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AUSTRALIAN PACKAGING MATERIAL FLOW ANALYSIS FOR 2020-21

Final report – system wide material flows

APCO

This report was prepared for APCO by the Institute for Sustainable Futures, at the University of Technology Sydney (UTS:ISF).

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Executive summary

The project

This report provides the findings from a material flow analysis (MFA) undertaken to quantify and evaluate the management of used packaging in Australia for the 2020-21 financial year. Performance of the used packaging management system is measured and compared by packaging material groups and consumption sectors.

Projected packaging recovery for 2024-25 was also estimated, and a scenario analysis was performed. The scenario analysis evaluated the impacts on packaging material recovery of: container deposit scheme (CDS) expansions nationally, including additional eligible container types; new pathways for business-to-consumer (B2C) soft plastics collection; and, increased rates of business-to-business (B2B) packaging collections for recycling.

Packaging flows in Australia, 2020-21

Approximately 6,740,000 tonnes of packaging were placed on the market in 2020-21, primarily consisting of paper packaging (50% of total placed on the market), and glass packaging (19% of total placed on the market). Plastic packaging made up 17% of total placed on the market. Overall, 3,980,000 tonnes of used packaging were collected for recycling, at a collection rate of 59%. Paper and glass packaging had the highest rates of collection for recycling, at 72% and 68% respectively. Non-household packaging (B2B) had a collection rate of 68% across all packaging types, compared to a collection rate of 47% for household packaging (B2C). Figure E1 shows the main flows of used packaging through the Australian management system. Approximately 3,800,000 tonnes of used packaging were recovered in 2020-21, representing an overall packaging recovery rate of 56%.

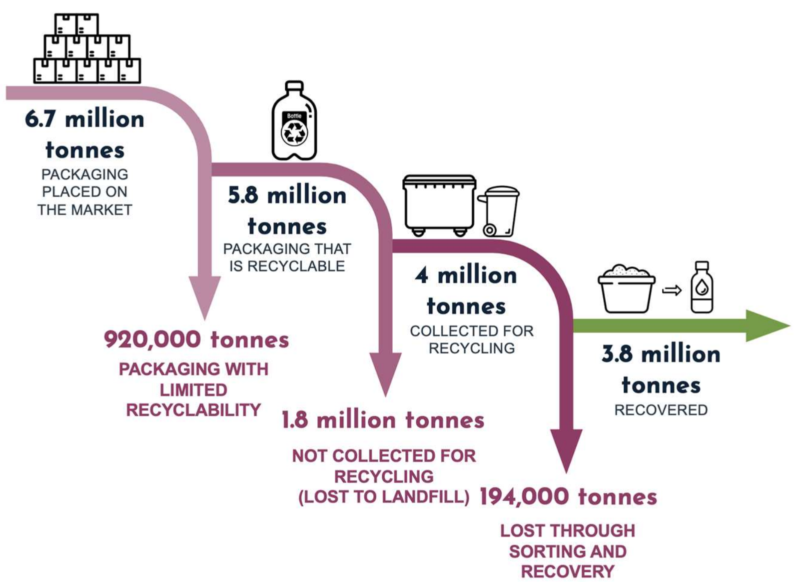

Figure E1: Summarised packaging flows of Australian packaging in 2020-21

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562,000 tonnes of packaging eligible for redemption via CDS systems were placed on the market in 2020-21, representing 31% of bottles and cans. Of this, 469,000 tonnes were collected for recycling, with 73% redeemed through CDS collection points and material recycling facilities. Recovery rates varied by material, with CDS-eligible metal and glass packaging having the highest rates (85% and 81% respectively), while polymer coated paperboard (PCPB) cartons had the lowest (27%). In comparison, non-eligible packaging had a lower overall recovery rate of 45%, compared to 78% for overall CDS-eligible packaging. Approximately 185,000 tonnes of recyclate suitable for packaging-grade applications was generated from recovered CDS-eligible packaging—equivalent to approximately 32% of all CDS-eligible packaging placed on the market. Compared to an equivalent 16% for non-eligible packaging, these findings illustrate that dedicated separate collection systems such as CDS, when coupled with incentives for behaviour change, can achieve greater management performance over typical kerbside collection systems, enabling the circulation of recovered materials into new packaging.

Projected packaging performance in 2024-25

Total packaging placed on the market is expected to increase to 7.5 million tonnes—an increase of 11% over 2020-21. Paper packaging will see the largest increase in quantities placed on the market, increasing by 13%. Rigid plastic packaging will see an increase of approximately 12%, compared to an increase of 4% for flexible plastic packaging types.

The projected overall packaging recovery rate for 2024-25 under business as usual (BAU) assumptions is projected to be 57.4%—an increase of 1.2% over 2020-21 performance. Glass and metal packaging will see the largest increase in recovery compared to 2020-21 performance, increasing by 4% and 2% respectively—a result of planned container deposit scheme expansions nationally by 2024-25. Plastic packaging recovery is projected to marginally increase from 17.5% to 18.5%, remaining significantly lower than the 2025 National Packaging Target for plastic recovery of 70%.

Expanding CDS eligibility to include glass wine and spirit bottles in 2024-25 was examined in a scenario analysis, showing an additional 196,000 tonnes of glass packaging potentially collected for recycling. This could lead to an increase in the glass recovery rate in 2024-25 from 67% to 72%. Expanding CDS eligibility to include additional plastic beverage containers (fruit juice, cordial and <2L flavoured milk) would result in an additional 10,000 tonnes collected for recycling via CDS. Further expansions to eligibility to include plastic food containers (e.g., PP and PET takeaway containers) would lead to an additional 40,000 tonnes of plastic packaging collected for recycling. These system changes focused on rigid plastic recovery could lead to plastic packaging recovery rates of 19-20%, and are not enough to make significant progress towards meeting the 2025 plastic packaging recovery target.

The scenario analysis also evaluated business-to-consumer (B2C) soft plastic collection pathways for 2024-25, including collection via the kerbside, and collection via dedicated separate collections. Based on the scenario assumptions, collection via the kerbside could make 35,000 tonnes of soft plastic available for recycling, compared to 18,000 tonnes via dedicated collection pathways. Both pathways could lead to soft plastic packaging recovery rates of 22% and 19% respectively, compared to a BAU soft plastics recovery rate of 16%. The impact of increased business-to-business (B2B) collections of soft plastic (namely LDPE wrap) was more significant than increased B2C collections, with the flexible plastic packaging recovery rate increasing to 24% in that scenario. Implementing all plastic packaging interventions assessed (for both rigid and soft plastics) could result in a plastic packaging recovery rate of approximately 28%—an increase of 10% over projected 2024-25 plastic recovery.

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Data gaps and recommendations

This analysis also evaluated data quality and impacts of available data on modelling estimates. Uncertainty of estimated material flows were within a reasonable range, with the overall packaging recovery estimate varying by ±11%. Wood packaging and flexible plastic packaging had the greatest uncertainty, with recovery rates for these materials varying ±32% and ±26% respectively. Several data gaps contributing to uncertain packaging flows were identified:

- Material recycling facility (MRF) sorting rates for all material types
- Dedicated soft plastic collections
- Stockpiling of plastic packaging
- B2B direct to reprocessing flows for paper and soft plastics
- Wooden packaging flows, including pallets placed on the market
- Collection losses from improper household disposal at the kerbside for all materials

Addressing the above data gaps in the future may require additional primary and/or secondary data collection, and further modelling and analysis; however, this will result in a more robust analysis, and greater confidence around modelling outputs.

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1. Introduction

1.1 Project background

This report describes material flow modelling undertaken to quantify and evaluate the management of used packaging in Australia for the 2020-21 financial year. Performance of the used packaging management system is measured and compared by packaging material groups and consumption sectors. Future scenarios are also analysed for the 2024-25 financial year, including expansion of container deposit scheme (CDS) eligibility to include a broader range of eligible container types; improved business-to-consumer (B2C) and business-to-business (B2B) soft plastic collections, and enhanced B2B paper collections. Key recommendations from a resource recovery perspective, and from a data and modelling perspective are also given.

This report is the key output of a research project conducted by the Institute for Sustainable Futures (ISF) at the University of Technology Sydney on behalf of APCO, that quantifies overall Australian packaging material flows in 2020-21. A separate report focusing on the material flows of CDS-eligible packaging was also completed as part of this research project and is referenced throughout this report as the *'standalone CDS report'*.

1.2. Scope of analysis

The timeframe of this analysis is the 2020-21 financial year, and the geographical scope is the Australian used packaging management system. **Table *1*** lists the packaging materials and aggregated material categories included within the scope of this analysis. The material categories listed in the table are used to quantify high-level national flows of materials and performance metrics. The material scope is consistent with the 2019-20 MFA[1], except for glass packaging that includes coloured glass as separate material categories. This was required for a detailed CDS scenario analysis considering an extension of CDS eligibility to include additional glass packaging types (e.g., beer, wine and spirits bottles).

[1] Australian Packaging Covenant Organisation, (2021). *Packaging Material Flow Analysis 2019-20*. Available at: https://documents.packagingcovenant.org.au/public-documents/Packaging%20Material%20Flow%20Analysis%202019-20

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Table 1: Material scope of analysis.

Packaging category	Packaging material
Glass	Glass – green
	Glass – amber
	Glass – clear
	Glass – other
Metal	Aluminium
	Steel
Paper	Polymer coated paperboard
	Paperboard and carton board
	Old-corrugated cardboard
	Other fibre packaging
Plastic (rigid and flexible)	PET
	HDPE
	LDPE
	PVC
	PP
	PS
	EPS
	Compostable
	Other polymers
Wood	Softwood
	Hardwood
	Fibreboard

1.3. Modelling approach

A material flow analysis (MFA) was performed to estimate the flows of used packaging through the Australian used packaging management system for the 2020-21 financial year. MFA is an approach used to quantitatively assess the state and change of flows and stocks of materials within a system.[2] The approach is based on the principle of the conservation of mass, and by balancing material inputs and outputs, the material flows within a system can be quantified and further analysed. The remainder of this section describes the MFA approach used for this project.

1.3.1. System specification

Systems investigated using MFA are typically characterised by a *system model*, which shows the *processes* and *flows* under investigation. **Figure *1*** shows the system model employed for this analysis, representing the Australian used packaging management system.

Material flows are estimated based on three estimation strategies, represented by different coloured flows in **Figure *1***. These are:

- Blue: raw data input.
- Orange: estimation via parameters, where flows are modelled using parameters from proxy data and/or relevant literature (e.g., materials recovery facility (MRF) sorting efficiencies, local reprocessor recovery rates).
- Pink: estimation via mass balance, i.e., by back-calculation to ensure mass balance is retained.

[2] Brunner, P.; Rechberger, H. (2017). *Handbook of Material Flow Analysis*. Boca Raton, Florida USA: CRC Press.

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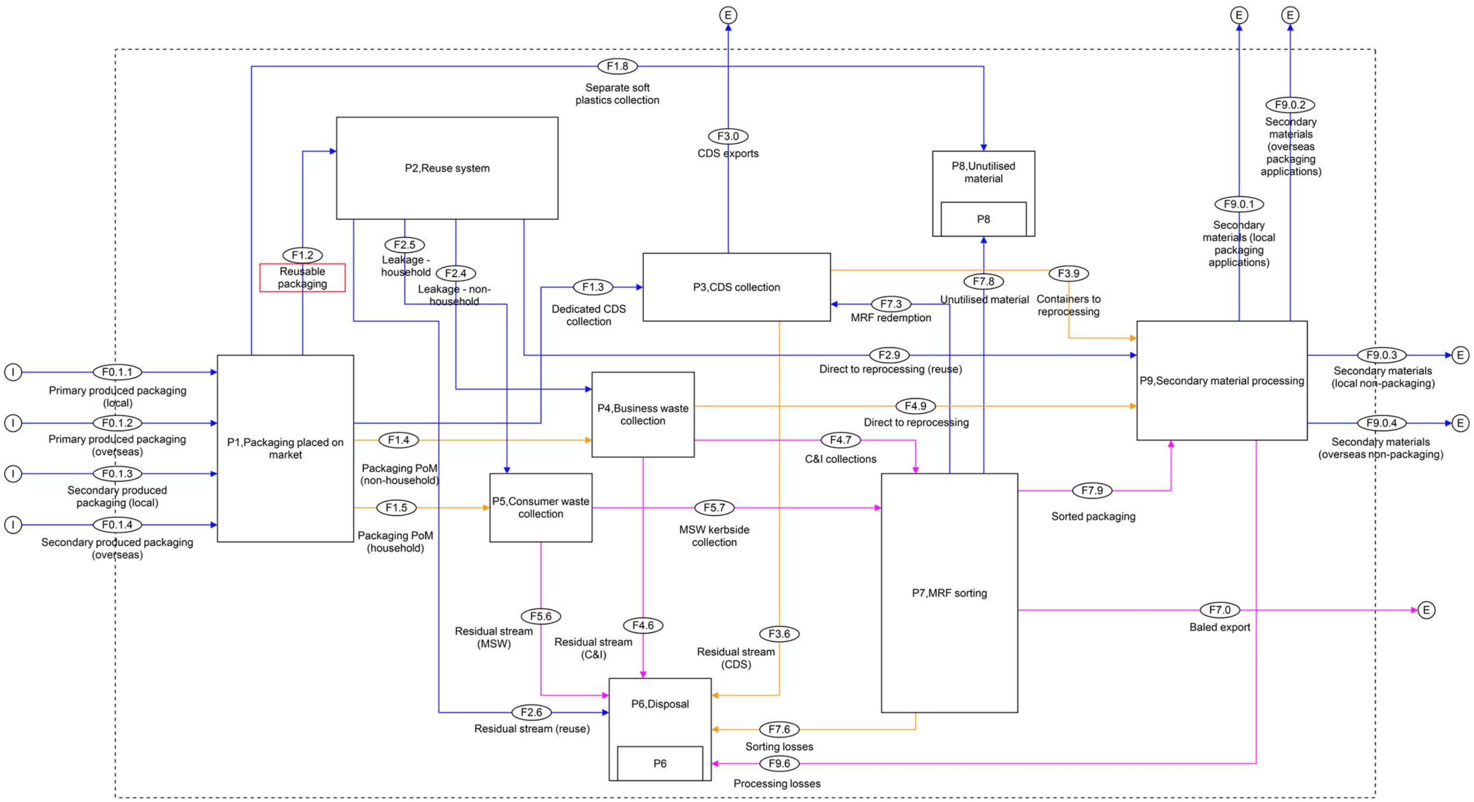

Key

- Data input
- Estimation via parameters
- Estimation via mass balance

Figure 1: Packaging system model used in this analysis.

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Overall, there are 9 system processes modelled, which represent physical (e.g., sorting, collection) and 'virtual' waste transformation and aggregation (e.g., plastic packaging consumption) steps in the used packaging management system. A total of 30 material flows were quantified, representing the transfer of materials between processes, imports into the system, and exports out of the system. For this work, flows are labelled using the following convention:

F[source process].[destination process].[sub-flow]

For example, the flow 'F1.3' represents a single material flow from process number 1 ('Packaging placed on the market') to process number 3 ('Dedicated CDS collection'). Flow 'F9.0.1' represents flows leaving the system from process number 9 ('Reprocessing') that are recovered locally, where sources/destinations outside the system are represented by process number 0. Sub-flow '1' in this example refers to quantities of material recovered for new packaging applications. Descriptions of system processes and material flows are provided in **Table *2*** and **Table *3***, along with approach for quantifying each flow.

Table 2: System processes modelled.

Process	Description
P1, Packaging placed on market	This process represents the use system, and aggregates flows of packaging placed on the market (PoM) from all sources including for B2B and B2C applications.
P2, Reuse system	This process represents the reuse system, where flows of reusable packaging from the use system enter this process as 'returns', and then are redirected back into the use system as 'reuse'.
P3, CDS collection	This process represents the nation-wide CDS collection system.
P4, Business waste collection	The business waste collection system, i.e., commercial and industrial (C&I) collection.
P5, Consumer waste collection	The consumer/household waste collection system, i.e., municipal solid waste (MSW) collection.
P6, Disposal	Aggregated disposal, representing disposal to landfill and informal disposal (i.e., littering).
P7, MRF sorting	This process represents nation-wide MRF sorting systems.
P8, Unutilised material	A stockpile of sorted and recovered material that is not utilised within the study timeframe.
P9, Secondary material processing	This process represents nation-wide secondary materials processing.

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Table 3: System material flows modelled.

Flows	Description	Estimation
F0.1.1, Primary produced packaging (local)	Quantity of packaging produced from primary materials locally.	Data input (Blue Environment, 2022)
F0.1.2, Primary produced packaging (overseas)	Quantity of packaging produced from primary materials overseas.	Data input (Blue Environment, 2022)
F0.1.3, Secondary produced packaging (local)	Quantity of packaging produced from secondary materials locally. Note: The pre- and post-consumer derived secondary packaging is differentiated.	Data input (Blue Environment, 2022)
F0.1.4, Secondary produced packaging (overseas)	Quantity of packaging produced from secondary materials overseas. Note: The pre- and post-consumer derived secondary packaging is differentiated.	Data input (Blue Environment, 2022)
F1.2, Reusable packaging (to pool)	Reusable packaging PoM contributing to the reusable packaging pool.	Data input (Blue Environment, 2022)
F1.3, Dedicated CDS-eligible collection	Eligible CDS containers collected through dedicated channels (e.g., reverse vending machines).	Data input (Blue Environment, 2022)
F1.4, Packaging PoM (non-household)	Packaging PoM and collected through non-household (e.g., business) waste collection.	Estimation via parameters [PoM – (F1.2 + F1.3)] * proportion non-household derived from Blue Environment (2022)
F1.5, Packaging PoM (household)	Packaging PoM and collected through household waste collection (kerbside).	Estimation via parameters [PoM – (F1.2 + F1.3)] * proportion household derived from Blue Environment (2022)
F2.6, EoL reusable packaging to landfill (from pool)	End-of-life (EoL) packaging from the reusable packaging pool that is disposed to landfill.	Data input (Blue Environment, 2022)
F2.9, EoL reusable packaging to reprocessing (from pool)	EoL packaging from the reusable packaging pool that is directed to reprocessing.	Data input (Blue Environment, 2022)
F2.4, Leakage – non-household (from pool)	EoL packaging from the reusable packaging pool that is diverted to non-household collection systems.	Data input (Blue Environment, 2022)
F2.5, Leakage – household (from pool)	EoL packaging from the reusable packaging pool that is diverted to household collection systems.	Data input (Blue Environment, 2022)
F3.0, CDS exports	Direct exports overseas of CDS collected material.	Data input (Blue Environment, 2022)
F3.9, CDS-eligible containers to reprocessing	Packaging collected through CDS and sent to materials reprocessing.	Estimation via parameters [F1.3 * CDS sorting rate from Pressley et al. (2015)] – F3.0 – F3.6
F3.6, CDS-eligible containers to landfill	Packaging collected through CDS and sent to landfill.	Estimation via parameters [F1.3 * (1 – CDS sorting rate from Pressley et al. (2015)]
F4.9, Direct to reprocessing (B2B)	Packaging from businesses sent direct to reprocessing.	Estimation via parameters B2B PoM * Proportion B2B direct to reprocessor, from ISF (2021)
F4.7, Non-household collections to sorting	Packaging collected through C&I collection and sent to MRFs for sorting.	Estimation via mass balance
F4.6, Collection losses (non-household)	Packaging from businesses disposed in residual stream bins, typically destined for landfill disposal; this may include recyclable and non-recyclable packaging.	Estimation via mass balance
F5.7, Household collections to sorting	Packaging collected through MSW collection and sent to MRFs for sorting.	Estimation via mass balance
F5.8, Separate soft plastics collection	Soft plastics collected separately and sent to material stockpiles.	Data input (Vedelago and Juanola, 2023)

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F5.6, Collection losses (household)	Packaging from households disposed in residual stream bins, typically destined for landfill disposal; this may include recyclable and non-recyclable packaging.	Estimation via mass balance
F7.3, CDS eligible containers (MRF redemption)	Eligible CDS containers entering CDS system via kerbside collection/MRFs from NT and SA only.	Data input (Blue Environment, 2022)
F7.8, Stockpiled sorted packaging	Sorted packaging material not recovered nor disposed.	Data input (Blue Environment, 2022)
F7.9, Sorted packaging	Sorted packaging sent to material reprocessing.	Estimation via mass balance
F7.0, Baled export	Exports of baled, sorted packaging destined for overseas processing.	Data input (Blue Environment, 2022)
F7.6, Sorting losses	MRF sorting residuals disposed to landfill.	Estimation via parameters [(F4.7 + F5.7) * (1 – MRF sorting rate from Pressley et al. (2015)]
F9.0.1, Secondary materials (local packaging applications)	Secondary materials destined for local packaging applications.	Data input (Blue Environment, 2022)
F9.0.2, Secondary materials (o/s packaging applications)	Secondary materials destined for overseas packaging applications.	Data input (Blue Environment, 2022)
F9.0.3, Secondary materials (local non-packaging)	Secondary materials destined for local non-packaging applications.	Data input (Blue Environment, 2022)
F9.0.4, Secondary materials (o/s non-packaging)	Secondary material destined for overseas non-packaging applications.	Data input (Blue Environment, 2022)
F9.6, Processing losses	Material losses from secondary materials processing.	Data input (Blue Environment, 2022)

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1.3.2. System performance indicators

To characterise the performance of the used packaging management system, key performance metrics were calculated from estimated material flows, and are shown in **Table *4***. These indicators are based on circular packaging indicators[3] and were calculated for each packaging material category considered to allow comparison between different material systems. Note that the post-consumer recovery rate indicator is calculated excluding estimated stockpiling of sorted material (flow F7.8). This is to ensure that stockpiled material is not erroneously counted towards recovery estimates.

