a small-group discussion or interview, with 50 attending a small-group discussion or interview. These organizations spanned the five study regions and included EJ advocates, immigrant and refugee service providers, tribal representatives, youth and education groups, agricultural and farmworker organizations, and social-service providers.

Across regions, participation levels were strong, with multiple CBOs engaged in each area: the Bay Area (12 organizations), Coastal region (10 organizations), Mountain region (eight organizations), Southern region (11 organizations), and Valley region (nine organizations). Together, these organizations provided trusted access to priority populations, including low-income residents, limited English proficient households, communities of color, rural and agricultural workers, and residents of EJ communities. Their reach supports grounding the study's findings in real community experience, capturing both regional nuances and shared priorities that will inform the assessment of reuse, refill, and source reduction strategies statewide. Appendix H, Table H-73 outlines CBO and college participants and invitees.

Community Member Focus Groups

As part of the community engagement track, the contractor convened focus groups with residents across the five study regions: Bay Area, Coastal, Mountain, Southern, and Valley.

The discussion framework was structured to capture both practical considerations (affordability, access, safety, convenience) and broader equity dimensions (inclusion of low-income households, rural residents, immigrant and limited English proficient communities, and people with disabilities).

Across five study regions, one focus group was held per region. Two focus groups were conducted in Spanish (one with urban participants, one with rural/suburban participants), and one focus group was conducted in Cantonese and Mandarin with limited English proficient participants from across the state. These language-specific groups ensured that participants could express their views fully and comfortably, without language barriers limiting input.

The information gathered was qualitative and descriptive, focusing on participants' awareness of single-use plastics, their familiarity with reuse and refill options, and the feasibility of alternatives for them. This data was consolidated into the broader engagement dataset, providing regionally specific inputs to feed into the findings of the study.

A total of 71 participants participated in focus groups across all five regions of California, reflecting a strong balance of urban, suburban, and rural representation. The participant pool captured a wide range of ages, income levels, languages, and community types**,** with two-thirds from environmental justice communities, demonstrating the success of this outreach effort in engaging and uplifting diverse voices statewide. Appendix H, Table H-74 describes some of the demographic reach based on self-reported information from participants in focus groups.

Interviews with Local Jurisdictions

The contractor invited two local jurisdictions per region for staff interviews for governmental perspectives to be represented alongside community input. Interviews often included multiple staff from a single jurisdiction. These jurisdiction interviews support the study but are tracked separately from public engagement totals reported in this section; they are not included in the public counts.

The contractor engaged jurisdictions in the following counties:

- Alameda.
- Humboldt.
- Nevada.
- San Francisco.
- Santa Barbara.
- Ventura.
- Yolo.

Small-Group Discussion with Tribal Community Members

The contractor held a dedicated small-group discussion with 16 participants, who self-reported following Tribal affiliations: Wok Tribe; Wiyot; Round Central Valley Indian Tribes / Lakota; Northern California Aztec Village; Nashville El Dorado Miwok; Mexica/Aztec; Mayo; Caxcán and Hñañu (Otomí); California Central Valley Miwok Tribe; Apache, Mayo; Towa descendant (New Mexico); Yurok; Coyote Central Valley Band of Pomo Indians. Their input surfaced culturally grounded stewardship practices, concerns about plastic impacts on lands and waterways, and barriers to affordable, durable reusables in Tribal communities.

In addition, a project pop-up at Native American Day in the Central Valley region engaged Tribal community members from across California. The statewide gathering included representatives from approximately 120 Tribes, offering broad opportunities to connect, listen, and invite continued participation in next-phase engagement.

Small-Group Discussion with Disability Community

A total of seven participants representing California's disability community participated through a small-group discussion and individual interviews. Participants included people experiencing a diverse range of disabilities that work as staff from Centers for Independent Living, are members of resource and support groups for people with disabilities, advocates, caregivers, and community members who contributed both lived and professional perspectives.

These discussions ensured that the contractor heard and respected the perspectives of people with disabilities and will be included in the statewide dialogue and will inform planning efforts to ensure equitable access to reuse and refill systems are designed to effectively support the development of inclusive, accessible, and safe single-use plastic packaging source reduction strategies moving forward.

