DECEMBER 2019

AUSTRALIAN PACKAGING CONSUMPTION & RESOURCE RECOVERY DATA

APCO
AUSTRALIAN PACKAGING COVENANT ORGANISATION

Contents

Acknowledgements
We acknowledge and thank the packaging manufacturing and reprocessing companies around Australia that took the time to respond to our information request for this project. The completion of this study was only possible because of your valuable and expert contributions.

Authors
Report prepared by Envisage Works, IndustryEdge, Institute for Sustainable Futures, Randell Environmental Consulting and Sustainable Resource Use on behalf of the Australian Packaging Covenant Organisation.

Executive summary

In 2018, all levels of Australian government, including representatives from Local, State and Territory and Federal governments, came together with industry to launch Australia's 2025 National Packaging Targets (2025 Targets), as shown in Figure 1; providing a clear mandate to deliver a new sustainable pathway for packaging in Australia.

This report provides the 2017–18 financial year baseline packaging consumption and recovery data for Australia, **to inform the measurement of progress towards the 2025 Targets**. APCO commissioned the collection of this data from new and existing sources to enable Australia to not only benchmark our current system, but also to **support strategic planning** across all levels of the life cycle of packaging – from design, manufacturing, use, disposal and end-of-life fate. This report portrays **granular data** on the packaging ecosystem that we have **never had before**, providing transparency to the areas in which we are excelling and to those which require collective attention to enable the transition to a circular economy.

The data collection, analysis and reporting has been undertaken in a manner that will support year-on-year comparisons into the future. This report also provides forecasts of key packaging material flow quantities out to 2025 under different scenarios.

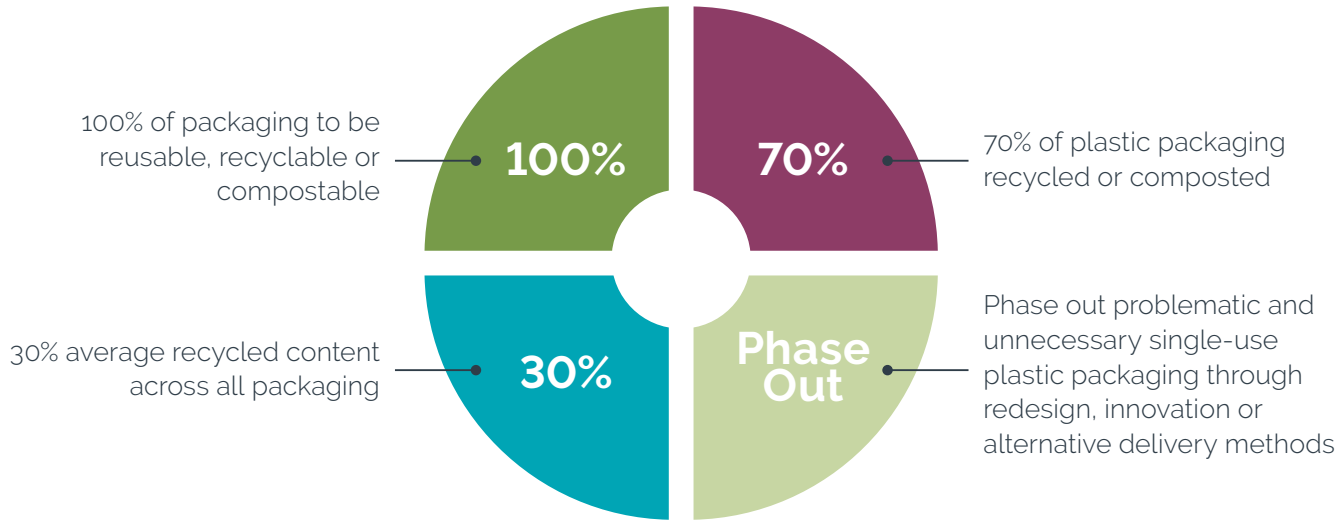


Figure 1: *Australia's 2025 National Packaging Targets*

Packaging consumption in 2017–18

Total packaging **placed on the market (POM)** in Australia in 2017–18 is estimated at **5.45 million tonnes (±13%)**. POM means that the packaging has been made available to the end-consumer (including business users).

Of the 5.45 million tonnes of packaging POM in 2017–18, **over half of this was paper and paperboard** packaging (53.2%), followed by glass packaging (23.3%), plastic packaging (19.6%) and metal packaging (3.9%).

Estimates for packaging POM by material group are provided in Table 1 and Figure 2. The aggregated accuracy range estimates for each of the material groups are also provided as error bars in Figure 2. The estimates include consumer and business-to-business (B2B) packaging.