Table 4: Performance metrics used in the analysis.

Performance indicator	Definition	Significance
Collection efficiency	Used packaging that is collected (not directed to landfill), divided by total packaging PoM. Calculation: [in the gate for CDS, reuse and MRF, and direct to reprocessors, divided by PoM].	Low efficiency means that a high proportion of packaging is not separated from materials at the household or business and is disposed in landfill, e.g., owing to loss by design, limited source separation and/or poor disposal practices including littering.
Sorting efficiency	Waste destined for reprocessing/downstream recovery, divided by total packaging PoM. Calculation: [∑(direct to reprocessor collections, end-of-life reuse and CDS eligible destined for recovery, and out the gate of MRF) divided by PoM].	This indicator describes the performance of the system for sorting used packaging. A decline in the efficiency from collection to sorting highlights opportunities to reduce contamination of collected materials received and/or improve sorting processes at the MRF/sorters.
Post-consumer recovery rate (excl. stockpiling)	Total waste recovered (excluding stockpiling of sorted packaging F7.8), divided by total packaging PoM. Recovery includes secondary material recovery for both packaging and non-packaging applications, and exports of baled materials for further processing overseas Calculation: [out the gate for reprocessors and MRF exports overseas divided by PoM]	This indicator describes the performance of the modelled system for recovering used packaging material. Stockpiling (F7.8) is excluded, under the assumption that this material is not utilised.
Local secondary material utilisation rate	Secondary material produced (excluding stockpiled amounts) to be utilised locally for manufacturing (including packaging and non-packaging applications) divided by total packaging PoM. Calculation: [out the gate of reprocessors for local utilisation and energy recovery divided by PoM].	This indicator describes the performance of the local secondary material utilisation system for packaging and non-packaging applications. Low material utilisation rates indicate that a high proportion of waste is either not recovered, exported, or stockpiled.
Packaging material circularity rate	Secondary material utilised locally for packaging applications. Calculation: [local packaging utilisation divided by PoM].	This indicator describes the circularity of the packaging system. High circularity indicates a higher proportion of used packaging is recovered to be used as recycled content in new packaging.

[3] Van Eygen, E.; Laner, D.; Fellner, J. (2018). *Circular economy of plastic packaging: Current practice and perspectives in Austria*. Waste Management, 72, pp. 55-64.

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1.3.3. Data utilised

Table *5* provides a summary of the data sources utilised in the analysis. The primary source of data for the MFA is packaging consumption and recovery data for 2020-21 provided by APCO and Blue Environment.[4] This data includes quantities of packaging placed on the market by material and format for 2020-21, including classification as rigid or flexible packaging. For plastic packaging, a large quantity of packaging placed on the market (approximately 125,000 tonnes) had unknown format or rigidity classification. This unknown quantity was apportioned across format types, and therefore quantities in this report may differ from other datasets reporting soft plastics placed on the market (e.g., *National Plastics Recycling Scheme – soft plastic market* data, provided by APCO).

Additional proxy datasets were utilised where actual data was not available. Key data gaps in the Blue Environment data include MRF sorting rates, separate collection of soft plastics (e.g., REDcycle), and kerbside collection system losses.

Table 5: Data sources used in the analysis.

Data source	Remark
Packaging consumption and recovery data 2020-21 by Blue Environment (2022)[4]	Data on packaging consumption and recovery for 2020-21. This data also includes eligible CDS packaging flows, as well as reuse system flows, and exports from the system.
LCA data on MRF and reprocessor efficiencies[5]	This study includes sorting and reprocessing efficiency rates for recyclable waste streams, based on a life cycle assessment study of MRFs in the USA. This data is used in the estimation of CDS system losses, and MRF sorting losses, and is considered to be applicable to the Australian system because the sorting and recovery processes, and the packaging materials of both countries are similar.
Previous Australian packaging system MFAs[6]	Previous MFA study performed by ISF, which includes validated assumptions around proportion of material collected from non-household consumption and diverted directly to reprocessing, bypassing MRF sorting.
Estimation of REDcycle collections in 2020-21[7]	Data on actual quantities of dedicated separate collections (e.g., REDcycle) is limited. Data is not reported officially, and quantities reported in unofficial sources vary dramatically. For this study, recent data found in a news article for the *Sydney Morning Herald* was utilised. As the data source is a news article, it has a high degree of uncertainty.

1.3.4. Uncertainty analysis

Uncertainty on estimated material flows resulting from variability in data was evaluated using a method utilised previously by ISF and based on the approach of Laner et al (2015).[8] This approach combines a qualitative assessment of data quality used in the MFA to generate a quantitative measure of data variability. The scoring system utilised is described in **Table *6***, and characterises the *input uncertainty*. Overall uncertainty on material flows is a function of this input uncertainty, and the propagation of

[4] Blue Environment (2022). Packaging consumption and recycling data 2020-21 – Packaging data tool.
[5] Pressley, P.N.; Levis, J.W.; Damgaard, A.; Barlaz, M.A.; DeCarolis, J.F. (2015). *Analysis of material recovery facilities for use in life-cycle assessment*. Waste Management, 35, pp. 307-317.
[6] ISF (2021). *Material flow analysis of Australian packaging, 2019-20*. Prepared by the Institute for Sustainable Futures, University of Technology for APCO, November 2021.
[7] Vedelago, C. and Juanola, M.P. (2023, February 3). *Coles, Woolworths ordered to dump tonnes of REDcycle soft plastics in landfill*. Sydney Morning Herald. Available at: https://www.smh.com.au/national/coles-woolworths-ordered-to-dump-tonnes-of-redcycle-soft-plastics-in-landfill-20230131-p5cgok.html.
[8] Laner, D.; Feketitsch, J.; Rechberger, H.; Fellner, J. (2015). *A novel approach to characterize data uncertainty in material flow analysis and its application to plastic flows in Austria*. Journal of Industrial Ecology, 20(5), pp. 1050-1062.

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uncertainty through the system, i.e., where the calculation of flow is based on one or more uncertain inputs. Estimated uncertainty ranges on key material flows and performance metrics are reported in Section 2.4., along with an assessment of overall modelling uncertainty and strategies for overcoming uncertainty in the future. Estimated material flow results appearing in Section 2 are reported as mean values without uncertainty, with all values rounded to 3 significant figures.

Table 6: Summary of the data uncertainty evaluation method.

Indicator	Definition	Score
Reliability	Focus is on the source of the data, including documentation, methodology and verification methods.	1: Methodology is well documented and consistent, peer-reviewed data. 2: Methodology of data generation is described, but not fully transparent. 3: Methodology not comprehensively described, but principles of data generation is clear. 4: Methodology of data generation unknown.
Completeness	Data includes all relevant material flows.	1: Value includes all relevant processes/flows in question (e.g., all material types are included in the data) 2: Value based on data with some missing information (e.g., data includes 75% of materials in scope) 3: Value based on data with moderate missing information (e.g., data includes 50% of materials in scope) 4: Only fragmented data available; important processes/flows are missing.
Temporal correlation	Congruence of the available data and the ideal data with respect to time reference.	1: Value relates to the relevant period of analysis. 2: Deviation of value 1 to 5 years. 3: Deviation of value 5 to 10 years. 4: Deviation more than 10 years.
Geographical correlation	Congruence of the available data and the ideal data with respect to geographical reference.	1: Value relates to the studied region. 2: Value relates to similar socioeconomical region (GDP, consumption pattern). 3: Socioeconomically slightly different region (e.g., 1 standard deviation in GDP) 4: Socioeconomically very different region (e.g., 2 standard deviations in GDP)
Other correlation	Congruence of the available data and the ideal data with respect to technology, product, etc.	1: Value relates to the same product, the same technology, etc. 2: Values relate to similar technology, product, etc. 3: Values deviate from technology/product of interest, but links can be established based on experience or data 4: Values deviate strongly from technology/product of interest with correlations being vague and speculative.

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2. Baseline results for 2020-21

This section contains results from the MFA performed for used packaging in Australia in 2020-21. An assessment of the packaging PoM data is first given, before describing MFA results in detail. This section also summarises findings for CDS-eligible packaging. Full details of MFA results for CDS-eligible packaging, including redemption rates and interstate flows of eligible packaging, are included in the *standalone CDS report*.

2.1. Packaging placed on the market in 2020-21

Table 7 shows the quantities of packaging PoM in 2020-21 by material type. Overall, approximately 6.7 million tonnes of packaging were PoM in 2020-21. Paper packaging types accounted for approximately 50% on a mass basis, with 3.4 million tonnes PoM. Old-corrugated cardboard made the largest contribution of the paper packaging types PoM, accounting for 75% of paper packaging PoM, and 38% of total packaging PoM. Glass packaging also made a significant contribution, accounting for 19% of all packaging PoM, noting however that glass packaging, which is predominately bottles, is relatively heavy. Plastic packaging accounted for 18% of all packaging PoM, with rigid polymer types accounting for 10%, and flexible types 8%. Wood packaging, primarily reusable and single-use pallets, made up 9% of packaging PoM, and metal made up 4%.

Table 7: Quantities of packaging PoM in 2020-21.

Material category	Material	Total PoM, 2020-21 [tonnes]
Paper	Polymer coated paperboard	94,000
	Paperboard and cartonboard	315,000
	Old-corrugated cardboard	2,539,000
	Other fibre packaging	439,000
Glass	Glass - Green	445,000
	Glass - Amber	233,000
	Glass - Clear	605,000
Plastic – rigid	PET - rigid	135,000
	HDPE - rigid	214,000
	LDPE - rigid	10,000
	PVC - rigid	4,000
	PP - rigid	166,000
	PS - rigid	17,000
	EPS - rigid	29,000
	Compostable - rigid	2,000
	Other polymers - rigid	62,000
Plastic – flex	PET - flex	14,000
	HDPE - flex	72,000
	LDPE - flex	321,000
	PVC - flex	10,000
	PP - flex	49,000
	Compostable - flex	1,000
	Other polymers - flex	70,000
Metal	Aluminium	102,000
	Steel	152,000
Wood	Wood	638,000
Total		**6,740,000**

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Figure 2 shows the distribution of packaging PoM in 2020-21 by format, and Figure 3 provides a breakdown of packaging formats by material category. Quantities of the ‘carton or box’ format PoM accounted for approximately 48% of all packaging PoM. From Figure 3, the majority of the ‘carton or box’ format consists of paper packaging, with only small quantities of wood and rigid plastic cartons PoM. The ‘bottle or jar’ format category also had large quantities PoM at approximately 1.6 million tonnes, or 24% of total packaging PoM. This category mostly consists of glass packaging types, making up over 75% of the ‘bottle or jar’ format category.

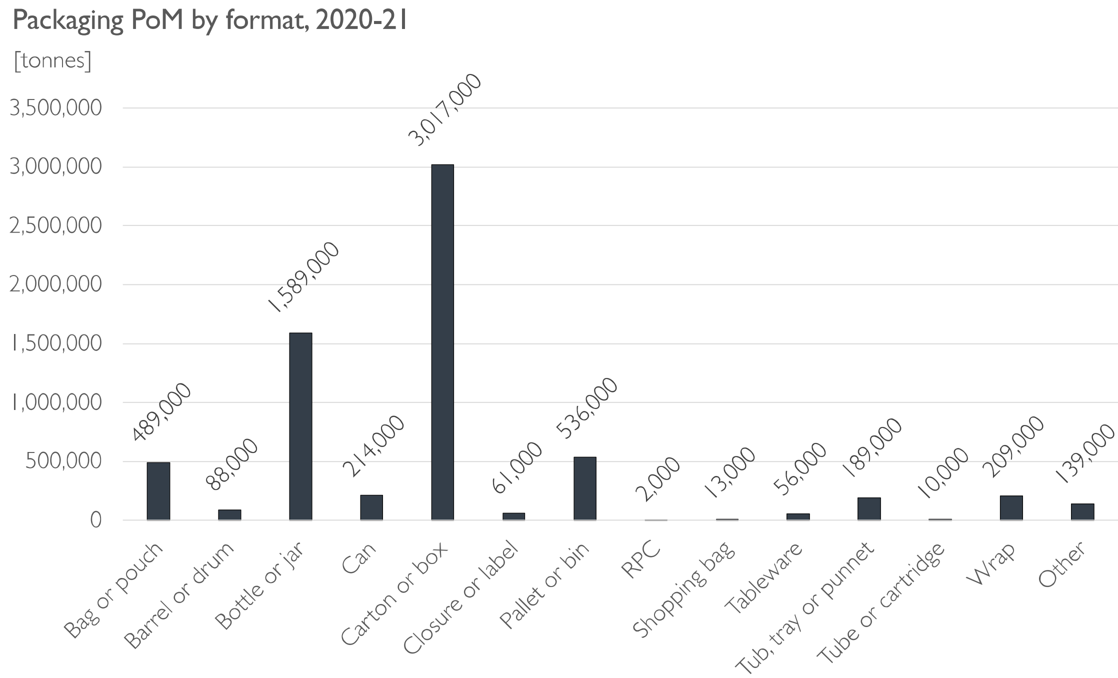

Figure 2: Distribution of packaging PoM by format.

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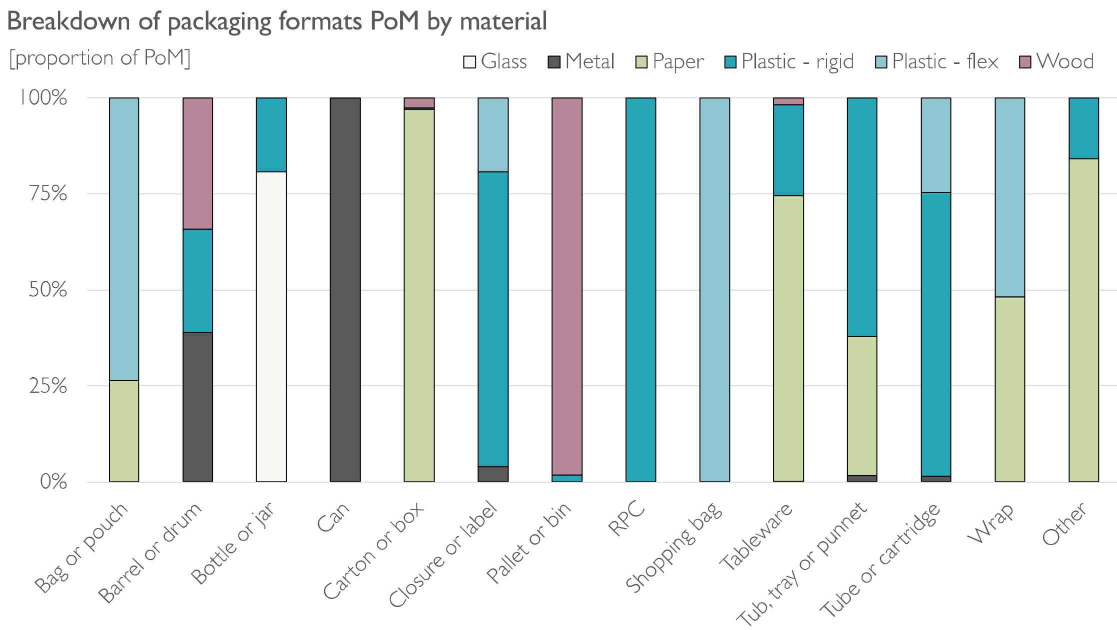

Figure 3: Breakdown of packaging formats by material type.

Packaging formats consisting of difficult-to-recover soft plastics, include the 'bag or pouch', 'shopping bag' and 'wrap' format categories. The total quantity of these formats PoM was approximately 713,000 tonnes, although these categories, namely 'bag or pouch' and 'wrap' do include a proportion (~33%) of paper material. Table 8 shows a breakdown of these formats for soft plastics by polymer, with approximately 482,000 tonnes PoM across 'bag or pouch', 'shopping bags' and 'wrap' format categories. The 'bag or pouch' category accounted for the majority of soft plastics PoM. A significant quantity of soft plastics PoM had the 'unknown' format category, representing approximately 26% of all soft plastics PoM. For this MFA, quantities of unknown packaging type PoM was apportioned to the other relevant format categories for each material type. As an example, 78% of flexible HDPE packaging PoM was 'bags or pouches', therefore 78% of flexible HDPE with unknown format was apportioned to the 'bags or pouches' format category.

Table 8: Soft plastic packaging PoM by format.

Material	Bags or pouches PoM [tonnes]	Closures and labels PoM [tonnes]	Shopping bags PoM [tonnes]	Tubes and cartridges PoM [tonnes]	Wrap PoM [tonnes]	Unknown format [tonnes]
PET	5,000	0	0	0	8,000	1,000
HDPE	57,000	1,000	4,000	3,000	0	8,000
LDPE	233,000	0	9,000	0	70,000	8,000
PVC	1,000	0	0	0	8,000	1,000
PP	17,000	4,000	0	0	18,000	9,000
Compostable	1,000	0	0	0	0	0
Other polymers	45,000	6,000	0	0	3,000	15,000
Total	**360,000**	**11,000**	**13,000**	**3,000**	**109,000**	**42,000**

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Table 9 shows the breakdown of packaging PoM by source, and primary vs. secondary materials. Overall, 3.7 million tonnes of packaging were imported, while 3 million tonnes was manufactured locally.

Table 9: Breakdown of packaging PoM by source.