Public Workshops

Two statewide interactive public workshops (one during lunch and one in the evening) were held to share preliminary results, confirm accuracy, and close the loop with participants. In total, 81 people attended. Workshop participants represented all five regions. Most attendees had already engaged earlier (focus groups, pop-ups, or small-group discussions), making the workshops an efficient forum to review what we heard and close the loop on the study's community engagement efforts.

Participants could ask questions, provide comments, and participate in optional discussion space. These workshops gave participants the opportunity to share personal and hear community concerns, perspectives, opinions, and effective approaches happening across the state.

Recommended Communities to Contact for Future Needs Assessment Updates

All organizations involved in community engagement outreach expressed interest in continuing to be part of the solution (particularly if future funding supports community education, local implementation, or technical assistance for reuse and refill programs) and requested to receive the final Needs Assessment report when available. When the final report is publicly available, the contractor will send a final thank-you email to all parties who provided contact information, including a link to the report.

During the engagement process, conversations and inputs were robust across regions and community types, and additional broad-based engagement is not considered necessary at this stage. However, a few specific partners in each region are continuing to lead, actively expanding efforts in reducing and reusing single-use plastics, or have shown a keen interest in further conversations and may serve as key resources for future needs assessments. These include (by region):

- Bay Area**:** Reuse Alliance, Students for a Sustainable Stanford, Rise South City, Community Agency for Resources, Advocacy, and Services (CARAS)
- Coastal Region: Bright and Green Humboldt, Friends of the Lost Coast
- Mountain Region**:** Sierra Business Council, Inyo Mono Advocates for Community Action (IMACA)
- Southern California**:** 5 Gyres Institute, San Diego Miramar Community College, Sustainability, Orange County Environmental Justice (OCEJ)
- Valley Region**:** Atrium916, Stone Soup Fresno, Camptonville Community Partnership, Central Valley Improvement Projects
- Tribal**:** Suscol Intertribal Council, Regional Tribal Operation Committee Representatives (RTOC)
- Disability**:** Center for Independent Living

Summary of Expert and Infrastructure Engagement

The contractor conducted more than 40 interviews with various experts and industries to understand the current state of reuse, refill, and source reduction strategies directly from the interested parties who are exploring, testing, and implementing these strategies. This was done to ensure the outputs from this project are grounded in a shared understanding of current reality.

The specific purposes, by component of this study, were:

- Current State of Source Reduction Report**:** Identify and characterize current reuse, refill, and other source reduction initiatives; identify discrete and generalizable solution types for further investigation; identify packaging system inputs, map infrastructure gaps, estimate cost drivers (e.g., collection, sanitization, transport), and understand barriers and opportunities for reuse, refill, and source reduction approaches.
- Needed State Report**:** Refine source reduction scenario typologies, test feasibility of source reduction scenarios to understand actions that can meet source reduction requirements, identify high-priority reduction pathways, understand risks and barriers to different strategies, and gather necessary data points to effectively model the actions and investments to meet the source reduction requirements.

A summary of the interviews conducted by expert category is detailed in Table 10-3.

Table 10-3: Summary of Interviews Conducted by Expert Category

Expert Category	Completed
Trade Associations	5
Retailers	5
Product Manufacturers	7
Packaging Manufacturers	3
B2B Food Service	1
Distributors	2
Food Service Establishments	6
Event Organizers, Stadiums, and Venues	2
Logistics Companies	1
Reuse and Refill Operators	8
Other	2
TOTAL	**42**

In order to complete this process, the contractor began by developing a long list of interested parties who may be impacted by or have a role to play in the implementation of reuse and refill systems as well as wider source reduction-related design change. The contractor refined this list and intended outreach approach as part of the development of the final study design.

The contractor sought to meet with a wide array of impacted industry sectors. To comprehensively assess the landscape and develop equitable recommendations, the contractor identified large, small, national, regional, and independent businesses across all categories when possible. Here is a select list of considerations for specific sectors that the contractor applied:

Retailers:

- Local, regional, and national players.
- Discount, mainstream, and high-end price points.
- Product categories sold.
- Retailers that have and have not been part of reuse, refill, or other source reduction efforts.

Product manufacturers:

- Small and large manufacturers.
- Product categories sold.
- Manufacturers that have and have not been part of reuse, refill, or other source reduction efforts.