Table 1 *Packaging POM in 2017–18, by material group*

MATERIAL GROUP	TOTAL POM		ACCURACY RANGE
	(TONNES)	(%)	(±%)
Paper and paperboard	2 901 000	53.2%	7%
Glass	1 273 000	23.3%	17%
Plastic	1 067 000	19.6%	21%
Metal	213 000	3.9%	23%
Total	**5 453 000**	**100.0%**	**13%**

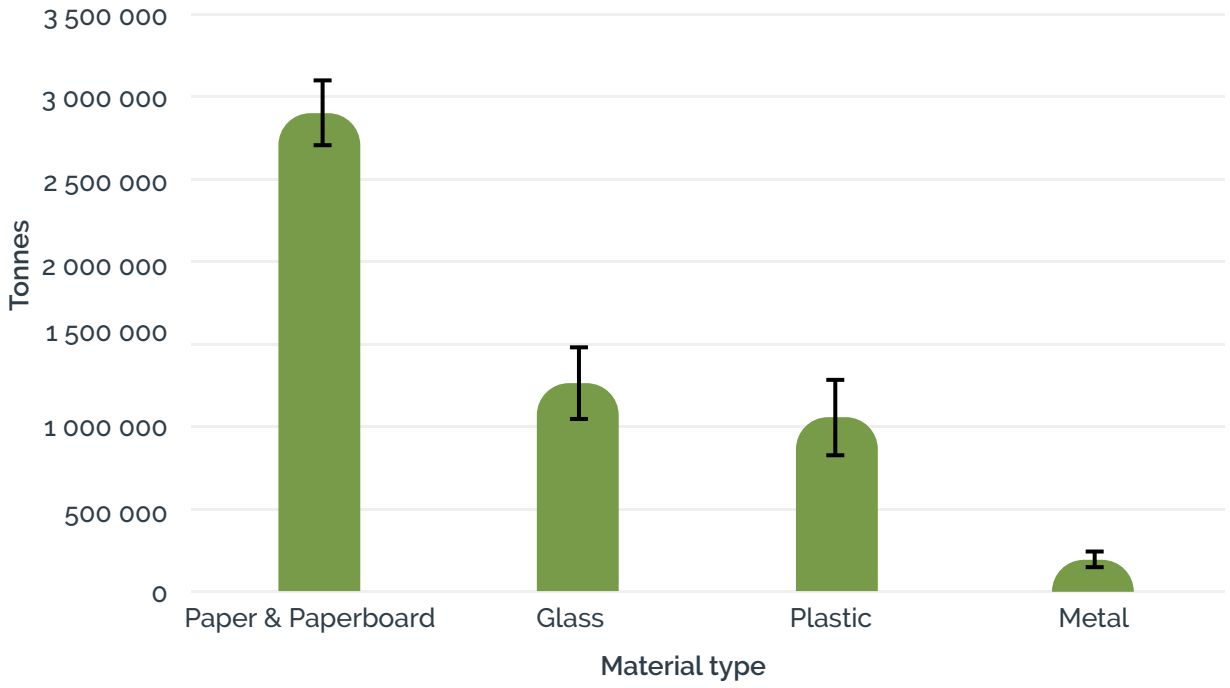


Figure 2 *– Packaging POM in 2017–18, by material group (tonnes)*

Packaging recovered in 2017–18

Of the 5.45 million tonnes (±13%) of post-consumer packaging POM in Australia in 2017-18, it is estimated that **2.67million tonnes (±14%)** was recovered. This number is measured at the out-going gate of the secondary processing facility for the used packaging.

Over two thirds of this was **paper and paperboard packaging (68.0%)**, followed by **glass packaging (21.8%)**, **plastic packaging (6.5%)** and **metal packaging (3.8%)**.

Estimates for post-consumer packaging recovery by material group are provided in Table 2 and Figure 3.

The aggregated accuracy range estimates for each of the material groups are also provided. The estimates include post-consumer packaging collected through municipal, commercial and industrial (C&I) and container deposit scheme (CDS) collection services.

***Table 2** – Post-consumer packaging recovery in 2017–18, by material group*

MATERIAL GROUP	RECOVERY		ACCURACY RANGE
	(TONNES)	(%)A	(±%)
Paper and paperboard	1 817 000	68.0%	11%
Glass	582 000	21.8%	23%
Plastic	173 000	6.5%	15%
Metal	102 000	3.8%	21%
Total	**2 673 000**	**100.0%**	**14%**

a) Percent contribution to the total amount of packaging recovered, and not the recovery rate.