Material	Local manufactured (primary material) [tonnes]	Local manufactured (secondary material) [tonnes]	Total local manufactured [tonnes]	Imported (primary material) [tonnes]	Imported (secondary material) [tonnes]	Total imported [tonnes]
Glass	438,000	395,000	**833,000**	251,000	199,000	**450,000**
Metal	19,000	3,000	**22,000**	137,000	94,000	**232,000**
Paper	424,000	1,117,000	**1,540,000**	665,000	1,182,000	**1,847,000**
Plastic – all	182,000	53,000	**235,000**	939,000	5,000	**944,000**
Plastic – rigid	*64,000*	*35,000*	***99,000***	*539,000*	*3,000*	***542,000***
Plastic – flexible	*118,000*	*18,000*	***136,000***	*400,000*	*2,000*	***402,000***
Wood	404,000	0	**404,000**	233,000	0	**233,000**
Total	**1,466,000**	**1,568,000**	**3,034,000**	**2,225,000**	**1,480,000**	**3,706,000**

Table 10 shows the breakdown of packaging PoM for consumption at-home and away-from-home. For this table, non-household packaging is aggregated by combining B2B consumption, and B2C away from home consumption. Approximately 55% of packaging PoM was consumed as non-household packaging. Non-household packaging is mostly dominated by paper packaging at 63%. For the other packaging materials, household consumption is generally higher, with the exception being wood packaging. A small (<2%) fraction of packaging PoM has an unknown consumption category.

Table 10: Breakdown of packaging PoM by consumption sector.

Material	Household packaging consumption (B2C – at home) [tonnes]	Non-household packaging consumption (B2B & B2C – away from home) [tonnes]	Unknown consumption category [tonnes]
Glass	910,000	373,000	0
Metal	164,000	90,000	0
Paper	893,000	2,370,000	124,000
Plastic – all	864,000	313,000	2,000
Plastic – rigid	*495,000*	*145,000*	*1,000*
Plastic – flexible	*369,000*	*168,000*	*1,000*
Wood	0	637,000	0
Total	**2,831,000**	**3,783,000**	**126,000**

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2.2. Packaging material flows and management performance in 2020-21

This sub-section shows results from the MFA for overall packaging flows. This includes detail on CDS-eligible packaging flows summarised from the *standalone CDS report*, as well as reusable packaging, and household vs. non-household packaging.

Figure 4 shows estimated material flows for Australian used packaging in 2020-21. The figure shows the management pathways for used packaging from consumption through to recovery and disposal. Of the approximately 6.7 million tonnes of packaging PoM in 2020-21, roughly 2.6 million tonnes was collected for recovery via kerbside systems. Approximately 322,000 tonnes of used packaging were also collected via dedicated CDS eligible collections. 159,000 tonnes of reusable packaging were PoM, contributing to an in-use pool of 1.1 million tonnes of packaging. Approximately 159,000 tonnes of reusable packaging also reached end-of-life during this period, entering the management system for further processing. 46,100 tonnes of reusable packaging were ultimately destined for landfill disposal. Approximately 950,000 tonnes of B2B soft plastics and paper packaging were sent directly to reprocessors, bypassing MRF sorting. Overall, 3.8 million tonnes of used packaging were recovered, with an overall recovery rate of 56.2%. It was estimated that 7,000 tonnes of soft plastics through the REDcycle system, and 1,000 tonnes of rigid HDPE through the kerbside system were collected for recycling but not utilised, contributing to existing stockpiles of unutilised packaging. Approximately 3 million tonnes of used packaging were disposed to landfill, mostly due to losses at collection (e.g., disposed to non-recyclable waste streams).

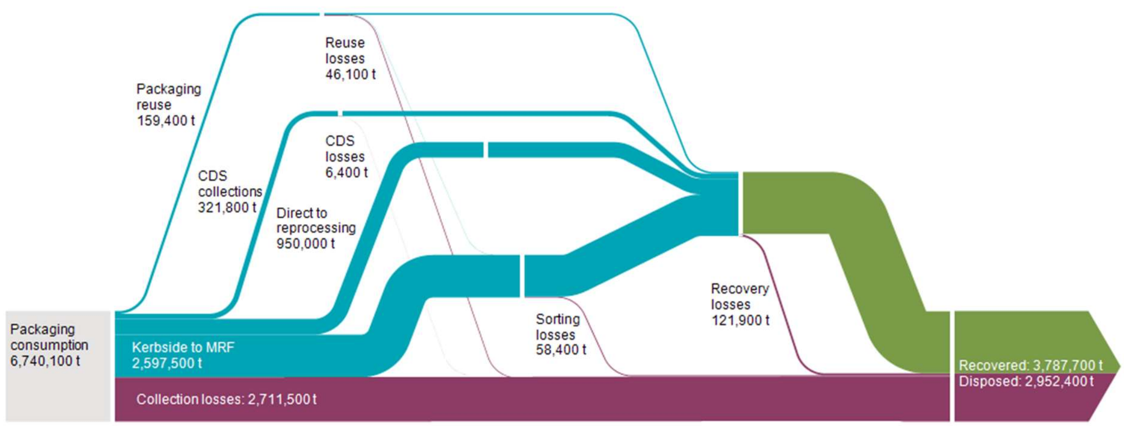

Figure 4: Simplified material flows of overall packaging PoM in Australia for 2020-21.

Figure 5 shows calculated performance metrics for all materials and material categories in scope for 2020-21.

Overall, the collection rate for all used packaging was approximately 59%, and was highest for paper (72%), glass (68%) and metal (63%) packaging. Of the individual packaging material types in scope, amber coloured glass (93%), old-corrugated cardboard (85%) and aluminium (80%) packaging had the highest collection rates. In the case of amber coloured glass and aluminium, CDS collections and kerbside collection via dry recyclable systems have likely contributed significantly to these high collection rates. In the case of old-corrugated cardboard, the collection rate of 85% is impacted by significant quantities of this material type collected via B2B and sent directly to reprocessing, as well as kerbside collection via dry recyclable systems. Collection rates were poorest generally for plastic packaging, which had collection rates of 28% for rigid polymers, and 10% for flexible polymers. Rigid

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PET, LDPE, HDPE, PP and EPS packaging all had lower collection rates relative to other material categories, with collection rates ranging between 20% to 45%. Polymer coated paperboard also had poor collection rates, at approximately 3%, attributed primarily to CDS collections.

Overall packaging recovery was 56.2%, and was highest for paper (70%), glass (63%) and metal (58%) packaging types. Recovery rate performance is consistent with collection performance, with amber glass, old-corrugated cardboard and aluminium packaging all achieving the highest levels of recovery. Recovery rates were poorest for plastic packaging, reflecting poor collection rates which are a key limiting factor to improving recovery rate performance.

Table 11 summarises total quantities of packaging recovered by recovery pathway. Overall, 3.8 million tonnes of packaging were recovered, with 2.8 million tonnes recovered locally as recyclate, destined for packaging and non-packaging applications. Approximately 1 million tonnes were recovered via overseas export pathways, primarily old-corrugated cardboard, paperboard, aluminium, steel, PET, HDPE and PP packaging types[9]. More than 90% of all aluminium recovery occurred via overseas export pathways. Notably, all glass packaging recovered in 2020-21 was done locally. This was also the case with flexible packaging recovery, with bag/pouch and wrap recovery all occurring locally. Paper packaging had the greatest quantity of material recovered locally (by weight).

From a material circularity perspective, amber glass and old-corrugated cardboard packaging had the highest circularity rates (proportion recovered utilised for new local packaging) of 45% and 44% respectively. Clear and green coloured glass had high local utilisation rates of 62% and 51% respectively, but lower rates of circularity, at 27% and 23% respectively. Almost half (45%) of all clear glass packaging PoM is imported from overseas, which could explain the difference between local utilisation and circularity rates for clear glass (i.e., demand is lower for locally manufactured clear glass packaging). In the case of green coloured glass, however, imported packaging accounts for only 28% of PoM, similar to amber glass PoM (24%). This may then indicate a low demand for local green glass recycled content for new packaging, or that local remanufacturing capacity for green coloured glass packaging is low.

Local utilisation and packaging material circularity rates for plastic packaging were poor, with only 9% of recovered plastic utilised locally, and only 4% used as inputs into new plastic packaging. Circularity rates were highest for rigid PET and HDPE, at 14% and 6% respectively. PET and HDPE bottles collected via CDS systems had packaging material circularity rates of 31% and 10% respectively. This was higher than PET and HDPE packaging collected via kerbside systems, which had packaging circularity rates of 2% and 4% respectively. This illustrates that the separate collection of rigid plastics can lead to a higher quality and cleaner input stream for plastic recyclers compared to kerbside collections, leading better circular outcomes. Notably, all rigid PET recovered locally was utilised for packaging purposes, however resolution on the ultimate application of recyclate for packaging (e.g., food contact, non-food contact) is unknown.

[9] Note that further restrictions on plastic waste exports came into effect in July 2021, and were not considered within the timeframe of our analysis (2020-21 financial year). Details on the plastic waste export bans that came into effect in July 2021 are found here: https://www.dcceew.gov.au/environment/protection/waste/exports/plastic

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Material	Collection rate [% of PoM]	Sorting rate [% of PoM]	Recovery rate [% of PoM]	Local utilisation [% of PoM]	Packaging material circularity rate [% of PoM]
Polymer coated paperboard	2.6%	2.5%	2.5%	0.3%	0.3%
Paperboard and cartonboard	35.1%	34.8%	34.4%	11.1%	11.1%
Old-corrugated carboard	85.1%	84.8%	83.3%	44.2%	43.8%
Other fibre packaging	33.9%	33.7%	32.9%	18.3%	18.2%
Glass - Green	56.3%	53.9%	51.4%	51.4%	23.0%
Glass - Amber	92.8%	90.9%	86.6%	86.6%	44.5%
Glass - Clear	67.7%	64.9%	61.8%	61.8%	27.2%
PET - rigid	44.8%	43.9%	42.6%	13.8%	13.8%
HDPE - rigid	32.7%	32.1%	30.3%	13.9%	5.8%
LDPE - rigid	33.0%	29.7%	28.3%	13.0%	2.3%
PVC - rigid	1.2%	1.1%	1.1%	0.1%	0.0%
PP - rigid	20.5%	18.5%	17.4%	10.5%	4.2%
PS - rigid	12.5%	11.2%	10.9%	3.3%	0.3%
EPS - rigid	34.1%	30.7%	30.5%	11.9%	0.5%
Compostable - rigid	3.9%	3.5%	3.2%	3.2%	0.0%
Other polymers - rigid	2.2%	2.0%	2.0%	0.6%	0.0%
HDPE - flexible	2.9%	2.8%	1.0%	1.0%	0.4%
LDPE - flexible	12.5%	11.5%	9.1%	8.5%	1.5%
PP - flexible	3.9%	3.7%	2.0%	1.9%	0.8%
Compostable - flexible	5.0%	4.6%	3.3%	3.3%	0.0%
Other polymers - flexible	15.4%	13.8%	13.3%	9.4%	0.0%
Aluminium	79.9%	74.4%	74.4%	0.3%	0.0%
Steel	51.0%	47.3%	46.8%	11.6%	0.0%
Wood	45.3%	45.3%	40.8%	40.8%	0.0%
Glass	68.3%	65.8%	62.7%	62.7%	28.9%
Metal	62.6%	58.2%	57.9%	7.0%	0.0%
Paper	71.5%	71.2%	70.0%	36.6%	36.2%
Plastic - all	20.0%	19.0%	17.5%	9.1%	3.7%
Plastic - rigid	*28.3%*	*27.2%*	*26.0%*	*11.2%*	*6.0%*
Plastic - flexible	*10.2%*	*9.4%*	*7.5%*	*6.6%*	*1.0%*
Wood	45.3%	45.3%	40.8%	40.8%	0.0%
Total	**59.1%**	**58.1%**	**56.2%**	**36.0%**	**24.4%**

Figure 5: Calculated performance metrics for used packaging in 2020-21. Note values in the table are highlighted on a colour scale green to red, indicating good to poor performance.

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Table 11: Quantities of used packaging recovered by pathway in 2020-21.

Material	Recovery via baled exports [tonnes]	Recovery via locally produced recyclate [tonnes]	Total recovered [tonnes]
Glass	0	805,000	805,000
Metal	126,000	21,000	147,000
Paper	820,000	1,550,000	2,370,000
Plastic - all	82,000	125,000	207,000
Plastic – rigid	*82,000*	*85,000*	*167,000*
Plastic – flexible	*0*	*40,000*	*40,000*
Wood	0	260,000	260,000
Total	**1,027,000**	**2,760,000**	**3,788,000**

2.2.1 Material flows of CDS-eligible packaging

This sub-section outlines MFA results for CDS-eligible packaging, summarised from data and results presented in the *standalone CDS report.*

Table 12 shows the quantities of CDS-eligible packaging PoM by material in 2020-21. Overall, approximately 562,000 tonnes of CDS-eligible packaging were PoM, accounting for around 8% of all packaging PoM. Amber coloured glass had the largest share of CDS-eligible material, at approximately 66% of overall amber glass packaging PoM. This is expected, as the majority of overall amber coloured glass packaging on the market are beer bottles and eligible for CDS redemption. The share of CDS-eligible aluminium was also high, at approximately 54%. This is also expected, given the majority of aluminium packaging PoM are beverage cans, and eligible for CDS systems. Quantities of CDS-eligible PET bottles PoM was also significant, at approximately 54% of overall PET bottle PoM. CDS-eligible HDPE bottles however had a much smaller proportion of total HDPE bottle PoM, at only 4%. This is likely owing to a large proportion of HDPE bottles being large (e.g., 2L and above) milk and juice bottles, not generally accepted for CDS, as well as non-food and beverage applications such as shampoo bottles.

Table 12: CDS-eligible packaging PoM in 2020-21.

Packaging material	CDS-eligible packaging PoM, 2020-21 [tonnes]	Fraction of overall packaging that is CDS-eligible
Glass	439,900	34.3%
Metal	53,000	20.9%
Paper	6,900	0.2%
Plastic – all	62,000	5.3%
Plastic – rigid	*62,000*	*9.1%*
Plastic – flexible	*0*	*0.0%*
Wood	0	0.0%
Total	**561,800**	**8.3%**

Figure 6 shows estimated material flows for overall CDS-eligible packaging in 2020-21. The figure shows the general management path for CDS-eligible packaging from consumption through to recovery and disposal. Approximately 321,800 tonnes of CDS-eligible material were collected via dedicated CDS collection (i.e., redemption point drop offs), with the remaining 239,900 tonnes of CDS-eligible material managed through the kerbside system. Losses of CDS-eligible packaging at the point of collection (e.g.,

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through littering, or disposal to the kerbside mixed waste stream) were estimated to be approximately 93,200 tonnes, representing the major source of losses in the system.

Table 13 summarises total recovery of CDS-eligible packaging by recovery pathway for 2020-21. Overall, approximately 438,300 tonnes of CDS-eligible packaging were recovered (78% recovery rate), with 379,100 tonnes recovered locally as recyclate, destined for packaging and non-packaging applications. Approximately 59,200 tonnes of CDS-eligible packaging were recovered via overseas export pathways, primarily aluminium packaging, which made up 75% of all CDS-eligible packaging exports. Polymer coated paperboard (PCPB) and steel packaging recovery was done so via overseas export exclusively. Significant quantities of plastic packaging (PET and HDPE) were also exported (11,400 tonnes and 1,200 tonnes respectively), however local recovery of these packaging types was also significant, with the majority of CDS-eligible plastic packaging recovered locally for recyclate. With further bans on plastic waste export in effect as of July 2021, it is likely that exports of CDS PET and HDPE packaging will continue, however the impact that the current bans will have on CDS export quantities is unclear at this stage. In order for waste plastic to be exported, it must first be sorted into single polymer streams and further processed (e.g., as flake or pellets), which is more practical for the source separated CDS stream compared with the commingled kerbside recyclable stream. All glass packaging recovered was recovered locally as recyclate.

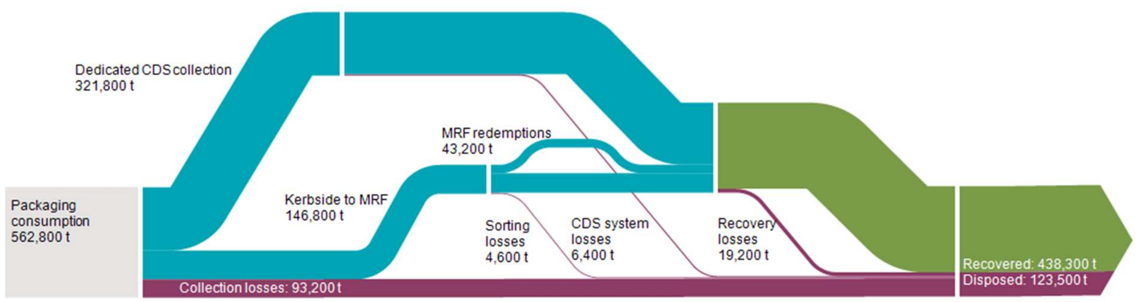

Figure 6: Simplified material flows of CDS-eligible packaging in Australia for 2020-21.

Table 13: Summary of Australian CDS-eligible packaging recovery in 2020-21.

CDS-eligible material	Recovery via export (bales) [tonnes]	Recovery via locally produced recyclate [tonnes]	Total recovery [tonnes]
Aluminium	44,600	100	44,700
Glass - Amber	0	136,700	136,700
Glass - Clear	0	136,700	136,700
Glass - Green	0	81,600	81,600
PET - rigid	11,400	22,500	33,800
HDPE - rigid	1,200	1,600	2,800
PCPB	1,800	0	1,800
Steel	200	0	200
Other polymers - rigid	0	0	0
Total	**59,200**	**379,100**	**438,300**

Table *14* shows quantities of redeemed CDS-eligible packaging by materials. Here, redeemed refers to packaging that has been collected through a redemption pathway, which includes dedicated CDS collection (e.g., CDS depot drop-offs, CDS reverse vending machines), and redemption through MRF sorting facilities. Overall, 73% of all CDS-eligible material in Australia was redeemed in 2020-21, with

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a total quantity redeemed of approximately 411,300 tonnes. Total CDS-eligible packaging not redeemed was approximately 151,500 tonnes. Glass packaging had the highest rates of redemption, at 77% for amber and clear containers, and 76% for green coloured containers. ‘Other polymer’ containers had the lowest redemption rates of 6%, however total volume of CDS-eligible packaging of this type is small, at only 7 tonnes PoM. Excluding ‘Other polymer’ containers, PCPB had the lowest redemption rates at 27%.

Table 14: CDS-eligible packaging redemption in 2020-21.

Material	CDS-eligible material redeemed (all pathways) [tonnes]	CDS-eligible material not redeemed [tonnes]	Redemption rate (proportion of CDS-eligible redeemed) [%]
Aluminium	36,100	16,600	69%
Glass - Amber	118,200	35,600	77%
Glass - Clear	134,700	40,100	77%
Glass - Green	84,900	26,400	76%
PET - rigid	33,200	23,000	59%
HDPE - rigid	2,200	3,600	38%
PCPB	1,800	5,000	26%
Steel	100	200	33%
Other polymers - rigid	-	<100	0%
Total	**411,300**	**151,500**	**73%**

Figure 7 shows calculated performance metrics for each CDS-eligible packaging material group, aggregated to the national level, and for overall CDS-eligible packaging. These metrics are also provided by material type for CDS-eligible and non-eligible packaging in

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Table ***15***.