Food service establishments:

- Local, regional, and national players.
- Low, middle, and high-end price points.

The contractor further established subcategories within each of the aforementioned categories, and aimed to meet with at least one party in each of the subcategories:

- Trade associations**:** Retail, food service; consumer brands; packaging; reusable packaging; stadiums/venues.
- Retailers: Large retailer (grocery and general merchandise); grocery (large chain); grocery (small chain); specialty retail.
- Product manufacturers**:** California-based contract manufacturers and fillers; home beauty and personal care; food and beverage; California-based food and beverage; consumer goods.
- Packaging manufacturers**:** Packaging manufacturer; small, California-based packaging designer and manufacturer.
- B2B food service.
- Distributors**:** Food service and restaurant distributors; California-based food service and restaurant distributors; other distributors; transport food service and distributors.
- Food service establishments**:** Casual dining/full-service restaurant (large chain); fast casual (large chain); fast casual (small/medium chain); quick service restaurant (large chain); quick service restaurant (small/medium chain).
- Event organizers, stadiums, and venues**:** Event space / venue; large event/festival; stadium/attraction.
- Logistics companies**:** Food delivery; logistics and delivery.
- Reuse and refill program operators**:** B2B reuse services; closed-loop reuse; open-loop reuse; enabling services.
- Other experts.

Activities commenced in late June 2025, with identification of interested parties for outreach and drafting outreach materials. Qualitative and quantitative data collection began in July 2025, with interviews continuing through August and September 2025.

The contractor first identified contact persons for the interested parties in each of the subcategories, with outreach following. To reach the targeted parties, the contractor began by utilizing their network of contacts, and/or using tools like LinkedIn to get in touch with the appropriate person(s), requesting introductions where necessary.

Outreach activities to contact interested parties primarily consisted of emails or phone calls, depending on the nature of the relationship with the contact person and available contact information. The initial communication, via emails and phone calls, introduced the purpose of the engagement, the nature of the project, and confirmed that the contact is the most appropriate person at the organization to provide information related to the study. In most cases, this resulted in the scheduling of a virtual interview/meeting with the interested party.

The contractor sought a number of interviews per subcategory of interested parties far exceeding the quota, so as not to be overly dependent on reaching specific individual companies or people. This gave the contractor needed flexibility in case of challenges with engaging specific interested parties, as it allowed them to contact others that are in the same subcategory that have a similar profile.

When challenges arose securing an interview, the contractor utilized additional options for outreach:

- Activated alternate contacts from their reserve list.
- Used industry associations to facilitate outreach.
- Worked through common contacts, so the outreach is not cold.
- Cold-call outreach.

Prior to each interview/meeting, the contractor prepared questions, information, and data requests to address with each interested party. The contractor sent this to the interviewee in advance so that they could review and prepare. This included information about what the data gathered will be used for and options for attribution. Detailed notes were captured from all interviews/meetings, as described in the following. Additionally, a detailed log was maintained on the status of outreach, recording outreach activities, scheduled interviews, and follow-up responses. In cases where multiple parties were being engaged, with the assessment that it may require outreach to several parties for one to result in an interview, this was recorded in detail in the log, including: person or persons contacted; nature of contact (email, phone, LinkedIn, other); status of outreach and follow-up outreach, where applicable; any instructions for follow-up; and the person or persons who attempted outreach.

A detailed log recorded cases where multiple parties were being engaged, with the understanding that outreach to several individuals might be necessary before securing an interview. The log included:

- The person or persons contacted.
- The nature of contact (e.g., email, phone, LinkedIn, or other).
- The status of the outreach and any follow-up, where applicable.

- Any instructions for follow-up.
- The person or persons who attempted the outreach.

While outreach was mostly successful in generating a scheduled interview, the contractor was unable to secure an interview in specific instances where the appropriate person could not be identified or reached.

The most common scenarios were no response or initial response without continued response to emails. In some cases, the contractor successfully established contact and received responses, but the interested party then declined the invitation outright or implicitly by not responding to repeated follow-ups. In the case of initial response, the interested party typically answered a phone call or email by asking for more information about the process but then did not respond after, despite multiple follow-up requests.

A summary of interviews with experts and businesses is provided in Table 10-4.