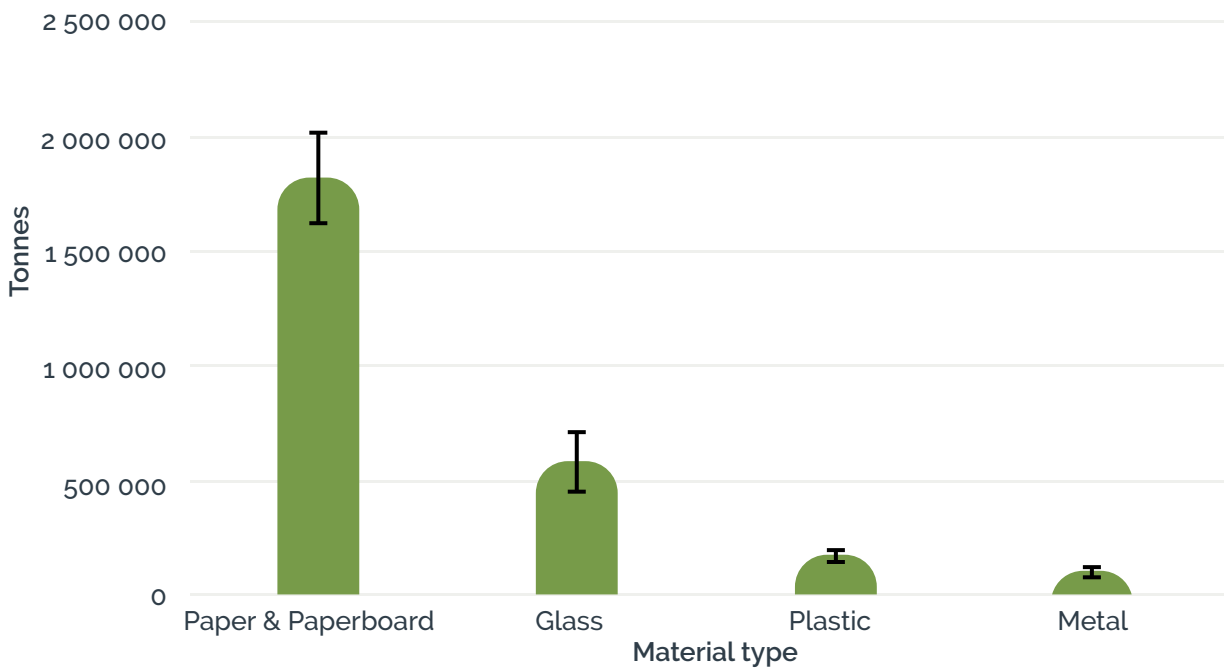


***Figure 3** – Post-consumer packaging recovery in 2017–18, by material group (tonnes)*

Packaging recovery rates in 2017–18

The Australian post-consumer packaging recovery rate in 2017–18 is estimated at **49%**. This is based on the recovery of each material group as measured at the out-going gate of the secondary processing facility for the used packaging (summarised above), divided by the related packaging POM by material group.

Paper and paperboard have the **highest recovery rate at 63%**, followed by **metal packaging at 48%**, **glass packaging at 46%** and **plastic packaging at the low level of only 16%**.

***Table 3** – Post-consumer packaging recovery rates in 2017–18, by material group*

MATERIAL GROUP	POM (TONNES)	RECOVERY (TONNES)	RECOVERY RATE (%)
Paper and paperboard	2 901 000	1 817 000	63%
Glass	1 273 000	582 000	46%
Plastic	1 067 000	173 000	16%
Metal	213 000	102 000	48%
Total	**5 453 000**	**2 673 000**	**49%**