The overall collection rate of CDS-eligible packaging was approximately 83%, compared to 47% for non-eligible packaging. Note that collection rates include both the proportion of CDS-eligible packaging collected via dedicated collections and collected for recycling at the kerbside. Collection rates have been shown previously to be the key limiting factor in packaging recovery[10]. Our analysis shows that collection rates of CDS-eligible plastic is significantly higher at 63%, compared to non-CDS eligible packaging, at 26%. This highlights how collection of packaging via dedicated separate collection systems that are convenient and easy to use, and coupled with the provision of incentives for behaviour change, can have a significant positive impact on packaging collection rates.

Amber coloured glass had the highest collection rates of all CDS-eligible material, achieving a collection rate of 95%, due to a high redemption via dedicated drop-offs (77%), and efficient collection at the kerbside. Clear and green coloured glass had poorer collection performance compared to amber, with collection rates of 84% and 79% respectively. It is unclear why amber glass achieves higher performance compared to other coloured glass, despite redemption rates being relatively consistent across the glass types. One possible reason may be due to consumption of bottled beer at licensed venues, from which used amber bottles may be deposited at redemption points. Note for all glass packaging, including non-CDS eligible packaging, a large proportion of recovered glass (approximately 50% across the glass colour types) was utilised for non-packaging applications (e.g., as abrasives, and civil projects). Reasons for this are unclear and outside the scope of investigation.

Excluding 'Other polymer' packaging, collection rates were poorest for PCPB (27%) and HDPE (51%). Notably, redemption rates for these materials varied significantly across the jurisdictions: between 4% (ACT) and 63% (SA) for HDPE; and 15% (ACT) and 44% (NT) for PCPB. Sorting rates were consistent across the material types, with only a small decrease in performance from collection to sorting or around 2%, indicating that MRFs are efficient in sorting kerbside collected material.

The overall recovery rate for CDS-eligible packaging was 78%, compared to 45% for non-eligible packaging.

[10] ISF (2021)

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Table ***15*** compares recovery rates for CDS-eligible vs. non-eligible material groupings, showing clearly that CDS-eligible packaging significantly outperformed non-eligible packaging in terms of recovery. This illustrates that improving collection rates via multiple channels, whether through separate collection or improved kerbside collection systems, can have a significant impact on potential recovery rates.

Of the packaging materials, amber coloured glass and aluminium had the highest recovery rates, at 89% and 85% respectively. PCPB and HDPE had the poorest recovery rates, consistent with collection rate performance for these materials.

The overall local utilisation rate for CDS-eligible packaging was 67%, and was highest for glass packaging types, especially amber. Aluminium, steel and PCPB had local utilisation rates below 1%, despite having recovery rates between 27% and 85%. This illustrates the reliance on overseas processing for those streams, with recovery via overseas export the only available pathway. This shows that recovery of these materials is sensitive to potential disruptions in waste material export pathways, which could significantly impact potential recovery of these materials in the future.

The overall packaging circularity rate for CDS-eligible packaging was 33%, compared to 17% for non-eligible materials. Packaging circularity was highest for glass packaging (33% - 46%), and PET packaging (31%). Notably, the circularity rate for CDS-eligible PET was significantly higher than non-eligible PET packaging, which achieved a packaging circularity rate of only 2%. This illustrates that the largely source separated stream of used packaging feedstock derived from CDS systems has a greater potential for producing recyclate for packaging purposes. This is compared to non-CDS and kerbside system derived material, which may be of a poorer feedstock quality.

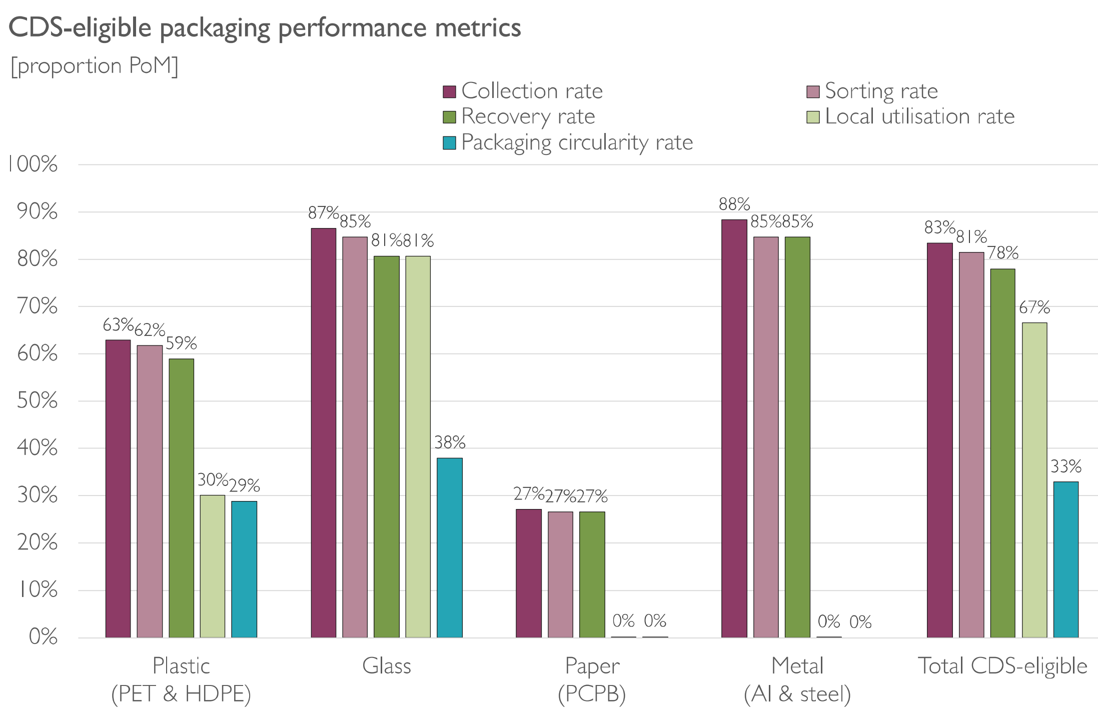

Figure 7: Performance indicators for CDS-eligible packaging in 2020-21.

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Table 15: Comparison of CDS-eligible and non-eligible packaging performance metrics for 2020-21.

CDS-eligible packaging performance					
Material	Collection rate	Sorting rate	Recovery rate	Local utilisation rate	Packaging material circularity rate
Aluminium	88.5%	84.8%	84.8%	0.1%	0.0%
Glass - Amber	95.1%	93.4%	88.9%	88.9%	45.6%
Glass - Clear	84.1%	82.0%	78.2%	78.2%	34.4%
Glass - Green	78.7%	76.9%	73.4%	73.3%	32.8%
PET - rigid	64.2%	63.0%	60.2%	30.7%	30.7%
HDPE - rigid	51.2%	50.3%	47.8%	24.6%	10.2%
PCPB	27.2%	26.6%	26.6%	0.2%	0.2%
Steel	63.0%	59.3%	59.3%	0.6%	0.0%
Other polymers	7.3%	7.0%	7.0%	3.3%	0.0%
Total	**83.4%**	**81.4%**	**78.0%**	**66.5%**	**32.9%**
Non-eligible packaging performance					
Material	Collection rate	Sorting rate	Recovery rate	Local utilisation rate	Packaging material circularity rate
Aluminium	70.6%	63.2%	63.2%	0.3%	0.0%
Glass - Amber	88.2%	86.2%	82.1%	82.1%	42.2%
Glass - Clear	61.1%	57.9%	55.2%	55.2%	24.3%
Glass - Green	48.8%	46.2%	44.1%	44.1%	19.7%
PET - rigid	30.6%	30.0%	29.8%	1.7%	1.7%
HDPE - rigid	27.1%	26.5%	25.2%	9.0%	3.7%
PCPB	0.7%	0.6%	0.6%	0.3%	0.3%
Steel	45.0%	40.5%	40.4%	0.9%	0.0%
Other polymers	1.8%	1.6%	1.6%	0.5%	0.0%
Total	**49.8%**	**47.1%**	**45.3%**	**36.4%**	**16.5%**

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2.2.2 Material flows of reusable packaging

Table 16 and Table 17 summarise quantities of new reusable packaging PoM for 2020-21 for in scope reuse, along with existing stock of reusable packaging in-use (the *in-use pool*), and quantities of reusable packaging reaching end-of-life. Table 16 shows this data by reusable packaging type, while Table 17 aggregates this data to the material category level.

Overall, approximately 159,400 tonnes of new reusable packaging were PoM in 2020-21. Wooden pallets accounted for approximately 59% of all reusable packaging PoM, and approximately 85% of the existing in-use pool of reusable packaging. Reusable plastic packaging also accounted for a significant proportion of total new reusable packaging PoM (27%). Several reusable packaging types were made of plastic or had significant plastic components. These include reusable pallets, non-collapsible and collapsible crates, drums and reusable shopping bags. Reusable shopping bags made up the majority of all reusable plastic packaging PoM.

Total end-of-life arisings of reusable packaging was approximately 159,000 tonnes, slightly less than new packaging PoM. This indicates that over the 2020-21 period, the stock of in-use reusable packaging has increased.

Table 16: Summary of reusable packaging PoM, in-use pool, and end-of-life by material category for 2020-21.

Reusable packaging type	Material category	New reusable PoM [tonnes]	In-use pool [tonnes]	Reusable packaging end-of-life [tonnes]
Kegs for beer & cider	Aluminium	100	3,500	100
	Steel	100	4,300	100
Drums (200–205 L)	HDPE – rigid	2,200	6,500	2,200
	Steel	13,200	39,300	13,200
	Steel	200	700	200
IBC – rigid	Steel	8,200	12,400	8,200
Reusable pallets – Plastic	HDPE – rigid	10,400	80,300	10,400
	Steel	2,300	23,400	2,300
	Wood – hard	29,600	296,200	29,600
	Wood – soft	61,800	617,800	61,800
Plastic crates – Non-collapsible	HDPE – rigid	500	5,300	500
	PP – rigid	500	5,300	500
Plastic crates – RPC	PP – rigid	1,000	9,600	500
Reusable shopping bags – HDPE	HDPE – flexible	6,000	300	6,000
Reusable shopping bags – LDPE	LDPE – flexible	17,000	500	17,000
Reusable shopping bags – PP	PP – flexible	5,900	1,800	5,900
Cups/mugs	Glass – clear	200	400	200
	LDPE – rigid	100	200	100
	PP – rigid	100	200	100
	Other – rigid	<100	100	<100
	Steel	<100	100	<100

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Table 17: Summary of reusable packaging PoM, in-use pool, and end-of-life by material category for 2020-21.

Material category	New reusable PoM [tonnes]	In-use pool [tonnes]	Reusable packaging end-of-life [tonnes]
Glass	200	400	200
Metal	24,200	83,700	24,300
Paper	0	0	0
Plastic - all	43,600	110,200	43,100
Plastic - rigid	*14,800*	*107,600*	*14,300*
Plastic - flexible	*28,900*	*2,600*	*28,900*
Wood	91,400	914,000	91,400
Total	**159,400**	**1,108,200**	**159,000**

While reusable packaging and reuse systems in general can contribute towards the circular flow of materials, a key benefit of current reusable packaging systems is the offsetting of new single-use packaging PoM. The estimated single-use offset is shown in Table 18, based on analysis in Blue Environment (2022). Reusable packaging in 2020-21 offset an estimated 2.6 million tonnes of new, single-use packaging PoM, representing an estimated reduction in single-use packaging demand of approximately 28%. The majority of this offset is wood, through the use of reusable wooden pallets. The use of reusable plastic crates contributed to over 100,000 tonnes of paper packaging avoidance, and approximately 1,000 tonnes of plastic packaging avoidance.

Table 18: Estimated single-use packaging offset through reuse for 2020-21.

Material	Single-use packaging offset through packaging reuse [tonnes]
Glass	32,000
Metal	42,000
Paper	145,000
Plastic - all	95,000
Plastic – rigid	*80,000*
Plastic – flexible	*15,000*
Wood	2,249,000
Total	**2,563,000**

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2.2.3 Household and non-household packaging

Figure 8 shows the path of materials management for household and non-household packaging for 2020-21, and Figure 9 shows performance metrics for household and non-household packaging by material.

Overall packaging recovery is significantly higher for non-household packaging, at approximately 2.5 million tonnes compared to 1.3 million tonnes for household packaging. As previously shown in Table 10, a key difference between the streams is that non-household packaging contains greater quantities of paper packaging, whilst the household stream contains greater quantities of plastic packaging. Paper packaging generally has higher rates of collection and recovery compared to other materials, while plastic packaging generally has low rates of collection and recovery (Figure 5). This leads to higher overall rates of collection and recovery for non-household packaging, at 68% collected and 66% recovered respectively, compared to 47% collected and 44% recovered for household packaging. Quantities of non-household paper (old-corrugated cardboard) and soft plastics (LDPE wrap) packaging directly received for reprocessing, bypassing kerbside collection and sorting, also contributes to higher non-household collection and recovery rates for these materials.

Performance of household glass packaging was significantly greater than the non-household stream, at 65% recovered compared to 55% for non-household glass. The majority of glass bottle consumption however is via the household waste stream, and this difference is likely due to large quantities of household glass packaging managed through CDS redemptions. Differences in performance for metal and rigid plastics were minor between household and non-household streams.

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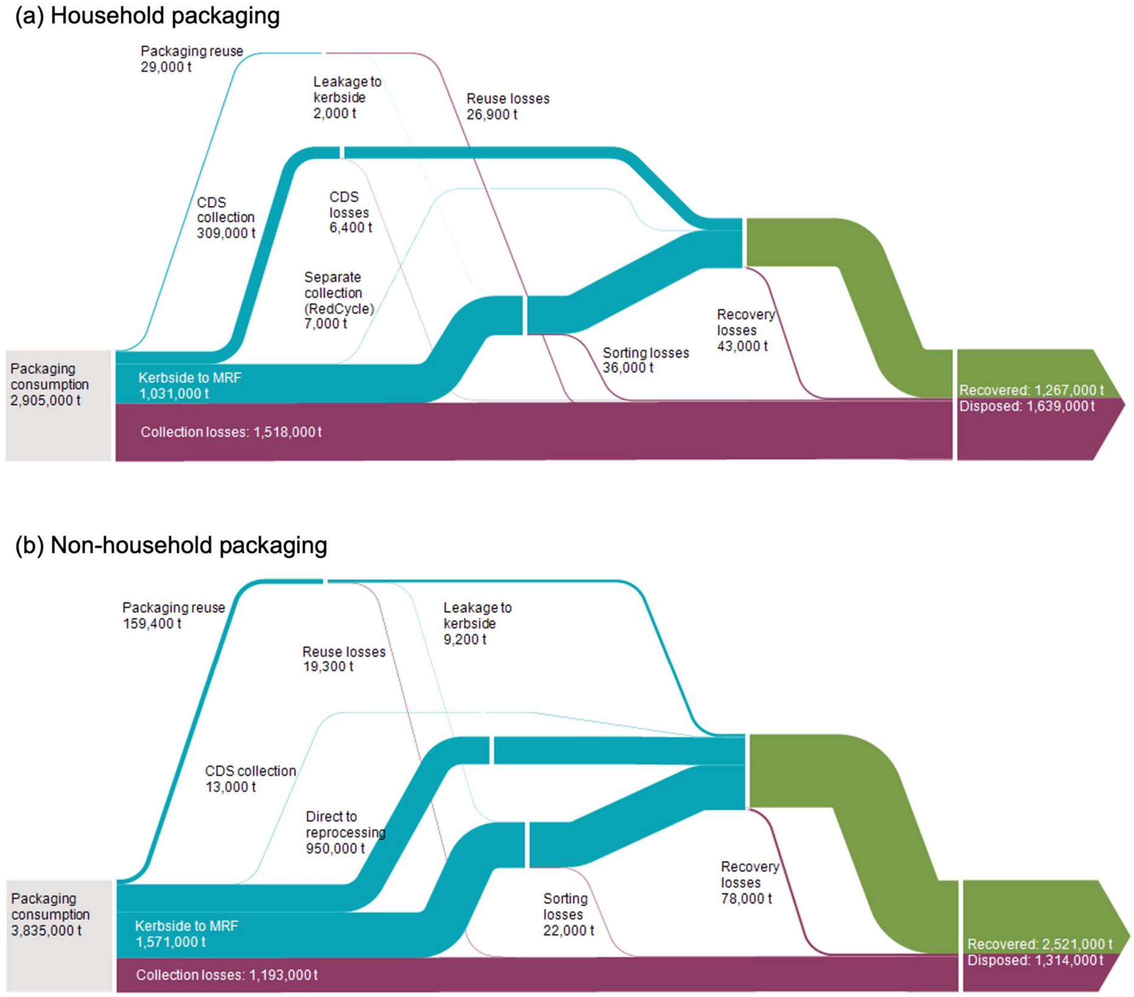

Figure 8: Simplified material flows of household and non-household packaging management in Australia for 2020-21.

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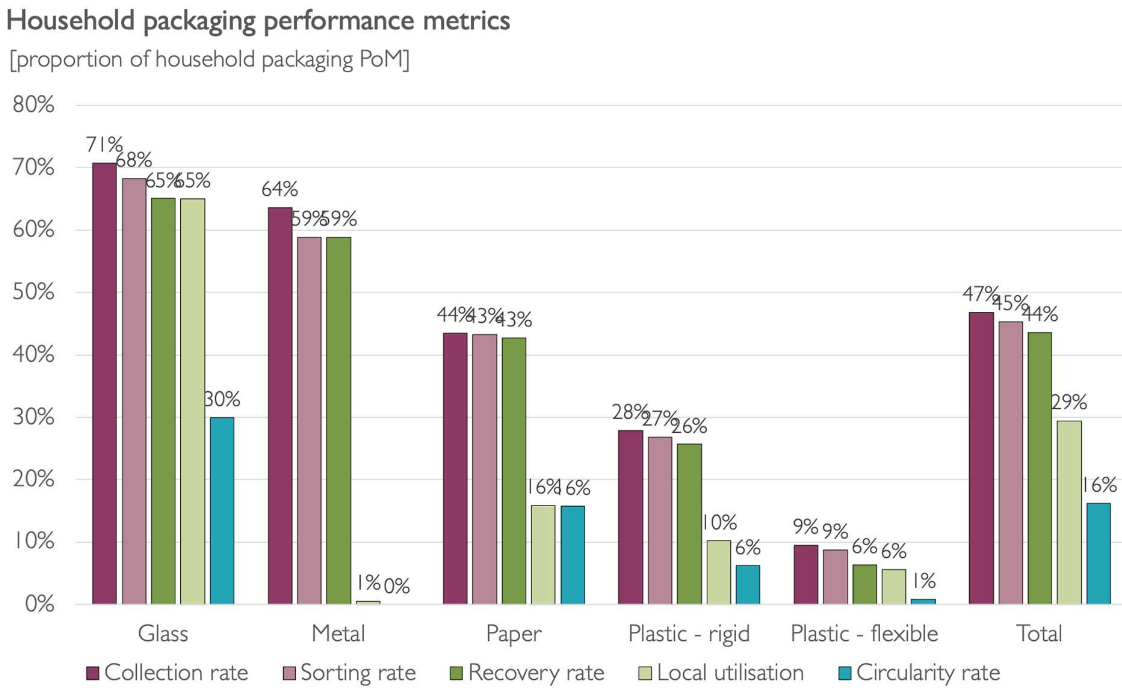

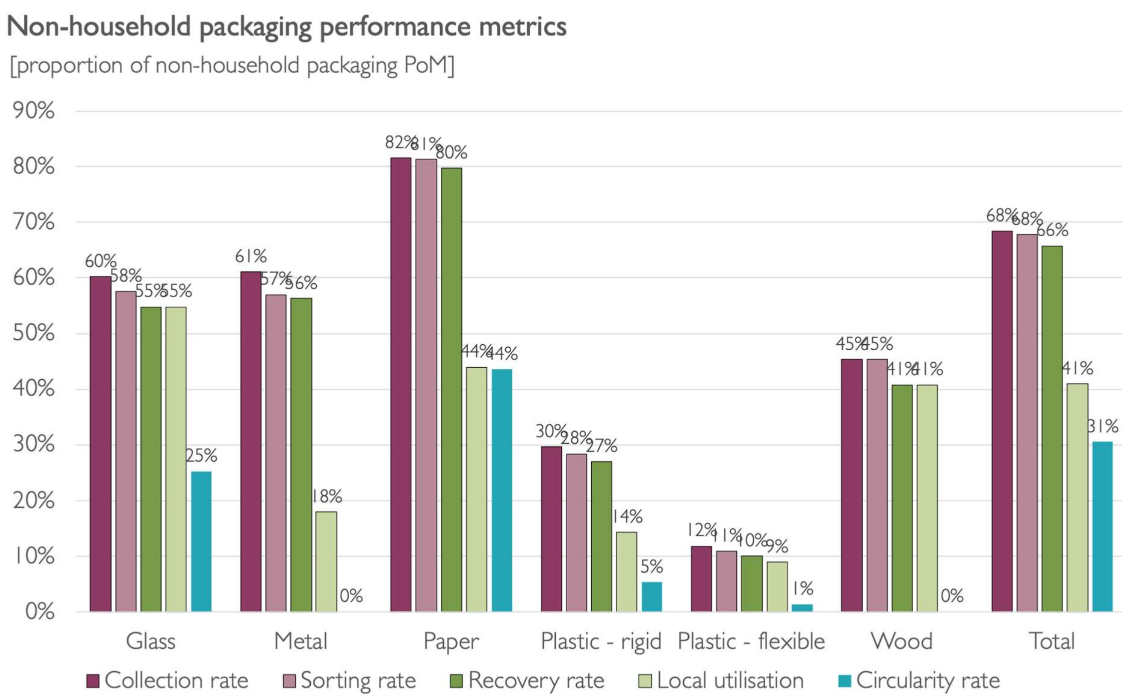

Figure 9: Comparison of performance metrics by packaging material, for household and non-household packaging.