Table 10-4: Summary of interviews with experts and businesses

Category	Subcategory	Number of organizations interviewed
Trade Associations	Restaurants	1
	Reusable Packaging	1
	Stadiums / Venues	1
	Retail	1
	Packaging	1
Retailers	Large Retailer – Grocery and General Merchandise	2
	Grocery – Large Chain	0
	Grocery – Small Chain	1
	Specialty Retail	2
Product Manufacturers	Contract Manufacturers and Fillers	1
	Home, Beauty and Personal Care	2
	Food and Beverage	2
	California-based Food and Beverage	1
	Consumer Goods	1
	Packaging manufacturer	2
Packaging Manufacturers	Small/California-based Packaging Manufacturer	1
B2B Food Service	B2B Food Service	1
Distributors	Food and Restaurant Distributors	1

Category	Subcategory	Number of organizations interviewed
	Food service and Restaurant Distributors – California-based	0
	Other Distributors	0
	Transport Food Service and Distributors	1
Food Service Establishments	Casual Dining/Full-Service Restaurant (Large Chain)	1
	Fast Casual (Large Chain)	1
	Fast Casual (Small / Medium Chain)	1
	Quick Service Restaurant (Large Chain)	2
	Quick Service Restaurant (Small/Medium Chain)	1
Event Organizers, Stadiums, and Venues	Event space/Venue	1
	Large event/Festival	0
	Stadium/Attraction	1
Logistics and Delivery	Food Delivery	0
	Logistics and Delivery	1
Reuse and Refill Program Operator Examples	Open-Loop Reuse	4
	B2B Reuse Services	1
	Closed-Loop Reuse	1
	Enabling Services	2
Other Experts	Other Experts	2

How Findings from Outreach and Engagement were Incorporated Throughout the Report

Outreach and engagement findings were important in assessing source reduction strategies. In particular, insights from businesses informed us of the balance of each strategy in Pathway A and Pathway B. Insights from priority populations informed consumer acceptance of different strategies as part of the strategy evaluation.

Table 10-5: Examples of Outreach and Engagement Findings Used in This Report

Finding from Outreach and Engagement	How the Finding was Used
Expert interviews and community engagement participants emphasized the need for multilingual outreach.	When describing the outreach and administrative support needed for businesses switching to reusable food service ware (and associated CAPEX and OPEX figures), it was noted that opportunities to join reuse systems should be available in multiple languages to make joining more accessible.
Interviews confirm refill systems are more labor intensive than shelving packaged goods, adding complexity and cost.	This information was used to inform prioritization scoring for Refill-in-Store for each Function Cluster (Section 5.0).
Current State of Source Reduction report engagement highlighted barriers for rural and low-income communities to using refill-in-store models, including long travel times and limited store coverage.	This information was used to inform prioritization scoring for Refill-in-Store for each Function Cluster (Section 5.0).
Engagement revealed consumer interest in prefill systems for convenience and hygiene but deposit costs and access to convenient return locations were raised as a concern. Many prefill solutions do not accept assisted payment programs like SNAP or EBT, which may restrict access for low-income households.	This information was used to inform prioritization scoring for Prefill B2C for each Function Cluster (Section 5.0).
Retailers and manufacturers view prefill systems as operationally less disruptive than refill-in-store. Liquid products are particularly well-suited due to compatibility with existing equipment.	This information was used to inform prioritization scoring for Prefill B2C for each Function Cluster (Section 5.0).

Finding from Outreach and Engagement	How the Finding was Used
Interviews highlighted interest from institutional buyers of packaged goods but noted barriers related to washing infrastructure and logistics.	This information was used to inform prioritization scoring for Prefill-B2B for each Function Cluster (Section 5.0).
Current State of Source Reduction report interviews confirm that open-loop systems are more complex and costly than closed-loop models due to distributed return points and higher loss rates.	This information was used to inform prioritization scoring for Open-Loop Food Service Ware for each Function Cluster (Section 5.0).
Community engagement showed strong interest in reuse for to-go food, but there were concerns about convenience and hygiene.	This information was used to inform prioritization scoring for Open-Loop Food Service Ware for each Function Cluster (Section 5.0).
Current State of Source Reduction report interviews indicate that closed-loop systems are less costly and easier to manage than open-loop models.	This information was used to inform prioritization scoring for Open-Loop and Closed-Loop Food Service Ware for each Function Cluster (Section 5.0).
Engagement revealed strong public support for closed-loop systems in high-traffic venues, citing convenience and environmental benefits.	This information was used to inform prioritization scoring for Closed-Loop Food Service Ware for each Function Cluster (Section 5.0).