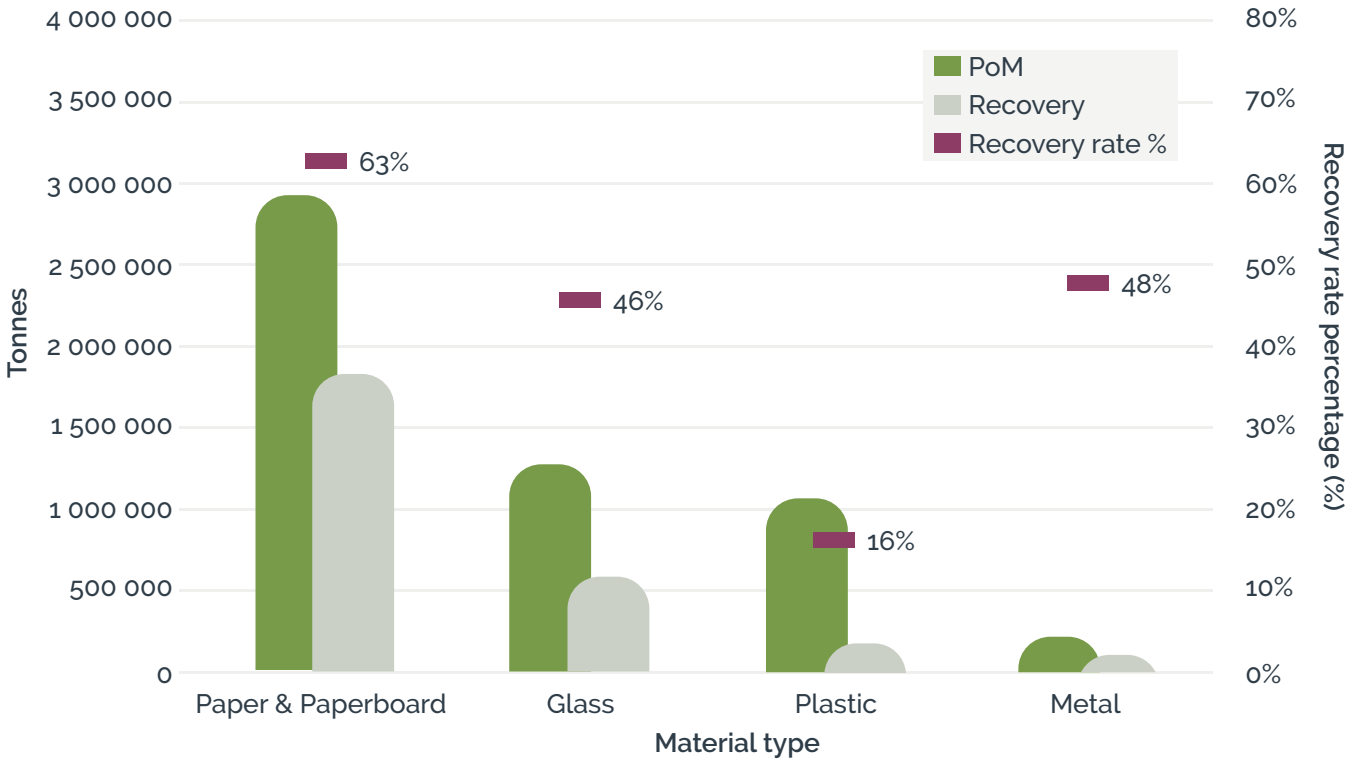


***Figure 4** – Post-consumer packaging recovery rates in 2017–18, by material group*

Packaging recycled content in 2017–18

Estimates of the recycled content incorporated into packaging POM in 2017–18, by material group, are provided in Table 4 and Figure 5. The post-consumer recycled content across all packaging was 1.9 million tonnes, or 35% of total packaging POM, the pre-consumer recycled content was 0.7 million tonnes (12%), and nearly 2.9 million tonnes (53%) was sourced from virgin (primary) feedstocks.

***Table 4** – Packaging POM in 2017–18, by material group and recycled content*

MATERIAL GROUP	POST-CONSUMER SOURCE (TONNES)	PRE-CONSUMER SOURCE (TONNES)	VIRGIN SOURCE (TONNES)	TOTAL (TONNES)
Paper and paperboard	1 421 000	441 000	1 038 000	2 901 000
Glass	407 000	146 000	720 000	1 273 000
Plastic	23 000	7 000	1 037 000	1 067 000
Metal	64 000	68 000	81 000	213 000
Total (tonnes)	**1 915 000**	**661 000**	**2 876 000**	**5 453 000**
Total (%)	**35%**	**12%**	**53%**	**100%**