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2.3. Uncertainty of material flow estimates

Table 19 shows estimated uncertainty ranges on performance metrics calculated per packaging material group. Uncertainty was within a reasonable range, with the overall recovery estimate varying by ±11%-points, or ±20% relative uncertainty. Wood and flexible plastic packaging had the greatest level of uncertainty on performance metrics, with recovery rates for these materials varying ±32% and ±26% respectively, relative to baseline performance. In the case of wood packaging, there was high uncertainty on quantities PoM, which impacts on uncertainty of subsequent system flows. In the case of soft plastics, there is high uncertainty on key flows, including REDcycle collections, and MRF sorting rates.

Table 19: Estimated uncertainty ranges on calculated performance metrics by packaging material.

Material	Collection rate	Sorting rate	Recovery rate	Local utilisation rate	Packaging circularity rate
Glass	68% [59% - 78%]	66% [54% - 78%]	63% [54% - 72%]	63% [54% - 72%]	29% [25% - 33%]
Metal	64% [58% - 70%]	58% [50% - 66%]	58% [50% - 66%]	7% [6% - 8%]	0% [0% - 0%]
Paper	71% [62% - 81%]	71% [59% - 83%]	70% [56% - 84%]	37% [28% - 45%]	36% [28% - 44%]
Plastic – all	23% [19% - 26%]	18% [14% - 23%]	18% [14% - 21%]	9% [7% - 11%]	4% [3% - 4%]
Plastic – rigid	*29% [25% - 33%]*	*27% [22% - 33%]*	*26% [21% - 31%]*	*11% [10% - 13%]*	*6% [5% - 7%]*
Plastic – flex	*16% [12% - 19%]*	*8% [6% - 10%]*	*7% [5% - 9%]*	*7% [5% - 8%]*	*1% [1% - 1%]*
Wood	49% [34% - 63%]	45% [32% - 59%]	41% [28% - 54%]	41% [28% - 54%]	0% [0% - 0%]
Total	**60% [51% - 69%]**	**58% [47% - 69%]**	**56% [45% - 67%]**	**36% [29% - 43%]**	**24% [19% - 29%]**

Figure 10 shows greater resolution of estimated uncertainty for each material flow and material category, classified as 'low', 'medium', 'high' and 'very high'. Uncertainty on each material flow in the figure impact on the uncertainty ranges presented in Table 19. Material flows associated with MRF sorting were generally medium to high across all material groups, and highest for plastic packaging. Uncertainty on MRF flows is due to a reliance on international proxy data on MRF sorting, as no data exists on local MRF sorting efficiencies. Uncertainty on MRF flows also has an impact on estimates for collection losses, which are estimated via back calculation based on expected inputs into MRFs, as well as uncertainty on recovery for quantities of material sorted at MRFs before reprocessing. Medium-high relative variance on PoM quantities also has an impact on overall uncertainty through the system, as many subsequent material flow calculations rely on PoM estimates. The effect of high variance on PoM quantities can be seen clearly with wood packaging, which had the highest variance on PoM quantities from the Blue Environment (2022) data compared to other materials. All subsequent wood packaging material flows are also either high, or very high where other uncertainties are introduced (e.g., flow F4.9 – direct to reprocessing).

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Flow name	Flow num.	Glass	Metal	Paper	Plastic - all	Plastic - rigid	Plastic - flex	Wood
Packaging placed on the market	F0.1	Medium	Low	Low	Medium	Medium	Medium	High
Reusable packaging	F1.2	Low	Low	NA	Medium	Low	Medium	High
Dedicated CDS-eligible collection	F1.3	Medium	Low	Low	Low	Low	NA	NA
Packaging consumption (non-household)	F1.4	Medium	Low	Low	Medium	Medium	Medium	High
Packaging consumption (household)	F1.5	Medium	Low	Low	Medium	Medium	Medium	High
EoL reusable packaging to reprocessing	F2.9	Low	Low	NA	Medium	Medium	Medium	High
Leakage - non-household	F2.4	Low	Low	NA	Medium	Medium	Medium	High
Leakage - household	F2.5	Low	Low	NA	Medium	Low	Medium	High
EoL reusable packaging to landfill	F2.6	Low	Low	NA	Medium	Low	Medium	High
CDS exports	F3.0	NA	Medium	Low	Low	Low	NA	NA
CDS containers to reprocessing	F3.9	Medium	NA	NA	Low	Low	NA	NA
CDS containers to landfill	F3.6	Medium	Medium	Low	Low	Medium	NA	NA
Direct to reprocessing (B2B)	F4.9	NA	NA	High	Low	NA	Medium	Very high
Non-household collections to sorting	F4.7	Medium	Medium	Low	Medium	Medium	Medium	High
Collection losses (non-household)	F4.6	Medium	Medium	Low	Medium	Medium	Medium	High
Household collections to sorting	F5.7	Medium	Medium	Low	Medium	Medium	Medium	High
REDcycle	F5.8	NA	NA	NA	High	NA	Very high	NA
Collection losses (household)	F5.6	Medium	Medium	Low	Medium	Medium	Medium	High
CDS eligible containers (MRF redemption)	F7.3	High	Low	NA	Low	Medium	NA	NA
Sorted packaging	F7.9	High	Medium	Medium	High	High	High	NA
MRF exports	F7.0	NA	Medium	Medium	Medium	High	NA	NA
Sorting losses	F7.6	High	Medium	Medium	High	High	High	Very high
Stockpiled sorted packaging	F7.8	NA	NA	NA	High	High	High	NA
Local reprocessor recovery	F9.0	Medium	NA	High	Medium	Medium	Medium	NA
Reprocessor losses	F9.6	Low	Low	High	Medium	Low	Medium	High

Key

Green	±5-10% uncertainty
Yellow	±10-20% uncertainty
Light red	±20-30% uncertainty
Red	±30%+ uncertainty

Figure 10: Summary of uncertainty on estimated material flows by material.

Some degree of uncertainty is always expected when modelling systems as complex as that analysed for this study. Table 19 shows that uncertainty across the material flow estimates do not result in unreasonably high uncertainties on calculated performance metrics, and gives confidence that the best available data was utilised for this analysis. Data gaps are however present, and addressing material flows with high uncertainty will lead to improved modelling uncertainty for future analyses. Table 20 gives a summary of identified data gaps, and potential approaches for addressing them.

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Table 20: Summary of identified data gaps, based on the uncertainty analysis performed.

Data gap/limitation	Significance	Recommendations
Limited data on MRF sorting flows	- Data on MRF sorting flows are limited, with only flows of direct export from MRFs available in the Blue Environment (2022) data. - Proxy data[11] utilised for calibrating MRF flows, however this data is specific to the United States, and is more than 5 years old. - MRF flows are used to estimate kerbside collection flows, therefore uncertainty in MRF flows impacts on collection loss estimates.	- Data collection describing flows of material at Australian MRFs would negate the need for proxy data, and would improve uncertainty around MRF and collection system flows. However, MRF data is challenging to obtain, given the commercial nature of MRFs. - Process modelling of MRFs in Australia, whereby the individual components of the sorting process and their efficiencies are modelled, could improve uncertainty. Such an approach would still require proxy data (e.g., efficiency of optical sorters for sorting plastic packaging), and surveys of local MRF facilities to understand what processes are in place in Australian MRFs. This approach is a middle ground between current MRF flow estimation, and comprehensive primary data collection from MRFs.
Limited data on kerbside collection	- Kerbside collection material flows are estimated based on assumed quantities entering MRF sorting facilities, as well as dedicated CDS collections, via back calculation. This introduces uncertainty into kerbside collection estimates.	- Data on quantities of material collected via kerbside collection is challenging to obtain, given that they are managed by local government areas in Australia. - Utilising data from the Packaging Recyclability Evaluation Portal (PREP) and recyclability data from Blue Environment, littering data from the Australian Litter Measure (AusLM), as well as available jurisdiction data on coverage of kerbside recycling systems, could lead to a more robust estimate of collection losses. - Performing the modelling on a material-format basis (e.g., PET-bottle, Aluminium-can, etc) basis would be required in order to best utilise PREP and local government area kerbside system data. While this would introduce uncertainty into the model, the result would be a better characterisation of packaging collection losses.
Uncertainty of packaging PoM	- Some materials, including wood, glass and plastic packaging PoM, have relatively high uncertainty on quantities PoM. This uncertainty at the input side of the system model impacts uncertainty across all material flows, as illustrated in Figure 10, especially for wood packaging.	- Working with APCO and Blue Environment is needed to help understand why some materials have high uncertainty on quantities PoM, and to address this data limitation.

[11] Pressley, P.N.; Levis, J.W.; Damgaard, A.; Barlaz, M.A.; DeCarolis, J.F. (2015). Analysis of material recovery facilities for use in life-cycle assessment, *Waste Management* 35, 307-317

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3. Scenario analysis

For this study, nine separate scenarios were evaluated for 2024-25, including a baseline business-as-usual (BAU), and a combined scenario. The aim of the scenario analysis was to measure the impacts of different management interventions on packaging recovery. Each scenario is modelled using the system model for the 2020-21 analysis. These scenarios are summarised in Table 21, with more detail on scenario assumptions included in the appendix. System performance metrics are calculated for each scenario, and recovery rates compared to estimated 2024-25 BAU performance, to identify the relative impact that each scenario may have on improving packaging management performance. BAU performance is based on packaging PoM projections in Blue Environment (2022), as well as assumed expansion of CDS systems to all Australian states and territories by 2024-25.

Note that Scenarios 1, 2 and 6 in Table 21 target the CDS system, and are the same as scenarios 2 to 4 in the *standalone CDS report*. Performance for these scenarios is reported here on total packaging basis rather than CDS-eligible packaging basis, as in the *standalone CDS report*.

Table 21: Overview of scenarios for 2024-25 modelled in this analysis.

Scenario	Packaging material targeted	Significance
Business-as-usual, 2024-25	All	BAU includes increasing packaging PoM as projected in Blue Environment (2022), and also includes expansion of CDS to all Australian jurisdictions.
Scenario 1 – expanded plastic beverage container CDS eligibility	Plastic – rigid	CDS eligibility across Australia expanded to include additional plastic beverage containers, namely: flavoured milk varieties (up to and including 3L bottles), juice and cordial bottles.
Scenario 2 – plastic food containers eligible for CDS	Plastic – rigid	CDS eligibility expanded across Australia to include rigid plastic food containers.
Scenario 3 – B2C soft plastics collection via kerbside recycling	Plastic – flexible	Consumer soft plastic packaging (HDPE, LDPE and PP) is collected for recycling via existing kerbside collection systems.
Scenario 4 – B2C soft plastics collection via dedicated collection	Plastic – flexible	Consumer soft plastic packaging (HDPE, LDPE and PP) is collected for recycling via a dedicated separate collection system, similar in design to a CDS scheme.
Scenario 5 – increase in B2B soft plastics collection	Plastic – flexible	B2B collections of flexible LDPE packaging are ramped up, which is sent direct to reprocessing, bypassing MRF sorting.
Scenario 6 – CDS wine and spirit bottle eligibility	Glass	CDS eligibility expanded across Australia to include wine and spirit glass bottles.
Scenario 7 – increase in B2B paper packaging collection	Paper	B2B collections of old-corrugated cardboard packaging is ramped up, which is sent direct to reprocessing for recovery, bypassing MRF sorting.
Scenario 8 – combined impact scenario	Plastic – rigid Plastic – flexible Glass Paper	This scenario evaluates the combined impact of interventions modelled in the above scenarios on potential packaging management performance in 2024-25.

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3.1. Packaging placed on the market, 2024-25

Table *22* shows the projected quantities of packaging PoM in 2024-25, compared to quantities in 2020-21. Overall, packaging consumption will increase by approximately 11% in 2024-25 over 2020-21 levels. Glass, metal and wood packaging all see increases in quantities PoM between 9% and 11%. Paper packaging will see the largest increase in quantities PoM, at 13% overall. Of the paper packaging materials, PCPB quantities will see the highest increases in PoM, at 15%. Overall plastic packaging PoM will increase by 8%, driven mainly by increases in rigid plastic PoM. On average, flexible plastic packaging PoM will increase by approximately 4% driven mostly by increases in flexible LDPE PoM. **Figure *11*** shows the change in quantities of plastic packaging PoM between 2020-21 and 2024-25. An additional 43,900 tonnes of flexible LDPE packaging are projected to be PoM in 2024-25, and an additional 600 tonnes of flexible compostable polymers are also projected to be PoM. All other flexible polymer packaging will see a decrease in PoM volumes in 2024-25 compared to 2020-21 of approximately 24,500 tonnes in total.

Table 22: Projected packaging PoM in 2024-25, compared to 2020-21.

Material	Packaging PoM in 2020-21 [tonnes]	Projected packaging PoM in 2024-25 [tonnes]	Percentage change
Glass	1,283,000	1,409,000	9.8%
Metal	254,000	276,000	8.7%
Paper	3,387,000	3,826,000	13.0%
Plastic - all	1,179,000	1,277,000	8.3%
Plastic – rigid	641,000	719,000	12.2%
Plastic – flexible	538,000	558,000	3.7%
Wood	638,000	705,000	10.5%
Total	**6,740,000**	**7,493,000**	**11.2%**

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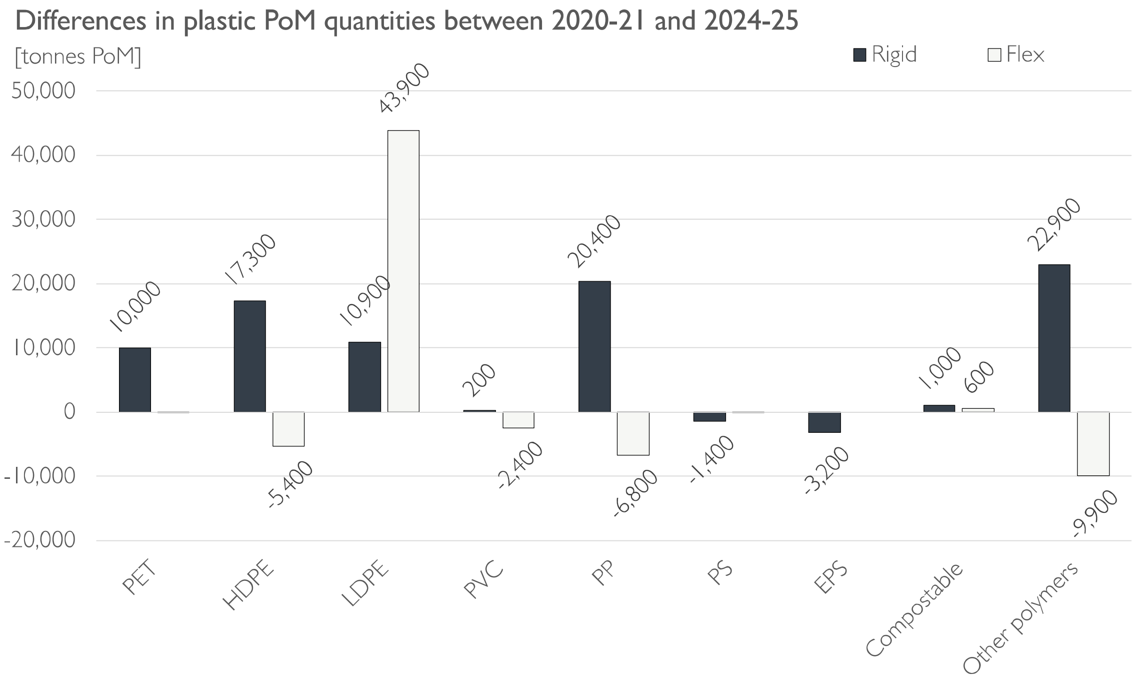

Figure 11: Differences in plastic packaging PoM quantities between 2020-21 and 2024-25.

3.2. Projected packaging recovery system performance in 2024-25

Figure 12 shows the simplified material flows for the BAU 2024-25 system.. Material flows in 2024-25 are proportionally similar to 2020-21 system flows (shown in **Figure *4***) with the key difference being a greater proportion of B2C packaging collected via CDS as a result of the expansion of CDS nationally. Overall, approximately 4.3 million tonnes of packaging are projected to be recovered in 2024-25, an increase of approximately 13% over 2020-21 recovery.

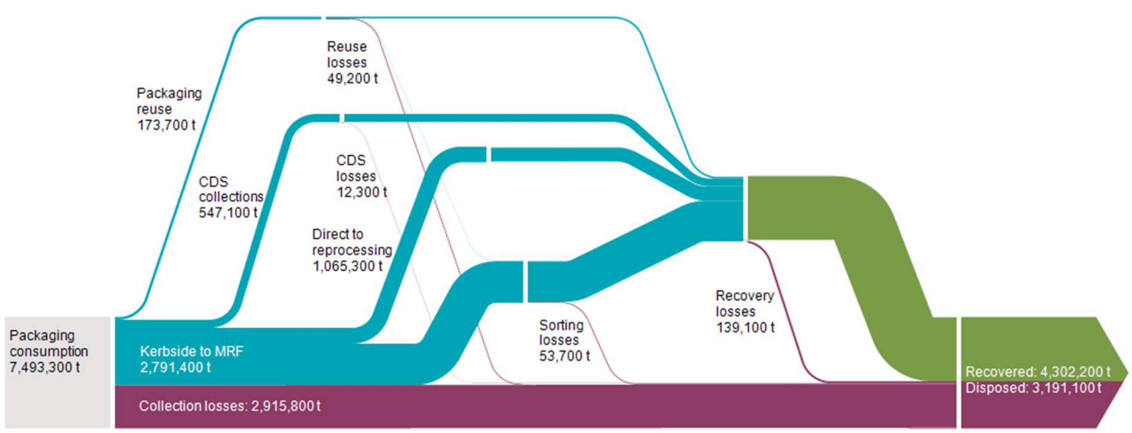

Figure 12: Simplified material flows for the projected business-as-usual (BAU) 2024-25 scenario.