11.0 Abbreviations and Acronyms

ADA: Americans with Disabilities Act

AAPI: Asian American and Pacific Islander

BIPOC: Black, Indigenous, and People of Color

B2B: Business-to-Business

B2C: Business-to-Consumer

BCRP: Beverage Container Recycling Program

BOPP: Biaxially Oriented Polypropylene

BYO: Bring Your Own

CalRecycle: California Department of Resources Recycling and Recovery

CAPEX: Capital Expenditure

CPP: Cast Polypropylene

CPET: Crystallized Polyethylene Terephthalate

CBO: Community Based Organization

CMC: Covered Material Category

CRV: California Redemption Value

CSU: California State University

EBT: Electronic Benefit Transfer

EJ: Environmental Justice

EVOH: Ethylene Vinyl Alcohol Copolymer

EPR: Extended Producer Responsibility

FMCGs: Fast-Moving Consumer Goods

FTE: Full Time Equivalent

GIS: Geographic Information Systems

HDPE: High-Density Polyethylene

IBC: Intermediate Bulk Container

LDPE: Low-Density Polyethylene

LGBTQ+: Lesbian, Gay, Bisexual, Transgender, Questioning, or Queer, and +

ONy: Oriented Nylon

OCEJ: Orange County Environmental Justice

OPEX: Operational Expenditure

PCR: Post-Consumer Recycled Content

PET: Polyethylene Terephthalate

PHA: Polyhydroxyalkanoate

PHB: Polyhydroxybutyrate

PE: Polyethylene

PP: Polypropylene

PSL: Pressure Sensitive Labels

PS: Polystyrene

PCR: Postconsumer Recycled Content

PVC: Polyvinyl Chloride

PRO: Producer Responsibility Organization

R&D: Research and Development

RPC: Reusable Plastic Container

RTOC: Regional Tribal Operation Committee

RVM: Reverse Vending Machine

SKU: Stock-Keeping Unit

SNAP: Supplemental Nutrition Assistance Program

SRB: Source Reduction Baseline

WIC: Women, Infants, and Children

12.0 Glossary of Terms

The terminology used in this report is consistent with the definitions set forth in the glossary and is only intended for this report. Terminology used in this report may differ from the definitions used by other organizations or as outlined in the Plastic Pollution Prevention and Packaging Producer Responsibility Act (Allen, Chapter 75, Statutes of 2022). The terminology used in this report does not represent or affect the interpretation, implementation, or enforcement of the Act. Specifically, this report considers the current and needed state of reuse and refill materials and infrastructure, and does not endorse any products or materials as satisfying the criteria for "reusable" or "refillable" as defined in the Act.

Americans with Disabilities Act (ADA): A federal civil rights law that prohibits discrimination against people with disabilities in everyday activities.

Beverage Container Recycling Program (BCRP): CalRecycle administers the California Beverage Container Recycling & Litter Reduction Program (BCRP) in which consumers pay a refundable deposit every time they purchase an included beverage and then receive – California Refund Value (CRV) – when they return the empty container to a certified recycling center, registered dealer cooperative, or participating retail location. Californians may instead choose to forfeit their deposit by donating beverage containers to certified community service programs, or giving them to a registered curbside or certified drop-off or collection program for recycling.

Business-to-Business (B2B): Commercial transactions and interactions between two companies, rather than between a company and an individual consumer. This can involve one business providing raw materials, services, or finished goods to another business, which might then use them in its own operations or resell them.

Business-to-Business Enabler (B2B Enabler): Refers to a tool, service, or role that indirectly supports and facilitates the transactions and processes between two businesses.

Business-to-Consumer (B2C): The business model of selling products directly to customers.

Bulk: Material that is often sold in large quantities.

California Redemption Value (CRV): See definition for Beverage Container Recycling Program.

Capital Expenditure (CAPEX): Funds used by a company to acquire, upgrade, and maintain essential physical assets like property, technology, or equipment, crucial for expanding operational capacity and securing long-term economic benefits.