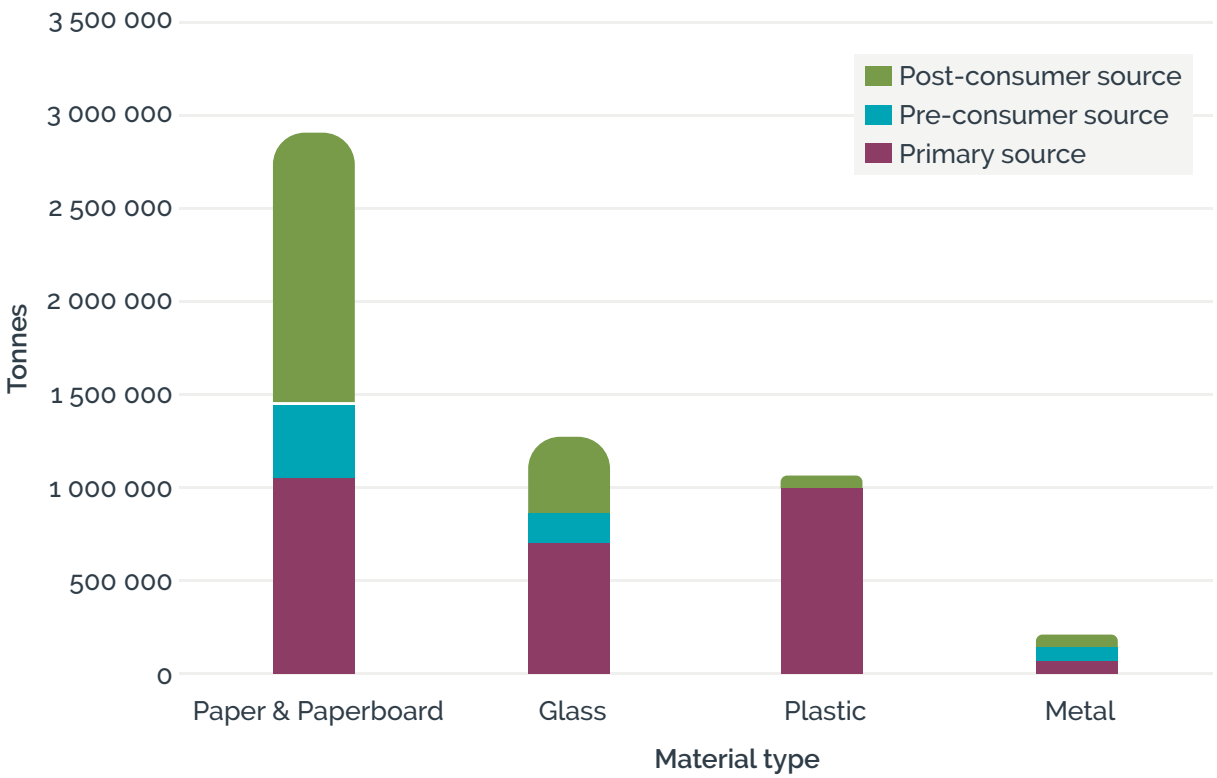


***Figure 5** – Packaging POM in 2017–18, by material group and recycled content (tonnes)*

Packaging recyclability in 2017–18

Provided in Table 5 below is an outline of packaging recyclability classifications and definitions that have been adopted for the purpose of this report.

Estimates of recyclable packaging or compostable packaging POM in 2017–18 are provided in Table 6 and Figure 6. Reusable packaging POM has not been quantified. See Appendix A for the full definitions of these three terms.

Note throughout the report the term packaging recyclability is used as an umbrella term for recyclable, compostable or reusable packaging.

The agreed determination of the recyclability, compostability and reusability of all packaging formats is a developing area, and the estimates provided here are indicative only.

Further investigation and consultation is required to resolve an agreed method and packaging classifications to improve the determination of this evaluation measure. For example, the reusability, recyclability or compostability classifications could be systematically aligned with the related Packaging Recyclability Evaluation Portal (PREP) classification algorithms.

***Table 5** – Packaging recyclability classifications and definitions*

CLASSIFICATION	DESCRIPTION	SCOPE
Good recyclability	Technically recyclable, collection and recycling services are widely available and there are viable end markets.	All bottles and jars, all cans, fibre-based cartons and boxes (but not PCPBs), tubs, trays and punnets, LDPE film, fibre-based 'other'.
Poor recyclability	Recyclable with lost value and/or more limited recycling services and/or may contaminate other recycling streams.	PCPBs, PVC, all wraps and film seals (except for LDPE film), EPS.
Not recyclable	Not technically recyclable and/or no recycling service available.	Remaining material (except for 'Unknown').
Unknown recyclability	Insufficient information to determine recoverability.	-

Recyclable or compostable packaging POM in 2017–18, by recyclability classification