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Table 23 shows projected quantities of CDS-eligible packaging PoM and redemption of eligible materials in 2024-25, summarised from the *standalone CDS report*. 955,500 tonnes of CDS-eligible packaging are expected to be PoM in BAU 2024-25, an increase of approximately 70% compared to 2020-21 PoM. This large increase is expected given projected increases in packaging consumption in 2024-25, along with geographical expansion of CDS systems to include all Australian states and territories by 2024-25. Quantities of eligible glass packaging, especially clear glass packaging, will see the largest increases in eligible packaging PoM. Projected redemption of CDS-eligible packaging is expected to be approximately 699,300 tonnes, an increase over 2020-21 levels of almost 70%.

Table 23: Projected quantities of CDS-eligible packaging PoM and redemption in 2024-25.

Material	Projected CDS-eligible PoM in 2024-25 [tonnes]	Projected CDS-eligible PoM redeemed in 2024-25 [tonnes]
Aluminium	88,300	60,500
Glass - Amber	241,100	185,200
Glass - Clear	314,300	242,200
Glass - Green	194,200	148,200
PET - rigid	94,900	56,100
HDPE - rigid	9,300	3,500
PCPB	12,845	3,400
Steel	580	200
Other polymers	<100	<100
Total	**955,500**	**699,300**

Table 24 summarises performance metrics for 2024-25. Values highlighted in bold within the table denote significant deviations from the performance observed in 2020-21.[12] Notably, performance in 2024-25 is slightly improved over 2020-21 performance across all materials and indicators. Recovery rate performance increases from 56.2% in 2020-21 to 57.4% in 2024-25 for the BAU scenario. The only significant improvements in performance were seen with overall plastic and rigid plastic circularity rates, due to expanded CDS.

Table 24: Projected performance metrics for business-as-usual (BAU) 2024-25.

Material	Collection rate 2024-25 [% of PoM]	Sorting rate 2024-25 [% of PoM]	Recovery rate 2024-25 [% of PoM]	Local utilisation rate 2024-25 [% of PoM]	Packaging material circularity rate 2024-25 [% of PoM]
Glass	72.2%	69.9%	66.7%	66.6%	30.7%
Metal	65.7%	60.2%	59.9%	7.0%	0.0%
Paper	71.5%	71.2%	70.0%	36.5%	36.2%
Plastic – all	23.6%	20.0%	18.4%	10.1%	4.7%
Plastic – rigid	29.6%	28.1%	26.8%	12.7%	7.5%
Plastic – flexible	15.8%	9.6%	7.6%	6.8%	1.1%
Wood	48.6%	45.0%	40.5%	40.5%	0.0%
Total	**61.1%**	**59.4%**	**57.4%**	**37.0%**	**25.1%**

[12] Deviations are determined by taking into account the uncertainties associated with 2020-21 performance, which are described in Table 19. Any projected performance indicator that falls outside the range of uncertainty from the 2020-21 table is deemed to be significantly different.

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Table 25 compares recovery rates for 2020-21 and BAU 2024-25. As indicated previously, recovery rates in 2024-25 are not significantly different to 2020-21 with BAU scenario assumptions. The largest increase in recovery rates was seen for glass, increasing by 4%, a result of CDS-expansions. Notably, plastic packaging recovery performance is significantly below performance necessary to meet the 2025 National Packaging Targets (2025 Targets), and the impacts of CDS expansion is marginal - increasing recovery rate performance by approximately 1%. Significant system changes are necessary to improve plastic packaging recovery to meet the 2025 Target. Soft plastic packaging must be targeted also for improved recovery, given that flexible packaging types make up almost half of all plastic packaging PoM. It is noted that recently announced plans for expansion of local soft plastic packaging recovery will potentially have a significant impact on soft plastics recovery in the future, beyond the 2024-25 timeframe. For example, the *National Plastics Recycling Scheme*[13] developed by the Australian Food and Grocery Council, is Australia's largest industry-led plastics recycling scheme, and aims to increase the amount of plastic waste recovered by 190,000 tonnes per year towards meeting the 2025 National Packaging Target for plastics. The *Soft Plastics Taskforce*[14] has also recently been established by major supermarket retailers to address growing volumes of soft plastics waste through improved access to soft plastics collection.

Table 25: Comparison of recovery rate performance between 2020-21 and 2024-25.

Material	Packaging recovery rate in 2020-21	Projected packaging recovery rate in 2024-25	Percentage-point change
Glass	62.7%	66.7%	+4.0%
Metal	57.9%	59.9%	+2.0%
Paper	70.0%	70.0%	+0.0%
Plastic - all	17.5%	18.4%	+0.9%
Plastic – rigid	*26.0%*	*26.8%*	*+0.8%*
Plastic – flexible	*7.5%*	*7.6%*	*+0.1%*
Wood	40.8%	40.5%	-0.3%
Total	**56.2%**	**57.4%**	**+1.2%**

[13] Australian Food and Grocery Council (2023). *National Plastics Recycling Scheme*, https://www.afgc.org.au/industry-resources/national-plastics-recycling-scheme#nprs|0 (accessed 7th September 2023)

[14] Woolworths Group (2023). *Soft Plastics Taskforce lays out path to resout soft plastic recycling*, https://www.woolworthsgroup.com.au/au/en/media/latest-news/2023/soft-plastics-taskforce-lays-out-path-to--restore-soft-plastic-r.html (accessed 7th September 2023)

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3.3. Comparison of scenario performance

This sub-section compares collection and recovery performance across all scenarios and BAU for 2024-25. Scenario assumptions are found in the appendix, and more detailed CDS-specific findings for Scenarios 1, 2 and 6 are found in the *standalone CDS report*.

3.3.1. Packaging collection performance

Key points:

- Implementing all scenario interventions would see an additional 557,000 tonnes of packaging collected for recycling compared to BAU
- Increased collection of B2B cardboard packaging would lead to an addition 206,000 tonnes of cardboard collected for recycling
- Expansion of CDS eligibility to include wine and spirit bottles would lead to an additional 196,000 tonnes of glass packaging collected for recycling
- Increase in B2B soft plastics collection, and the collection of B2C soft plastics via the kerbside would lead to an addition 86,000 tonnes of soft plastics collected for recycling, resulting in an increase in soft plastics collection rate from 16% in BAU, to 33%.

Table *27* summarises quantities of additional used packaging collections for recycling above BAU 2024-25 quantities for each scenario analysed. If all interventions are implemented, there would be an expected 557,000 tonnes of additional used packaging collected for recycling - representing 7% of total projected PoM for 2024-25. Scenarios 6 and 7 individually had the highest volumes of additional packaging collected. Approximately 206,000 tonnes of additional old-corrugated cardboard were collected with additional B2B collections (Scenario 7). Assumed additional collections of B2B old-corrugated cardboard was limited by assumed spare paper recovery capacity in 2024-25.[15] Expanding glass packaging eligibility to include wine and spirit bottles (Scenario 6) would lead to an additional 196,000 tonnes of clear and green coloured glass packaging collected for recycling, which will have a significant impact on glass packaging performance (evaluated further in this section). Considering estimated capacity levels in 2024-25 reported by Blue Environment (2022), there would likely be sufficient glass recovery capacity to process this additional quantity locally.

Additional rigid plastic packaging collections for recycling were lower than glass and paper. Expanding beverage container eligibility (Scenario 1) will lead to an additional 10,000 tonnes of packaging collected for recycling, and expanded food packaging eligibility (Scenario 2) will lead to an additional 40,000 tonnes collected (PET, HDPE, PP and PVC types). It is expected that sufficient recovery capacity will exist to process additional quantities of plastic packaging locally[16]. It is also expected that a significant proportion of the additional rigid plastic packaging collected for recycling would be eligible for export overseas for further processing. This is due to CDS collections resulting in a cleaner stream of used packaging compared to MRF sorting, that would potentially still be eligible for export under federal plastic waste export rules.

With respect to soft plastics, the collection of consumer soft plastics via existing kerbside collection systems (Scenario 3, based on current Australian trials by the National Plastics Recycling Scheme) would lead to an additional 35,100 tonnes of soft plastic packaging collected and available for recycling

[15] Blue Environment (2022)
[16] Blue Environment (2022)

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- an increase of approximately 40% compared to BAU levels. The collection of soft plastics via dedicated collection pathways (Scenario 4) will also lead to an increase in collection for recycling, increasing by 17,900 tonnes, or 21% above BAU levels. The potential for additional soft plastics collection from the B2B stream however is greater, with approximately 51,000 tonnes of additional soft plastic (LDPE) collected for recycling and sent directly to local reprocessing for recycling (Scenario 5). This is equivalent to approximately 40% of B2B flexible LDPE packaging PoM in 2024-25. Note that assumed capacities for local soft plastic recovery are conservative, and that there is a significant degree of uncertainty on projected recovery capacity in Australia for soft plastics. For this study, data in Blue Environment (2022) is used which estimates approximately 51,000 tonnes of flexible LDPE recovery capacity coming online by 2024-25. A recent report published by APCO[17] indicates future soft plastics capacity expansion ranging from 45,000 tonnes to over 100,000 tonnes of additional capacity, depending on a range of capacity investments coming online by 2025 (e.g., IQ Renew Soft Plastics Engineered Commodities plants).

Implementing all interventions targeting plastic packaging (Scenarios 1 to 5 including rigid and flexible), would lead to an additional 154,500 tonnes of plastic packaging collected for recycling - a significant increase over BAU of approximately 30%. Available processing capacity however is insufficient to process this increased quantity of plastic packaging collections, especially with respect to soft plastics.[18] Ensuring that local recovery capacity is sufficient for future packaging management interventions is essential in ensuring additional materials collected are processed and utilised, and not stockpiled.

Table 26: Summary of additional quantities of packaging collected for recycling above baseline 2024-25 levels, for each scenario and packaging material.

Material	Scenario 1 CDS expansion (plastic bottles) [tonnes]	Scenario 2 CDS expansion (plastic food containers) [tonnes]	Scenario 3 B2C soft plastic collection via kerbside [tonnes]	Scenario 4 B2C soft plastic collection via dedicated pathway [tonnes]	Scenario 5 B2B increased collection of soft plastics [tonnes]	Scenario 6 CDS expansion (glass bottles) [tonnes]	Scenario 7 B2B increased collection of old-corrugated cardboard [tonnes]	Scenario 8 Combined impact scenario [tonnes]
Glass	0	0	0	0	0	+196,400	0	+196,400
Metal	0	0	0	0	0	0	0	0
Paper	0	0	0	0	0	0	+206,200	+206,200
Plastic	+10,200	+40,200	+35,100	+17,900	+51,100	0	0	+154,500
rigid	*+10,200*	*+40,200*	*0*	*0*	*0*	*0*	*0*	*+50,400*
flex	*0*	*0*	*+35,100*	*+17,900*	*+51,100*	*0*	*0*	*+104,100*
Wood	0	0	0	0	0	0	0	0
Total	**+10,200**	**+40,200**	**+35,100**	**+17,900**	**+51,100**	**+196,400**	**+206,200**	**+557,100**

[17] Australian Packaging Covenant Organisation (2023). *Review of the 2025 National Packaging Targets – Final Report*. Available at: https://documents.packagingcovenant.org.au/public-documents/Review%20of%20the%202025%20National%20Packaging%20Targets

[18] Blue Environment (2022)

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3.3.2. Packaging recovery performance

Key points:

- Implementing all scenario interventions would see an improvement over BAU recovery rates of 3%-points
- Interventions targeting plastic packaging would lead to increases in plastic packaging specific recovery rates of up to 10%-points—less than required to meet the 2025 National Packaging Target for plastic packaging recovery
- Expanded CDS eligibility would have the most impact on glass packaging recovery, increasing from a recovery rate of 67% to 72%
- Expansion of CDS eligibility to include wider range of plastic bottles types (e.g., juice and cordial) would have a marginal impact on plastic packaging recovery, increasing by <1%-points over BAU recovery
- Additional collections of B2C and B2B soft plastics make a relatively small impact on the plastic recovery rate, with increased B2B collections having the largest impact on recovery

Figure *13* shows overall packaging recovery rates (i.e., total recovered divided by total PoM) for BAU 2024-25, and for each scenario including the combined impact scenario. **Table *27*** summarises recovery rates by scenario compared to BAU, by material category impacted by each scenario (e.g., Scenario 1 impacts plastic recovery, Scenario 7 impacts paper recovery, etc.). The overall packaging recovery rate for the combined impact scenario is 60.4%, an increase of 3% over BAU performance. The combined scenario has a major impact on the plastic packaging recovery, increasing from 18.4% for BAU, to 28.2%. This is expected, given the significant increases in plastic packaging collected for recycling in this scenario. Notably, even with implementing all scenario interventions, the 70% plastic packaging recovery 2025 Target is not able to be met.

Of the individual scenarios, the expanded glass packaging eligibility scenario (Scenario 6) had the largest impact on recovery performance, with glass recovery increasing from a rate of 66.7% for BAU 2024-25, to 71.8%. The impact of this scenario on overall packaging recovery however was small, increasing from 57.4% for BAU 2024-25, to 58.4%. A key benefit of CDS from a recovery system perspective, is packaging collected via CDS is cleaner (i.e., reduced contamination) than waste collected via mixed recycling. This improves the potential applications of recyclate generated from the CDS systems to be used for the production of new packaging. Expansion of CDS systems to include wine and spirit bottles will almost double the potential quantities of packaging-grade recyclate generated, increasing from 117,000 tonnes in the BAU case, to 203,000 tonnes. This highlights that CDS can have a major impact on promoting material circularity for glass packaging.

Ramp up of B2B collections of flexible LDPE (Scenario 5) had the second largest increase in recovery rate of the scenarios examined, and the largest impact on plastic packaging recovery. The soft plastics recovery rate increased from 7.6% for BAU 2024-25, to 15.3%. This increase in soft plastics recovery performance corresponds to an improvement in the overall plastic packaging recovery rate, increasing from 18.4% in the BAU case, to 21.8%. Collection of B2C soft plastics via the kerbside (Scenario 3) also had a significant impact on plastic packaging recovery, increasing by 2% over BAU to 20.4%, and was the second most impactful plastic scenario. Collection of B2C soft plastics via dedicated separate collection (Scenario 4) had a smaller impact on the overall plastic recovery rate, seeing a 1.7% increase in recovery rate, increasing to 20.1%. The performance improvement is greater in Scenario 3 compared to Scenario 4, due to the greater volumes of soft plastics collected, as shown in **Table *26***, which leads

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to a proportional impact in quantities recovered. From a recovery perspective, the dedicated collection pathway is the preferred pathway, as it generates a cleaner stream that bypasses MRF sorting. However, the volumes of soft plastics potentially collected via the kerbside are higher, and therefore has a greater potential impact on the plastic recovery rate, albeit at a lower efficiency. The analysis performed is conservative and increases in quantities collected via dedicated collection in Scenario 4 would be expected to increase over time, as the scheme matures. Quantities collected via kerbside collection are based on recent data on the performance of a similar scheme in Spain[19], and are conservative and it is uncertain what volumes would likely be expected in Australia if a within-bag kerbside collection system was implemented

Expanding plastic packaging eligibility for CDSs nationally had a small impact on plastic recovery performance. Expanded beverage container eligibility (Scenario 1) would lead to a plastic recovery rate of 19.0%, an increase of only 0.6% compared to BAU 2024-25. Expanding eligibility to include food containers (Scenario 2) would have a slightly larger impact on plastic recovery rates - increasing to 20.4% owing to the greater quantities available for collection and recycling. Overall, the impacts of expanding CDS eligibility to include a greater quantity of plastic packaging does not have a large impact on the 2025 Target of 70% plastic packaging recovered. This is due to the relatively small proportion of total plastic packaging PoM that is CDS-eligible. It follows that large quantities of used packaging must be managed by kerbside systems, where losses are significantly higher. For BAU 2024-25, CDS-eligible packaging makes up approximately 8% of all plastic packaging PoM. This increases to 10% in Scenario 1 with expanded beverage containers, and 12% for Scenario 2 with food containers eligible. Even when expanding dedicated collection to include soft plastics (Scenario 4), the proportion of packaging PoM collected via dedicated collection is still too low to have a significant impact on achieving the 70% plastic packaging recovery target.

The additional collections of old-corrugated cardboard in Scenario 7 had a small impact on overall paper packaging recovery rates. Despite the additional 206,000 tonnes of old-corrugated cardboard collected via B2B and sent directly to reprocessing, recovery rates for old-corrugated cardboard increased by approximately 1%, and only 0.6% for overall paper packaging. The scenario modelling assumes that the additional collection of B2B cardboard is sent directly to reprocessing and would not impact on the efficiency of the kerbside system. As such, B2B Scenario 2 has reduced quantities of non-household material collected from the kerbside for recycling and disposed to landfill compared to BAU. This is because additional material is diverted from kerbside collection to direct B2B collection. However, the rate of non-household kerbside losses remains the same (approximately 13%), as no efficiency change in kerbside collection was assumed. The small improvement in paper packaging recovery for Scenario 7 highlights that non-household old-corrugated cardboard management is already efficient. The efficiency gains from additional direct B2B collections are minor and are a result of avoided sorting losses. Targeting the household consumption sector for more direct old-corrugated cardboard collection may result in increased gains in performance, given household kerbside collection is less efficient for paper compared to non-household (see Figure 9).