Closed-Loop or Closed Network: A reuse system where the consumption and purchase happen in the same location, and the reusable packaging or food ware item does not typically or cannot leave the premises.

Concentrate/Concentration: Reduction in the amount of packaging needed for a good by reformulating it to allow for smaller quantities of the good to be used for the same purpose as the previous, larger quantity. (PRC § 42041 (d))

Converters: Entities which transform raw packaging materials (such as plastic resins, paper, board, aluminum, or glass) into finished or semi-finished packaging components—through processes like extrusion, molding, printing, laminating, or cutting—ready for filling, assembly, or use by brand owners and packers.

Co-packing/Co-filling: Entities which hygienically repack finished products into smaller packaging on behalf of brands for local resale, return, washing and reuse; these entities can pack or fill for multiple brands and could do so using reusable packaging at regional facilities.

Covered Material Category (CMCs): A covered material category is one that includes covered material of a similar type and form, as determined by CalRecycle (PRC section 42041(f)).

Crate (reusable): Refers to durable large containers designed for heavy-duty shipping and protective storage, commonly used for food and retail products; typically stackable.

Cube Efficiency: A measure of how effectively packaging uses space, referring to the proportion of available volume (in transport, storage, or on-shelf) that is filled with product, with higher cube efficiency indicating less wasted space and more efficient logistics.

Downgauging: A form of lightweighting typically used in reference to flexibles.

Drum (reusable packaging): Durable, cylindrical industrial containers made of materials such as steel or high-density plastic specifically engineered to be used for multiple trips in a supply chain. These drums are designed for longevity, repeated recovery, inspection, and reconditioning for subsequent use in the same or a similar application.

Dunnage: Material used to secure, support, or protect cargo and products during shipping.

Durable Goods: Goods typically kept for a longer time than FMCGs and purchased less frequently.

Elimination: The removal of a plastic component from a covered material without replacing that component with a nonplastic component, with respect to source reduction. (PRC § 42041 (j))

Extended Producer Responsibility (EPR): A policy approach that holds producers responsible for end-of-life management of their products and packaging to reduce environmental impacts.

Fast-Moving Consumer Goods (FMCGs): Goods that are relatively inexpensive and typically bought many times in a year. In this study, FMCGs were categorized into food and beverage, household care and cleaning, personal care, and pet food.

Format: Refers to the physical shape and properties of the plastic covered material, like its rigidity, size, and weight.

Format Cluster: A group of plastic covered material that are in the same (or functionally very similar) formats. The contractor created 35 Format Clusters for this analysis.

Fractional Manufacturing: Process of producing a good from start to finish on behalf of brands as a subset of their production. These entities can produce for multiple brands and could do so using reusable packaging at regional facilities.

Function Cluster: Group together all uses of plastic covered material that serve the same unique function, regardless of the packaging format. The contractor created 42 Function Clusters for this analysis.

Good: Refers to the item sold, excluding the packaging or food service ware used to contain it.

Item Journey: This encompasses the item sales channel (i.e., B2B and B2C) and, for food service ware, the item's point of use (on-premises or off-premises).

Large-Format Packaging: Packaging for a large amount of a good in a large package, thereby offsetting the need for multiple smaller packaging units for the same amount of good. (PRC § 42041 (b))

Lightweighting: Reducing the weight or amount of material used in a specific packaging or single-use plastic food service ware without functionally changing the packaging or food service ware. "Lightweighting" does not include changes that result in a recyclable or compostable covered material becoming nonrecyclable or noncompostable or less likely to be recycled or composted. (PRC § 42041 (l))

Material Design: Refers to the design of materials, particularly features that achieve source reduction or enhance the ability to reuse and refill packaging or food service ware. Material design may include features such as form, composition, and labeling; may also refer to a material's ability to be recycled or composted.

Material Substitution: Replacing a plastic material with a different material, such as paper, metal, or glass**,** resulting in an overall reduction of plastic use.

Off-Premises: A reuse system where the goods purchased in a reusable package are consumed in a different location from the place they were purchased (i.e., takeout, including at home).

On-Premises: A reuse system where the consumption and purchase happen in the same location, and the reusable packaging or food ware item does not typically or cannot leave the place of purchase (i.e. consumption within restaurants/canteens).