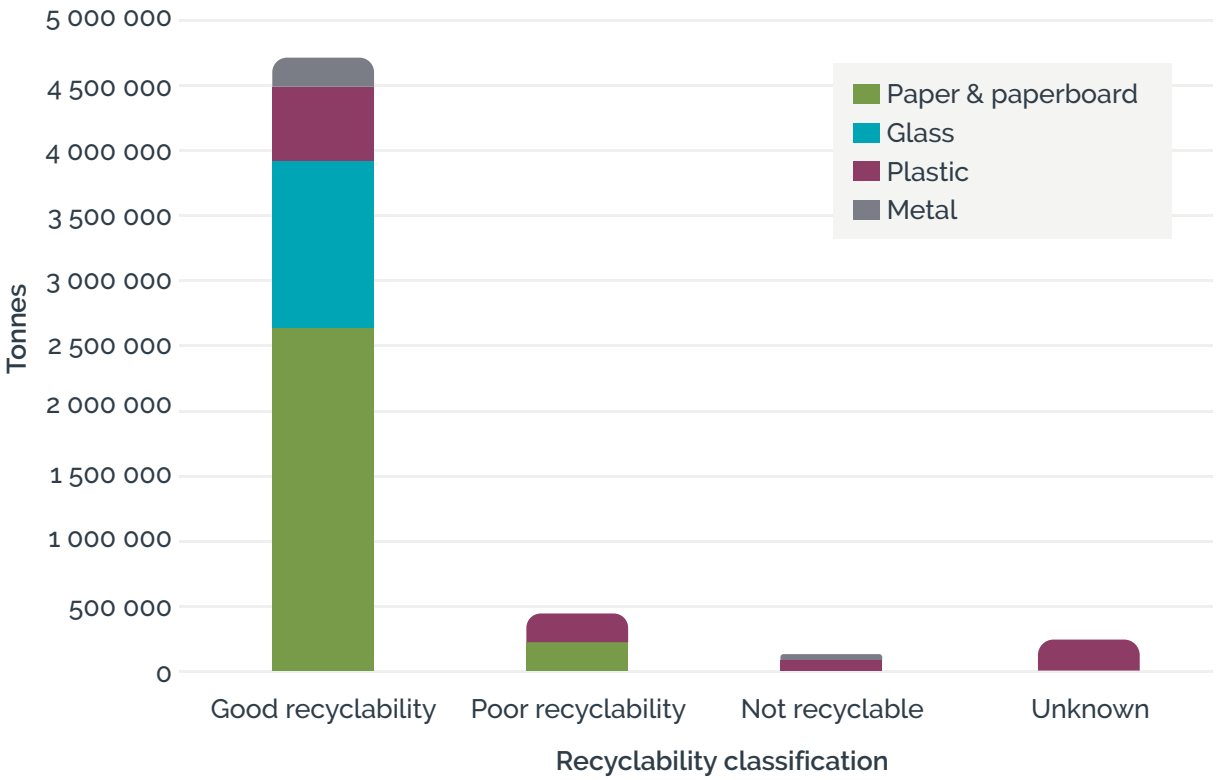


Figure 6 – Recyclable or compostable packaging POM in 2017–18, by recyclability classification

Table 6 – Recyclable or compostable packaging POM in 2017–18, by recyclability classification

MATERIAL GROUP	GOOD RECYCLABILITY (TONNES)	POOR RECYCLABILITY (TONNES)	NOT RECYCLABLE (TONNES)	UNKNOWN (TONNES)	TOTAL (TONNES)
Paper and paper-board	2 658 000	227 000	15 000	0	2 901 000
Glass	1 273 000	0	0	0	1 273 000
Plastic	572 000	181 000	83 000	231 000	1 067 000
Metal	204 000	0	9 000	0	213 000
Total (tonnes)	**4 707 000**	**408 000**	**107 000**	**231 000**	**5 453 000**
Total (%)	**86%**	**8%**	**2%**	**4%**	**100%**

It is estimated that **4.7 million tonnes (86%)** of packaging POM in 2017–18 has good recyclability. This is dominated by paper & paperboard (of which 92% has good recyclability) and glass (of which 100% has good recyclability). 96% of metal packaging is classified as having good recyclability, but only 54% of plastic packaging is classified as having good recyclability.

Around 0.5 million tonnes (10%) of packaging is classified as having poor recyclability or being not recyclable. Around 51% of these quantities is plastic packaging, and another 47% is paper & paperboard packaging.

The National Packaging Targets and related 2017–18 results

Provided in Figure 7 below, is a summary of the key packaging consumption and recovery data, compared to the related 2025 Targets.

As can be seen in Figure 8 the most challenging of the 2025 Targets to meet may be the achievement of the recycling or composting of 70% of Australia's plastic packaging by 2025.