[19] Gibovic and Bikfalvi (2021). Incentives for plastic recycling: how to engage citizens in active collection. Empirical evidence from Spain. *Recycling* Vol. 6, article 29

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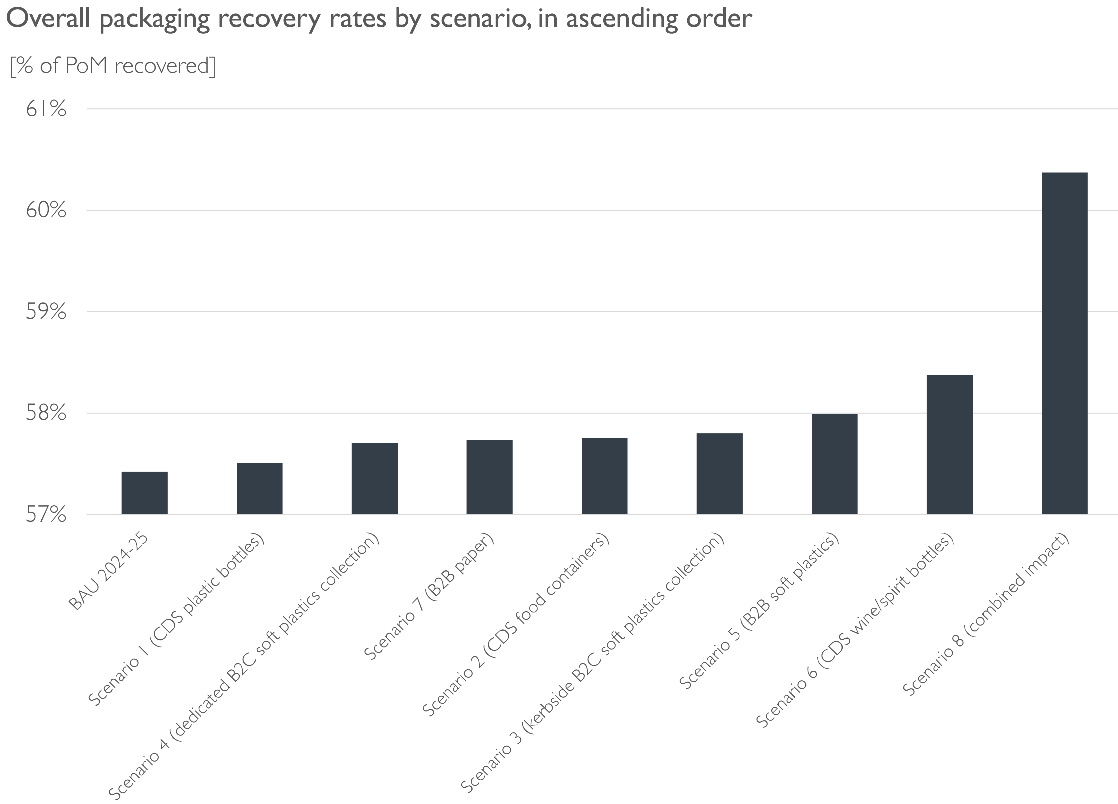

Figure 13: Overall packaging recovery rates by scenario.

Table 27: Comparison of scenario recovery rates compared to business-as-usual (BAU) 2024-25. Scenarios are ordered by recovery rate from lowest to highest.

Scenario	Recovery rate (plastic packaging)	%-point difference to BAU 2024-25
BAU 2024-25 (plastic only)	18.4%	-
Scenario 1 – expanded plastic beverage container CDS eligibility	19.0%	0.5%
Scenario 4 – B2C soft plastics collection via dedicated collection	20.1%	1.7%
Scenario 2 – plastic food containers eligible for CDS	20.4%	2.0%
Scenario 3 – B2C soft plastics collection via kerbside recycling	20.7%	2.3%
Scenario 5 – increase in B2B soft plastics collection	21.8%	3.4%
Scenario 8 – combined impact	28.2%	9.8%
Scenario	**Recovery rate (glass packaging)**	**% difference to BAU 2024-25**
BAU 2024-25 (glass only)	66.7%	-
Scenario 6 – expanded glass container CDS eligibility	71.8%	5.1%
Scenario	**Recovery rate (paper packaging)**	**% difference to BAU 2024-25**
BAU 2024-25 (paper only)	70.0%	-
Scenario 7 – increase in B2B paper packaging collection	70.6%	0.6%

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4. Conclusions and recommendations

Packaging placed on the market in 2020-21

- Approximately 6,740,000 tonnes of packaging material were PoM in 2020-21.

- Paper packaging made up 50% of all packaging PoM (3,387,000 tonnes). Of the paper packaging types, old-corrugated cardboard had the largest quantities PoM (2,539,000 tonnes).

- 45% of all packaging PoM was of the 'carton or box' format category. The 'bottle or jar' category had the second largest share of packaging PoM at 24%. 81% of bottles or jars were glass (1,283,000 tonnes PoM), with the remaining 19% made from plastic.

- Approximately 562,000 tonnes of CDS-eligible packaging were PoM across Australia in 2020-21, accounting for 8% of all used packaging. Eligible glass bottles made up 78% of all CDS-eligible packaging, with 440,000 tonnes PoM.

- 159,000 tonnes of reusable packaging were PoM in 2020-21, offsetting an estimated 2.5 million tonnes of single-use packaging consumption.

Packaging recovery in 2020-21

- Approximately 3,788,000 tonnes of used packaging were recovered in 2020-21, at an overall recovery rate of 56.2%.

- Paper and glass packaging had the highest recovery rates of the materials evaluated, at 70% and 63% respectively. The highest observed recovery rates for the individual material categories were ambered coloured glass (87% recovered) and old-corrugated cardboard (83% recovered).

- The plastic packaging recovery rate was 17.5%, significantly lower than the 2025 National Packaging Target of 70% for plastics. The recovery rate for rigid plastic packaging was 26%, significantly higher than soft plastics recovery at 7.5%. Recovery of redeemed CDS-eligible container accounted for 22% of total rigid plastic recovery.

- Approximately 27% of all packaging recovered was exported for overseas processing. Exports were highest for metal, where 86% of all recovered metal packaging was processed overseas.

- 1,642,000 tonnes of packaging-grade recyclate was generated in 2020-21, equivalent to 24% of all packaging PoM. Quantities of packaging recyclate were highest for paper packaging (1,227,000 tonnes), and glass packaging (371,000 tonnes).

- Approximately 437,300 tonnes of all CDS-eligible packaging PoM (562,000 tonnes) was recovered in 2020-21, at a recovery rate of 78%. This includes recovery of CDS-eligible packaging not redeemed via CDS systems nationally.

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- CDS-eligible packaging achieved significantly higher recovery performance compared to non-eligible bottles and cans, which had a total recovery rate of 45%. Collection rates were significantly higher for CDS-eligible packaging at 83% compared to 50%, illustrating that separate collection of packaging can achieve high collection rates, which can enable subsequent downstream recovery.

- The packaging circularity rate for CDS-eligible packaging was 33%, compared to 16% for non-eligible packaging. This illustrates that separate container collection can potentially enable more circular outcomes for packaging by enabling cleaner used packaging feedstock streams for the production of packaging grade recyclate.

Projected packaging management performance in 2024-25

- Approximately 7,493,000 tonnes of packaging are projected to be PoM in 2024-25, an overall growth rate of 11% on 2020-21 quantities PoM.

- Paper and rigid plastic packaging will see the largest increases in quantities PoM compared to 2020-21 quantities. Flexible plastic packaging had the smallest increase, at 4%. Several packaging materials will see a decrease in quantities PoM in 2024-25, namely rigid PS and EPS, and flexible PET, HDPE, PVC and PP.

- An anticipated 4,302,000 tonnes of packaging will be recovered in 2024-25, at an overall recovery rate of 57.4%. This is an improvement over 2020-21 performance, and can be attributed to a reduction in harder to recycle materials (i.e., flexible packaging types), and expansion of CDS systems nationally.

- The anticipated plastic packaging recovery rate is improved over 2020-21 performance, increasing from 17.5% to 18.4%. Without further significant system changes, it is unlikely the 70% recovery target will be met by 2025.

Impact of management interventions on 2024-25 performance

- **Scenario 1:** Expansion of CDS eligibility to include a greater number of beverage containers (e.g., PVC cordial bottles) will have a small impact on overall plastic packaging recovery, increasing from 18.4% (baseline 2024-25) to 19%.

- **Scenario 2:** Expansion of CDS eligibility to include plastic food containers would have a larger impact on plastic recovery than expanded beverage eligibility, increasing the plastic recovery rate to 20.4%.

- **Scenario 3:** The collection of soft plastics via existing kerbside recycling collection could lead to a plastic packaging recovery rate of 20.7%. More than half of all soft plastic packaging is consumed by households, and there is a potential to collect a greater quantity of soft plastics from households via kerbside systems as this collection pathway matures over time.

- **Scenario 4:** The collection of soft plastics from households via dedicated collection pathways will have a similar impact on plastic packaging recovery than collections via kerbside systems

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(Scenario 3). The plastic packaging recovery rate is expected to increase to 20.1% in this scenario.

- **Scenario 5**: Ramping up the collection of B2B flexible LDPE packaging will have the most significant impact on the plastic packaging recovery rate, increasing to 21.8%. Quantities of flexible packaging consumed in the B2B sector is smaller than the household sector, however both consumption sectors must be targeted to significantly improve plastic packaging recovery towards the 70% 2025 Target.

- **Scenario 6:** Expansion of CDS eligibility to include wine and spirit bottles will have a significant impact on glass recovery, increasing from 67% in BAU 2024-25 to 72%. This intervention would also have the largest impact on overall packaging recovery, increasing to 58.4%.

- **Scenario 7:** Ramping up the collection of B2B old-corrugated cardboard will have a minor impact on paper and overall recovery performance. The paper packaging recovery rate would increase from 70% in the BAU 2024-25 case, to only 70.6%.

- **Scenario 8:** The combined impact of implementing all scenario interventions would lead to an anticipated plastic recovery rate of 28.2%, and an overall packaging recovery rate of 60.4%.

- Implementing scenario interventions evaluated in this study would require expansion in local reprocessing capacity, especially for soft plastics recovery.

Recommendations for improving packaging system modelling

- Uncertainty on estimated material flows was reasonable, with expected variance on recovery rates estimated as ±11%.

- Material flows related to MRF sorting had the greatest impact on modelling uncertainty. This is a known data gap, where proxy data is required in order to calculate input and output flows from MRFs. Some flows in the system, include collection losses and expected inputs into local reprocessing facilities are calculated on estimated MRF flows, which leads to uncertainty in these estimates as well. Obtaining data on MRF flows in Australia would improve overall system uncertainty.

- Assumptions used for modelling expansion of CDS eligibility to additional container types could be improved with data on specific product types PoM. Previous work performed by ISF utilised label manufacturing data to estimate the product distribution of milk bottles on the Australian market. Similar data could be utilised to better understand other food and beverage product distributions, giving a clearer understanding of what might be eligible for future CDS system expansions.

- Having a clearer understanding of existing processing capacity as well as new capacity coming online before 2025 is necessary to both improve scenario modelling assumptions, and to prioritise capacity expansion for targeted packaging materials (e.g., soft plastics).

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- Future material flow analysis performed at the material and format level would result in greater resolution of the flows of used packaging through the system, allowing for identification of key material-format combinations that should be prioritised for intervention.

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Appendix

A1. Scenario analysis approach and assumptions

A1.1 Business-as-usual, 2024-25

Each scenario modelled is compared to the BAU case for 2024-25. BAU 2024-25 assumes a growth in overall packaging PoM in 2024-25 from Blue Environment (2022) and assumes expansion of CDS systems to include Western Australia in 2022, Victoria in 2023 and Tasmania in 2024. For this analysis, it was assumed that packaging material categories eligible for CDS for these additional states were the same as CDS-eligible packaging in the 2020-21 analysis.

In order to estimate quantities of CDS eligible packaging across Australia for 2024-25, overall quantities of packaging PoM in 2024-25 for materials and formats eligible were first taken from the Blue Environment data, which are summarised in Table 28 and compared to total packaging PoM quantities for 2020-21. Note that the table includes total tonnes of packaging PoM for materials, therefore including both CDS-eligible and non-eligible quantities.

Table 28: Quantities of overall packaging PoM in 2020-21 and 2024-25 for material types and formats in scope.

Material	Total PoM, 2020-21 [tonnes]	Total PoM, 2024-25 [tonnes]
Aluminium	98,515	106,695
Glass - Amber	232,872	255,802
Glass - Clear	605,463	665,081
Glass - Green	444,542	488,315
PET - rigid	103,995	108,299
HDPE - rigid	156,597	164,607
PCPB	64,131	74,341
Steel	115,115	126,450
Other polymers - rigid	17,333	19,040
Total	**1,838,562**	**2,008,630**

The approach for estimating CDS-eligible packaging PoM in 2024-25 is illustrated in Figure 14. The projected packaging PoM shown in Table 28 is utilised along with the breakdown of packaging PoM by jurisdiction from the 2020-21 data, to estimate quantities of packaging PoM in 2024-25 by jurisdiction. The proportion of packaging PoM that is CDS-eligible is then applied by jurisdiction to estimate the CDS-eligible packaging PoM by jurisdiction for 2024-25. For ACT, NSW, NT, QLD and SA, the proportion of CDS-eligible packaging PoM is taken from the 2020-21 data. For WA, quantities of CDS eligible packaging PoM for 2024-25 is derived from data from *WA Return Recycle Renew Limited*[20] for the 2021-22 financial year. For the additional jurisdictions with CDS in 2024-25, the average proportion of CDS-eligible PoM from the 2020-21 data is applied.

[20] WARRL (2023). Annual Report 2021-22, WA Return Recycle Renew Limited. Available at: https://cdn.warrl.com.au/2023/03/WARRL-2021-22-Annual-Report.pdf

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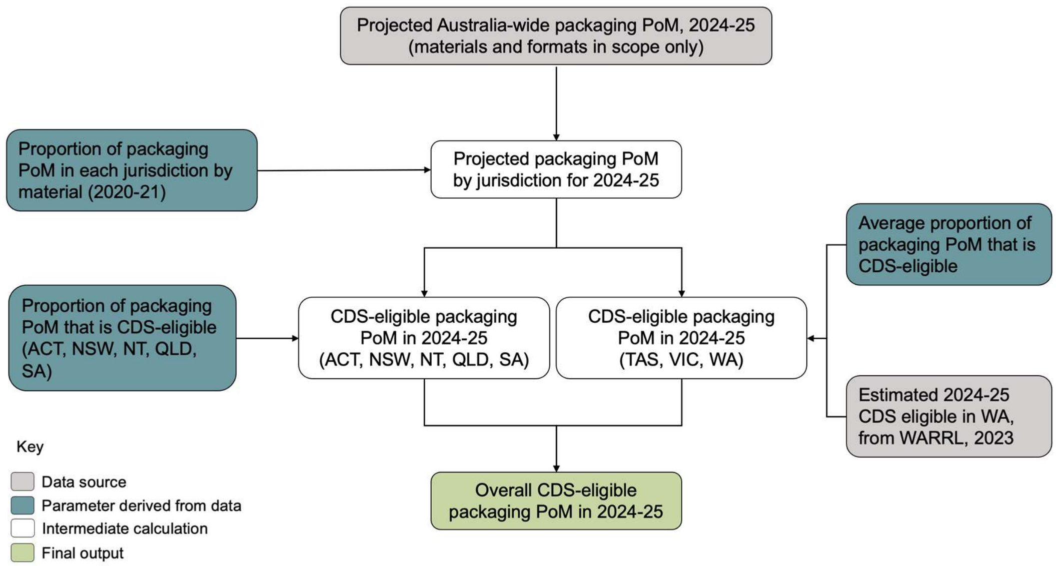

Figure 14: Approach for estimated 2024-25 CDS-eligible packaging PoM.

The estimated quantities of CDS-eligible packaging PoM for 2024-25 as well as a comparison with 2020-21 are shown in Table 29. Quantities of CDS-eligible packaging PoM by jurisdiction are shown in Table 30.

Table 29: Estimated quantities of CDS-eligible packaging PoM in 2024-25, compared with 2020-21 quantities.

Material	CDS-eligible PoM, 2020-21 [tonnes]	CDS-eligible PoM, 2024-25 [tonnes]
Aluminium	52,700	88,100
Glass - Amber	153,800	241,100
Glass - Clear	174,800	314,200
Glass - Green	111,200	194,100
PET - rigid	56,200	95,000
HDPE - rigid	5,800	9,200
PCPB	6,900	12,900
Steel	300	600
Other polymers - rigid	<100	<100
Total	**561,800**	**955,500**

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Table 30: Estimated CDS-eligible packaging PoM by jurisdiction in 2024-25.

Material	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
Aluminium	900	20,400	1,000	29,000	5,700	1,600	19,000	10,500
Glass - Amber	3,200	73,600	1,500	75,100	15,600	4,400	50,600	17,100
Glass - Clear	3,600	82,800	4,000	84,500	17,200	6,200	71,700	44,200
Glass - Green	2,300	53,200	1,100	54,300	11,200	3,100	36,300	32,600
PET - rigid	1,000	24,800	900	27,800	5,600	1,700	21,300	11,900
HDPE - rigid	200	2,000	100	3,200	500	200	2,200	800
PCPB	200	3,100	100	3,300	1,200	300	3,100	1,600
Steel	0	200	0	100	0	0	200	100
Other polymers	<100	<100	<100	<100	<100	<100	<100	<100
Total	**11,400**	**260,200**	**8,700**	**277,200**	**57,100**	**17,600**	**204,400**	**118,900**

To estimate quantities of CDS-eligible packaging redeemed, redemption rates from the 2020-21 data were applied by jurisdiction and material to the estimated 2024-25 CDS-eligible packaging PoM quantities for jurisdictions with CDS active in 2020-21. For example, NSW redemption rates in 2020-21 were applied to estimated NSW 2024-25 CDS-eligible packaging PoM. This is a conservative assumption. While there may be improvements in redemption rates, illustrated by more established schemes (e.g. SA) having high redemption rates, any improvements would be difficult to quantify and have high uncertainty. For the additional jurisdictions included in Scenario 1, the average redemption rates by material were applied to the estimated 2024-25 CDS-eligible packaging PoM shown in Table 30. Table 31 summarises the estimated CDS redemptions nationwide for 2024-25.

Estimated CDS-eligible PoM and quantities redeemed were then used as input data into the system model, to estimated overall material flows for 2024-25 under BAU conditions. As such, all sorting and reprocessing efficiencies, and recovery pathways (i.e., proportion recovered via export versus local reprocessing) are consistent with the 2020-21 system analysis.

Table 31: Estimated quantities of CDS-eligible packaging redeemed in 2024-25.

Jurisdiction	Expected quantities of redeemed packaging, 2024-25 [tonnes]
ACT	6,600
NSW	193,300
NT	7,000
QLD	198,100
SA	45,100
TAS	12,900
VIC	149,200
WA	87,100
Total	**699,300**

Table 32 gives a summary of key assumptions for BAU 2024-25, which are also carried over to other scenarios.

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Table 32: Summary of system assumptions for business-as-usual (BAU) 2024-25.

BAU scenario assumption	Assumption detail
Change in packaging PoM: 2020-21 to 2024-25 (material category)	Glass: +9.8% Metal: +8.7% Paper: +13.0% Plastic – all: +8.3% Plastic – rigid: +12.2% Plastic – flex: +3.7% Wood: +10.5% Total: +11.2%
Jurisdictions with CDS active in 2024-25	All of Australia
Material categories eligible for CDS in 2024-25	Same as 2020-21
CDS-eligible packaging PoM in 2024-25	Aluminium: 88,279 t Glass – amber: 241,071 t Glass – clear: 314,277 t Glass – green: 194,210 t PET – rigid: 94,889 t HDPE – rigid: 9,288 t PCPB: 12,845 t Steel: 580 t Other polymers – rigid: 16 t
Redemption rates (ACT, NSW, NT, QLD and SA)	Same as 2020-21
Redemption rates (TAS, VIC and WA)	Aluminium: 68.5% Glass – amber: 76.8% Glass – clear: 77.1% Glass – green: 76.3% PET – rigid: 59.1% HDPE – rigid: 37.9% PCPB: 26.7% Steel: 32.7% Other polymers – rigid: 5.7%
Proportion of redeemed via redemption point drop off	Aluminium: 89% Glass – amber: 77% Glass – clear: 77% Glass – green: 77% PET – rigid: 82% HDPE – rigid: 87% PCPB: 100% Steel: 100% Other polymers – rigid: 100%

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A1.2. Scenario 1: expanded plastic beverage container eligibility

This scenario examines the impact on packaging management performance from the expansion of CDS eligibility in 2024-25 to include additional plastic beverage containers nation-wide. Table 33 summarises assumed beverage containers that will become eligible by 2024-25, based on a recent report on enhancing the NSW CDS.[21] There is some uncertainty with respect to assumed material types, especially for cordial and juice bottles, which is explained below.