Open-Loop or Open Network: A reuse system where the goods purchased in a reusable package are consumed in a different location from where they were purchased.

Operational Expenditure (OPEX): Expenditure that a business incurs as a result of performing its normal business operations and that differs from capital expenses**.**

Optimize/Optimization: Limiting the amount of covered material used in packaging by meeting goods or packaging needs with minimal material. This includes, but is not limited to, eliminating unnecessary components, right sizing, concentrating, and using bulk or large- format packaging. (PRC § 42041 (r))

Package-Free Shop: "Package Free Shops" sell goods to consumers using the consumer's dispensers to deliver goods into consumer-owned packaging or use no packaging.

Packaging: Any separable and distinct material component used for the containment, protection, handling, delivery, or presentation of goods by the producer for the user or consumer, ranging from raw materials to processed goods. "Packaging" includes, but is not limited to, all of the following: (PRC § 42041 (s))

1) Sales packaging or primary packaging intended to provide the user or consumer the individual serving or unit of the good and most closely containing the good, food, or beverage. (PRC § 42041 (s)1)

2) Grouped packaging or secondary packaging intended to bundle, sell in bulk, brand, or display the good. (PRC § 42041 (s)2)

3) Tertiary packaging intended to protect the good during transport. (PRC § 42041 (s)3) Packaging components and ancillary elements integrated into packaging, including ancillary elements directly hung onto or attached to a good and that perform a packaging function, except both of the following:

   a) An element of the packaging or food service ware with a de minimis weight or volume, which is not an independent plastic component, as determined by the department.

   b) A component or element that is an integral part of the good, if all components or elements of the good are intended to be consumed or disposed of together.

Pallet: A durable platform, often made of wood, plastic, or metal, that is designed for multiple uses to store and transport goods in a supply chain.

Pallet Wrap: A durable alternative to single-use plastic stretch film, designed to secure palletized loads for repeated use. Made from materials like heavy-duty mesh, vinyl, or canvas, these wraps often feature straps or hook and loop fasteners for easy application and removal.

Plastic: A synthetic or semisynthetic material chemically synthesized by the polymerization of organic substances that can be shaped into various rigid and flexible forms, and includes coatings and adhesives; includes, without limitation, polyethylene terephthalate (PET), high density polyethylene (HDPE), polyvinyl chloride (PVC), low density polyethylene (LDPE), polypropylene (PP), polystyrene (PS), polylactic acid (PLA), and aliphatic biopolyesters, such as polyhydroxyalkanoate (PHA) and polyhydroxybutyrate (PHB), but does not include natural rubber or naturally occurring polymers such as proteins or starches. (PRC § 42041 (t))

Plastic Component: Any single piece of covered material made partially or entirely of plastic. A plastic component may constitute the entirety of the covered material or a separate or separable piece of the covered material. (PRC § 42041 (u))

Plastic Covered Material: Packaging made entirely or partially of plastic as defined in PRC section 42041(t).

Pooling: A system wherein standardized packaging is transported after cleaning to the closest filling location where it is needed, and to any manufacturer participating in the return network, potentially reducing the total distance between sorting and cleaning centers and the filling sites.

Post Consumer Recycled (PCR) Content: Products or materials that were bought, used, and recycled by consumers; e.g., a newspaper that has been purchased, recycled, and used to make another product would be considered postconsumer material; sometimes referred to as just recycled content.

Prefill: A prefilled packaging system providing packaging that is filled by a manufacturer and designed to be a part of a system wherein it is returned back to the producer for reuse, not recycled.[43]

Primary Packaging: Sales packaging or primary packaging intended to provide the user or consumer the individual serving or unit of the good and most closely containing the good, food, or beverage.