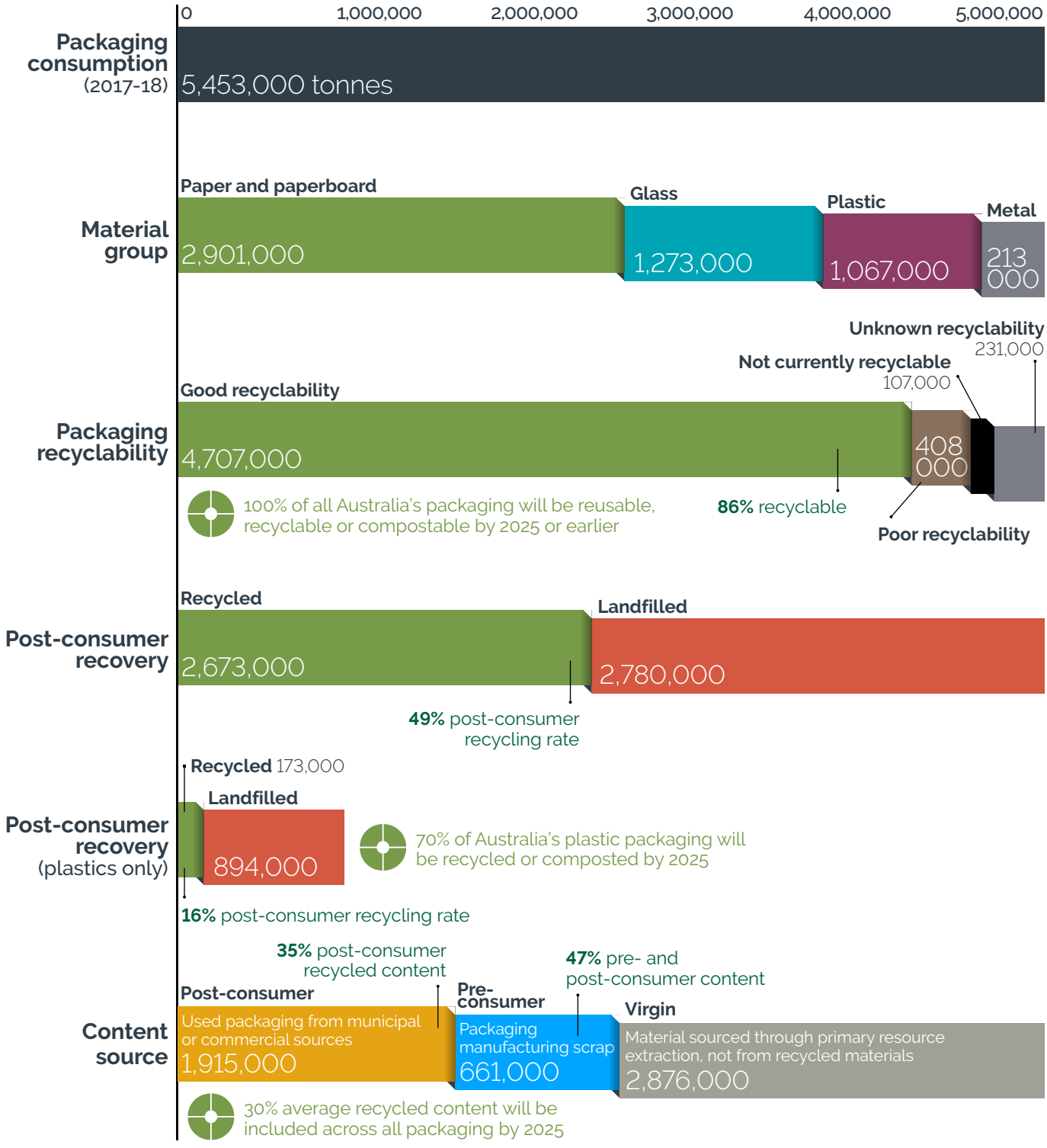


Figure 7 – Packaging data in 2017–18 and the National Packaging Targets (tonnes)