Table 33: Expanded packaging eligibility for this scenario.

Expanded plastic beverage container types eligible	Assumed materials
Flavoured milk (up to and including 3L)	HDPE (and some PET)
Fruit and vegetable juice, including concentrates (up to and including 3L)	HDPE and PET
Cordial (up to and including 3L)	PET and PVC

Quantities of flavoured milk, fruit and vegetable juice, and cordials made eligible by 2024-25 were based on NSW data of eligible packaging from a cost-and-benefits analysis for expanding the scope of the NSW CDS[22] (applied to estimate national CDS-eligible packaging PoM for these products). The data in that study does not differentiate polymer types for the expanded categories. For flavoured milk, it was assumed 100% of CDS-eligible packaging PoM was HDPE, based on the Madden et al. (2023) study. For juice bottles, it was assumed that packaging PoM was evenly distributed across HDPE and PET container types (e.g., 50% of PoM was HDPE). For cordial, it was assumed containers were evenly distributed across PET and PVC container types. Considering phase out of PVC packaging, it is possible that the proportion of cordial bottles PoM that are PVC will diminish by 2024-25, however data was not available on this.

Table 34 summarises assumed quantities of CDS-eligible packaging PoM nation-wide, by product category for this scenario, while Table 35 lists the total estimated CDS-eligible quantities for materials impacted by this scenario, compared to BAU. For PVC, the national average redemption rate for eligible plastic packaging types is used, given that no PVC was eligible in 2020-21. Table 36 summarises key assumptions for this scenario. CDS-eligible PVC is assumed to be redeemed via direct collection (e.g., CDS drop offs) only. Additional quantities of PVC collected via CDS are assumed to be exported directly, given that export of PVC from the MRF accounted for over 90% of PVC recovery in the 2020-21 system analysis.

Table 34: Quantities of assumed CDS-eligible PoM for each product category for this scenario.

CDS-eligible product/container	Estimated CDS-eligible PET PoM, 2024-25 [tonnes]	Estimated CDS-eligible HDPE PoM, 2024-25 [tonnes]	Estimated CDS-eligible PVC PoM, 2024-25 [tonnes]
Flavoured milk (≤3L)	0	4,055	0
Fruit and vegetable juice (≤3L)	7,357	8,596	0
Cordial (≤3L)	920	0	719
Total	**8,902**	**61,581**	**719**

[21] NSW EPA (2022). Driving NSW's circular economy – Discussion paper on enhancing the NSW Container Deposit Scheme, NSW Environment Protection Authority

[22] Marsden Jacob Associates (2022). Cost-benefit analysis of options to improve resource recovery in NSW, Report completed for the NSW EPA

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Table 35: Estimated quantities of CDS-eligible packaging for impacted material categories for Scenario 1, compared with business-as-usual (BAU)

Material	Estimated CDS-eligible PoM, 2024-25 business-as-usual [tonnes]	Estimated CDS-eligible PoM, 2024-25 for this scenario [tonnes]
PET – rigid	94,889	103,166
HDPE - rigid	9,288	21,939
PVC - rigid	0	719

Table 36: Summary of system assumptions for Scenario 1.

Scenario 1 assumptions	Assumption detail
Change in packaging PoM: 2020-21 to 2024-25	Same as business-as-usual
Jurisdictions with CDS active in 2024-25	All of Australia
Material categories eligible for CDS in 2024-25	Same as 2020-21 Expanded to also include: - Flavoured milk bottles (≤3L) - Fruit/vegetable juice, including concentrates (≤3L) - Cordial (≤3)
Fruit/vegetable juice bottle composition	PET – rigid: 50% of market HDPE – rigid: 50% of market
Cordial bottle composition	PET – rigid: 50% of market PVC – rigid: 50% of market
CDS-eligible packaging PoM	Aluminium: 88,279 t Glass – amber: 241,071 t Glass – clear: 314,277 t Glass – green: 194,210 t PET – rigid: 103,166 t HDPE – rigid: 21,939 t PCPB: 12,845 t Steel: 580 t PVC – rigid: 719 t Other polymers – rigid: 16 t
Redemption rates (ACT, NSW, NT, QLD and SA)	Same as Scenario 1
Proportion of redeemed via redemption point drop off	Same as Scenario 1 PVC – rigid: 100%

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A1.3. Scenario 2: rigid plastic food containers eligibility

Scenario 2 examines the performance impacts from expanded CDS eligibility to include rigid plastic food containers nation-wide in 2024-25. It is assumed that CDS eligible food containers are within the 'Tub, tray and punnet' format category, and Table 37 summarises projected packaging PoM for this category in 2024-25, along the share of total packaging PoM. For this scenario, only PET and PP tubs, trays and punnets were assumed to become eligible in 2024-25.

Table 37: Quantities of packaging PoM in 2024-25 in the 'tub, tray and punnet' category, and the share of overall PoM for PET – rigid and PP – rigid.

Material	Tub/tray/punnet PoM in 2024-25 [tonnes]	Share of overall PoM in 2024-25 [tonnes]
PET - rigid	22,430	15.4%
PP - rigid	91,748	49.2%

To model this scenario, an assumption is required on the make-up of the tub, tray and punnet category in terms of food and non-food applications. Given there is no PoM data for the 'Carton or box' format category for PET or PP packaging, it is assumed that a large proportion of tubs, trays and punnets would be for non-food applications, for example, toy packaging, craft supplies, health and beauty products, etc. For this scenario, the proportion of food tub, tray and punnet packaging is assumed to be 50%. Table 38 shows the estimated quantity of CDS-eligible PET packaging PoM for this scenario (including eligible bottles), compared with BAU PoM for 2024-25. Scenario assumptions are summarised in Table 39. Recovery of CDS-eligible PP via the export recovery is assumed to be at the same rate as non-CDS eligible PP in the 2020-21 system, where approximately 35% of PP recovery occurred via export.

Table 38: Estimated quantities of CDS-eligible packaging for impacted material categories for Scenario 2, compared with business-as-usual (BAU)

Material	Estimated CDS-eligible PoM, 2024-25 business-as-usual [tonnes]	Estimated CDS-eligible PoM, 2024-25 CDS scenario 3 [tonnes]
PET - rigid	94,889	112,215
PP - rigid	0	45,874

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Table 39: Summary of system assumptions for Scenario 2.

Scenario 2 assumptions	Assumption detail
Change in packaging PoM: 2020-21 to 2024-25	Same as business-as-usual
Jurisdictions with CDS active in 2024-25	All of Australia
Material categories eligible for CDS in 2024-25	Same as 2020-21 Expanded to include PET – rigid and PP – rigid food packaging
Proportion of PET tub/tray/punnet format category that is food packaging	PET – rigid: 50% PP – rigid: 50%
CDS-eligible packaging PoM	Aluminium: 88,279 t Glass – amber: 241,071 t Glass – clear: 314,277 t Glass – green: 194,210 t PET – rigid: 106,104 t HDPE – rigid: 9,288 t PCPB: 12,845 t Steel: 580 t Other polymers – rigid: 14 t PP – rigid: 45,874 t
Redemption rates (ACT, NSW, NT, QLD and SA)	Same as business-as-usual
Proportion of redeemed via redemption point drop off	Same as business-as-usual

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A1.4. Scenario 3: soft plastics collection via kerbside recycling

This scenario examines the impact of improved collection of consumer (i.e., household) soft plastic packaging via collection using existing kerbside collection systems. For this, it was assumed that soft plastics collected for recycling would first be disposed to the dry recycling stream within bags that can then be sorted and directed to recycling from MRFs. From the international academic literature on waste recovery, this approach seems the most practical way to collect consumer soft plastics at the kerbside for recycling.[23]

Table 40 shows the quantities of flexible packaging placed on the for B2C (at home) consumption in 2020-21 and projected for 2024-25. This scenario aims to improve soft plastic collection rates, which will have a downstream effect on recovery by increasing quantities of soft plastics available for recycling. For this scenario, it is assumed that recovery capacity is sufficient to meet levels of recovery (note projected recovery capacity for flexible packaging in 2024-25 is approximately 97,500 tonnes).

Table 40: Quantities of flexible B2C (at home) packaging PoM in 2020-21 and 2024-25.

Flexible material	2020-21 flexible packaging PoM – B2C at home consumption [tonnes]	2024-25 flexible packaging PoM – B2C at home consumption [tonnes]
PET	12,026	12,827
HDPE	56,890	59,259
PVC	5,983	5,093
LDPE	209,409	244,046
PP	37,795	40,179
PS	64	59
Bioplastic	487	698
Other polymers	2,761	3,041
Total flexible packaging	**325,415**	**365,201**

Collection rates for this scenario are estimated as the midpoint between rigid plastic collection and soft plastics collection in the 2020-21 data and are shown in Table 41. This assumes that there is a significant increase in soft plastics collected for recycling, but not at the level seen with rigid plastics given that the rigid plastic collection, sorting, recovery system is more mature. The increase in collection rates over 2020-21 soft plastics collection is approximately 10%, which is consistent with available literature on the impacts of new soft plastics collection systems.[24]

Table 41: Summary of system assumptions for Scenario 3.

Scenario 3 assumptions	Assumption detail
Change in packaging PoM: 2020-21 to 2024-25	Same as business-as-usual
Collection rates for B2C soft plastics (i.e., proportion of B2C PoM collected for recycling)	HDPE – flex: 15% LDPE – flex: 22% PP – flex: 11%
Quantities of additional B2C soft plastics collected	HDPE – flex: 6,500 tonnes LDPE – flex: 26,100 tonnes PP – flex: 2,500 tonnes

[23] Basuhi et al. (2021). Environmental and economic implications of U.S. post-consumer waste management. *Resources, Conservation and Recycling* 167, 105391
[24] Gibovic and Bikfalvi (2021). Incentives for plastic recycling: how to engage citizens in active collection. Empirical evidence from Spain. *Recycling* 6, 29

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A1.5. Scenario 4: soft plastics collection via dedicated collection

This scenario examines the impact of a dedicated separate collection system targeting consumer soft plastic packaging. The scenario assumes a national scheme similar to CDS, that incentivises collection of accepted soft plastic packaging at dedicated collection points. It is assumed that consumer HDPE, LDPE and PP bags and wrap are in-scope in this scheme.

Similar to CDS, it is assumed only a proportion of the in-scope materials/formats would be eligible for dedicated collection. This eligibility rate for soft plastics is based on the CDS eligibility rate (i.e., proportion of plastic bottle PoM that is eligible for CDS). It is assumed that the proportion of eligible packaging would be less for soft plastics than bottles, as soft plastics are typically not as clearly labelled with respect to resin identification than with rigid formats. As such, the eligibility rate was selected as half that of the CDS eligibility rate for plastic bottles, at 12% (Table 42).

The collection (or redemption) rate for soft plastics in this scenario (that is, the proportion of eligible soft plastics collected via dedicated collection) is based on the CDS redemption rate. The CDS redemption rate for plastics from the 2017-18 data on the NSW CDS system was used, as this represents a collection/redemption rate early on in the scheme's implementation, which will improve over time as the scheme matures.

Assumed eligibility and collection rates for this scenario are summarised in Table 42. Quantities collected via this scheme are sent direct to reprocessing (accounting for efficiency losses), bypassing MRF sorting.

Table 42: Summary of system assumptions for Scenario 4.

Scenario 4 assumptions	Assumption detail
Change in packaging PoM: 2020-21 to 2024-25	Same as business-as-usual
Acceptable materials and formats	Flexible HDPE, LDPE, PP Bags and pouches, shopping bags, wrap
Eligibility rate	12%
Collection ('redemption') rate	47%
Quantities of soft plastics collected via dedicated collection pathway	HDPE – flex: 2,800 tonnes LDPE – flex: 13,400 tonnes PP – flex: 1,600 tonnes

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A1.6. Scenario 5: increase in B2B soft plastic collections

For this scenario, it is assumed there is a ramp-up of B2B collections of flexible LDPE which are sent direct to reprocessing for recovery, bypassing MRF sorting. Table 43 summarises quantities of B2B flexible LDPE PoM in 2020-21 and 2024-25.

Table 43: Quantities of flexible LDPE (B2B) PoM in 2020-21, and 2024-25.

Material	2020-21 flexible LDPE (B2B) PoM [tonnes]	2024-25 flexible LDPE (B2B) PoM [tonnes]
LDPE – flex	110,608	128,903

For the 2020-21 system, a small proportion (approximately 4%) of flexible B2B LDPE is collected and sent directly to reprocessors (chemical recycling), bypassing MRF sorting. For this scenario, it is assumed that this rate is significantly increased to utilise projected flexible LDPE recovery capacity in 2024-25.

To model this scenario, the additional LDPE recovery capacity projected for 2024-25 (that is, projected 2024-25 capacity minus 2020-21 capacity) is assumed to be the additional downstream recovered quantities of B2B LDPE packaging for this scenario. In order to estimate the quantities of B2B collected and sent directly to reprocessors, the LDPE reprocessor rate (that is, the recovery rate of LDPE at local reprocessors) is used to back-calculate quantities collected via B2B. Estimated quantities collected via B2B and sent directly to reprocessors are summarised in Table 44 for 2024-25 under this scenario, and compared to quantities in 2020-21. Given the above scenario assumptions, the proportion of B2B packaging collected and sent directly to reprocessors increases from 4% of B2B flexible LDPE PoM in 2020-21, to 55% in 2024-25. Table 45 summarises system assumptions for this scenario.

Table 44: Estimated quantities of B2B collections of LDPE sent directly to reprocessors for 2020-21 and this scenario.

Material	Quantities collected via B2B and sent direct to reprocessors, 2020-21 [tonnes]	Quantities collected via B2B and sent direct to reprocessors, 2024-25 [tonnes]
LDPE – flex	4,196	71,657

Table 45: Summary of system assumptions for Scenario 5.

Scenario 5 assumptions	Assumption detail
Change in packaging PoM: 2020-21 to 2024-25	Same as business-as-usual
Quantity of B2B soft plastics sent direct to reprocessing	LDPE – flex: 71,700 tonnes
Chemical recycling recovery rate[25,26]	93%

[25] Lase et al. (2023). How much can chemical recycling contribute to plastic waste recycling in Europe? An assessment using material flow analysis modelling. *Resources, Conservation and Recycling* 192, 106916

[26] Achilias et al. (2007). Chemical recycling of plastic wastes from polyethylene (LDPE and HDPE) and polypropylene (PP). *Journal of Hazardous Materials* 149, 3, 536-542

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A1.7. Scenario 6: wine and spirits bottle eligibility

This scenario examines the impacts on performance from the expansion of CDS systems nation-wide to include all wine and spirit bottles. No expansion of amber glass eligibility was assumed for this scenario. Table 46 shows the projected quantities of the 'bottle or jar' packaging format category PoM for 2024-25, as well as the BAU quantities of CDS-eligible glass.

Table 46: Quantities of glass bottle or jar packaging PoM in 2024-25, compared with business-as-usual (BAU) CDS-eligible PoM.

Material	Bottle or jar PoM in 2024-25 [tonnes]	Business-as-usual CDS-eligible PoM in 2024-25 [tonnes]
Glass – amber	255,802	241,071
Glass – clear	665,081	314,277
Glass – green	488,315	194,210

To estimate additional quantities of glass packaging eligible for CDS in 2024-25, data from the cost-and-benefits analysis for expanding NSW CDS[27] was utilised, extrapolating this data to the national level. This was done by calculating the ratio of additional CDS-eligible PoM for clear and green bottles in NSW from the cost-and-benefits analysis, to CDS-eligible clear and green bottles in NSW for the 2020-21 period, from the data Blue Environment data. This ratio (approximately 0.2 for clear bottles, and 1.6 for green) was then applied to the national level 2024-25 projections for clear and glass bottle CDS-eligible PoM (i.e., the BAU 2024-25 estimates for clear and green glass eligible PoM). Additional quantities of CDS-eligible spirit and wine bottles PoM for 2024-25 under this scenario are summarised in Table 47, and Table 48 summarises total CDS-eligible PoM packaging for glass packaging for Scenario 6, compared to BAU 2024-25. Spirit bottles are assumed to be clear glass, while wine is combination of both green and clear bottle varieties, based on data in the Marsden Jacob Associates (2022) report. System assumptions for this scenario are summarised in Table 49.

Table 47: Additional CDS-eligible glass packaging PoM for Scenario 6 by expanded product category.

Product category	Additional CDS-eligible PoM for Scenario 3, 2024-25 [tonnes]
Spirit bottles	62,551
Wine bottles	194,210

Table 48: Estimated quantities of CDS-eligible packaging for impacted material categories for Scenario 6, compared with business-as-usual (BAU) 2024-25.

Material	Scenario 1 estimated CDS-eligible PoM, 2024-25 [tonnes]	Scenario 3 estimated CDS-eligible PoM, 2024-25 [tonnes]
Glass – amber	241,071	241,071
Glass – clear	314,277	376,827
Glass – green	194,210	388,419

[27] Marsden Jacob Associates (2022)

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Table 49: Summary of system assumptions for Scenario 6.

Scenario 6 assumptions	Assumption detail
Change in packaging PoM: 2020-21 to 2024-25	Same as business-as-usual
Jurisdictions with CDS active in 2024-25	All of Australia
Material categories eligible for CDS in 2024-25	Same as 2020-21 Expanded to include spirit and wine (clear and green glass) bottles nationally
CDS-eligible packaging PoM	Aluminium: 88,279 t Glass – amber: 241,071 t Glass – clear: 376,827 t Glass – green: 388,419 t PET – rigid: 94,889 t HDPE – rigid: 9,288 t PCPB: 12,845 t Steel: 580 t Other polymers – rigid: 16 t
Redemption rates (ACT, NSW, NT, QLD and SA)	Same as business-as-usual
Proportion of redeemed via redemption point drop off	Same as business-as-usual

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A1.8. Scenario 7: increase in B2B old-corrugated cardboard collections

Scenario 7 assumes a ramp up of existing B2B collections of old-corrugated cardboard that is collected via B2B and sent directly to reprocessors for recovery. Table 50 summarises total quantities of B2B old-corrugated cardboard packaging PoM in 2020-21, compared with projected quantities for 2024-25.

Table 50: Quantities of old-corrugated cardboard (B2B) PoM in 2020-21, and 2024-25.

Material	2020-21 old-corrugated cardboard (B2B) PoM [tonnes]	2024-25 old-corrugated cardboard (B2B) PoM [tonnes]
OCC	1,939,732	2,189,558

For the 2020-21 system, a quantity of B2B old-corrugated cardboard was assumed to be sent directly from B2B collection to reprocessors, equal to approximately 34% of B2B old-corrugated cardboard packaging PoM -or 649,900 tonnes. Similar to the previous scenario on ramped up B2B LDPE collections, it is assumed that B2B old-corrugated cardboard collections are ramped up to utilise additional projected recovery capacity for old-corrugated cardboard in 2024-25. Quantities of B2B old-corrugated cardboard collected via this pathway are estimated following the same approach as described for LDPE in Section 2.2. Table 51 shows the expected quantities collected via B2B and sent directly to reprocessors, bypassing sorting for this scenario. The proportion of B2B old-corrugated cardboard collected via this pathway increases from 34% in the BAU case, to 43% under this scenario.

Table 51: Summary of system assumptions for Scenario 7.

Scenario 7 assumptions	Assumption detail
Change in packaging PoM: 2020-21 to 2024-25	Same as business-as-usual
Quantity of B2B old-corrugated cardboard sent direct to reprocessing	Old-corrugated cardboard : 939,800 tonnes

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