Priority population: Refers to disadvantaged communities, low-income communities, communities in rural areas, and Tribes. These communities are defined as follows:

- Disadvantaged communities**:** An area identified by the California Environmental Protection Agency pursuant to Health and Safety Code section 39711 or an area identified as a disadvantaged unincorporated community pursuant to Government Code section 650302.10 (PRC section 42041(i)). In 2022, CalEPA released an updated designation of disadvantaged communities and currently defines disadvantaged communities as:
  - The top 25% of census tracts experiencing disproportionate amounts of pollution, environmental degradation, and socioeconomic and public health conditions according to the Office of Environmental Health Hazard Assessment's CalEnviroScreen 4.0 tool.
  - Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps but receiving the highest 5% of CalEnviroScreen 4.0 Pollution Burden composite scores.
  - Census tracts identified in 2017 as disadvantaged, regardless of their scores in CalEnviroScreen 4.0; and
  - Lands under the control of federally recognized Tribes.
- Low-income community: An area with household incomes at or below 80% of the statewide median income or with household incomes at or below the threshold designated as low income by the Department of Housing and Community Development's list of state income limits adopted pursuant to Health and Safety Code section 50093 (PRC section 42041(n)).
- Rural Area: Has the same meaning as defined in Health and Safety Code section 50101 (42041(ah)).
- California Native American Tribes: A Native American Tribe located in California that is on the contact list maintained by the Native American Heritage Commission for the purposes of Chapter 905 of the Statutes of 2004.

Product: A good and the packaging or food service ware that contains it.

Producer Responsibility Organization (PRO): Entity established by manufacturers to follow through legal obligations related to the collection, recycling, and disposal of waste generated by their products. PROs operate independently from the parent company, overseeing compliance with recycling laws and regulations.

Refill via Concentrate: Refill via concentrate products deliver the good in a concentrated liquid, capsule / tablet, or powder form, to be reconstituted by the consumer in a reusable/refillable container provided by the producer, typically as part of the first purchase. It is differentiated from single-use concentrate because it is reconstituted in a package provided for that specific brand and good.

Refill/Refillable: Refers to packaging or food service ware that is refilled or reused by the consumer.

Reformulation: A process of altering a good's composition or processing to allow compatibility with an expanded range of packaging types.

Reusable/Reuse: Refers to packaging or food service ware refilled or reused by the producer.

Reuse-in-Store: Systems that allow consumers to purchase products by dispensing them into reusable, consumer-owned containers, either brought from home or purchased onsite.

Reusable Plastic Container (RPC): Durable plastic container designed for multiple uses and cycles, typically made from a durable polypropylene, or similar material.

Reverse Vending Machine (RVM): A stationary reverse vending machine that pays customers for beverage containers placed in the machine at time of deposit.

Right Size/Right Sizing: Reducing the amount of material used to package an item by reducing unnecessary space or eliminating unnecessary components of the packaging.

Secondary Packaging: Grouped packaging or secondary packaging intended to bundle, sell in bulk, brand, or display the good.

Single-Use Packaging: Packaging that is routinely recycled, disposed of, or discarded after its contents have been used or unpackaged, and typically not refilled or otherwise reused by the producer. (PRC § 42041 (e)1(A))

Single-Use Plastic Food Service Ware: This includes, but is not limited to, plastic-coated paper or plastic-coated paperboard, paper or paperboard with plastic intentionally added during the manufacturing process, and multilayer flexible material.

Source Reduction: The reduction in the amount of covered material created by a producer relative to a baseline; methods of source reduction include, but are not limited to, shifting covered material to reusable or refillable packaging or a reusable good or eliminating unnecessary packaging; excludes the following: ((PRC § 42041 (aj))

(1) Replacing a recyclable or compostable covered material with a nonrecyclable or noncompostable covered material or a covered material that is less likely to be recycled or composted; (PRC § 42041 (aj)(1))

(2) Switching from virgin covered material to postconsumer recycled content. (PRC § 42041 (aj)(2))

Source Reduction Baseline (SRB): A measurement of single-use plastic packaging and food service ware sold, offered for sale, and distributed in the state in 2023.

Supplemental Nutrition Assistance Program (SNAP): SNAP provides food benefits to low-income families to supplement their grocery budget so they can afford the nutritious food essential to health and well-being.

Tertiary Packaging: Transport packaging or tertiary packaging intended to protect the good during transport.

Tote (Reusable): Portable, box-type industrial containers, generally with secure, closed tops and built-in handles, designed for the secure transport and storage of items. Can be collapsible or stack and nest to conserve space when empty.

Women, Infants, and Children Program (WIC): A government supplemental nutrition program for women who are currently pregnant, recently pregnant, or breastfeeding, and for babies and children under age 5.

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