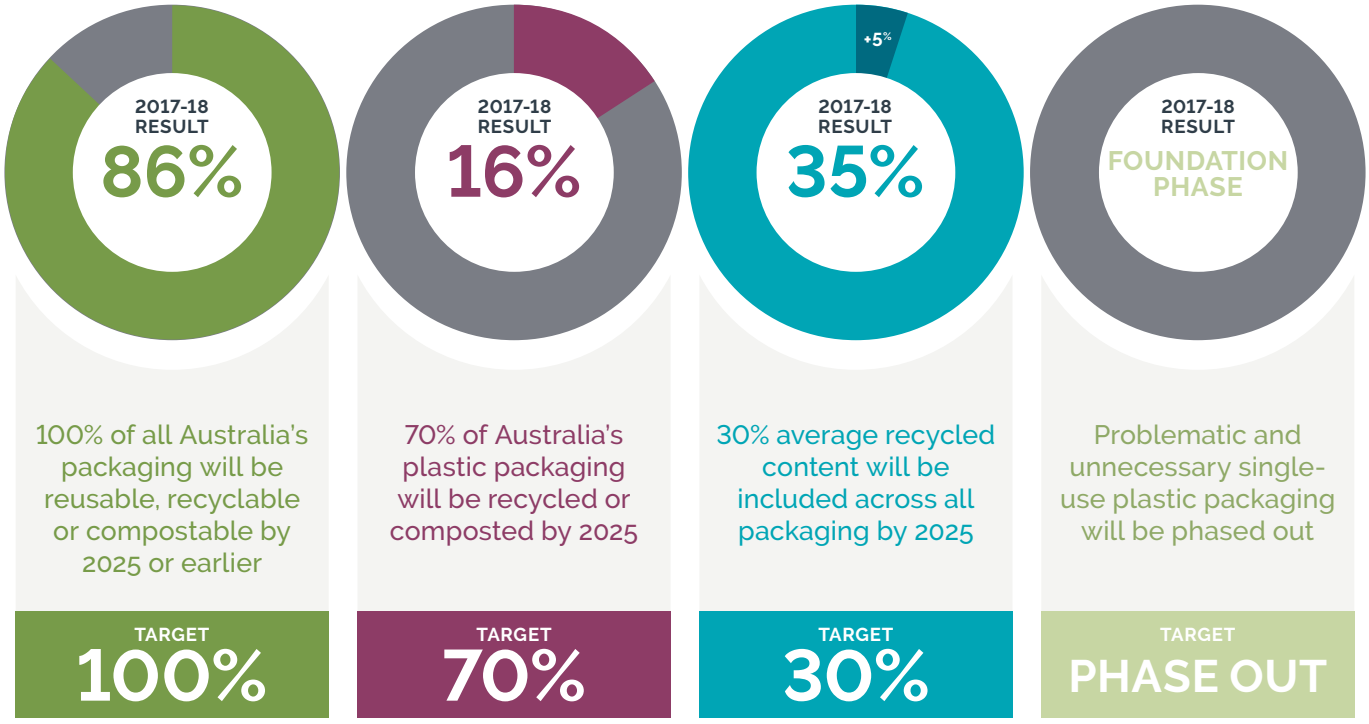


***Figure 8** – Summary of the National Packaging Targets and related 2017–18 results*

Project Methodology

Consumption quantification

Locally manufactured Australian packaging consumption has been determined through a survey of packaging manufacturers nationally, with production data estimated for all significant survey non-respondents.

Imported and exported new packaging has been determined through analysis of Australian Harmonized Tariff Item Statistical Code (HTISC) import data.

Packaging consumption is measured in terms of packaging (POM).

Recovery quantification

Australian packaging recovery has been determined through a survey of packaging reprocessors nationally, with recovery data estimated for all significant survey non-respondents.

Exported scrap packaging has been determined through analysis of Australian Harmonized Export Commodity Classification (AHECC) export data, and surveys with packaging reprocessors and exporters.

Recovery is measured at the out-going gate of the secondary processing facility for the used packaging. This is the point at which the processed material is typically 'input ready' for the manufacture of new packaging or other products. Examples of secondary processing facilities include; paper mills, glass beneficiation facilities, plastics flaking and washing facilities, and metal smelting facilities.

The overseas processing losses associated with the export of sorted but unprocessed materials have been estimated based on the losses reported by local operators of secondary processing facilities.

1 INTRODUCTION

1.1 This project

This project provides 2017–18 financial year baseline packaging consumption and recovery data for Australia.

The data will help inform progress towards the 2025 National Packaging Targets and support strategic planning across all levels of the life cycle of packaging: design, manufacturing, use, disposal and end-of-life fate.

The data collection, analysis and reporting has been undertaken in a manner that will support year-on-year comparisons into the future. This report also provides forecasts of key packaging flow quantities out to 2025 under different scenarios.

The 2025 National Packaging Targets are:

1. **100% of all Australia's packaging will be reusable, recyclable or compostable by 2025 or earlier**
2. **70% of Australia's plastic packaging will be recycled or composted by 2025**
3. **30% average recycled content will be included across all packaging by 2025**
4. **Problematic and unnecessary single-use plastic packaging will be phased out through design, innovation or introduction of alternatives**

1.2 This report

This report consists of five sections.

Executive summary

Overview of the project purpose, method and results, linked to the 2025 National Packaging Targets.

Section 1 – Introduction

Description of the project purpose and method.

Section 2 – Packaging consumption in 2017–18

Estimates of packaging placed on market (POM) in Australia in 2017–18, with POM data reported at the following levels:

- Packaging material groups and types.
- Packaging formats.
- Packaging material source locations.
- Rigid/flexible plastic packaging.
- Packaging degradability ratings.
- Recycled content and potential recycled content.

Section 3 – Packaging recovery in 2017–18

Estimates of post-consumer packaging recovery in Australia in 2017–18, with post-consumer recovery estimated at the out-going gate of the secondary processing facility for the used packaging. This is the point that the processed material is typically 'input ready' for the manufacture of new packaging or other products. Recovery data is reported at following levels:

- Packaging material groups and types.
- Recovered material use application (packaging/non-packaging).
- Recovered material use location (local/overseas).
- Rigid/flexible plastic packaging.
- Recovery rates by material groups and types.
- Recyclability.

Section 4 – Material flow analysis of packaging to 2025

This section of the report presents the material flow analysis (MFA) undertaken to characterise packaging flows through all stages of the packaging life-cycle, from manufacturing through to collection, sorting, recovery and disposal.

The MFA provides estimates of the performance of the waste packaging system against four resource recovery performance indicators: collection efficiency, sorting efficiency, post-consumer recovery rate, and local secondary material utilisation rate

The MFA also supports the identification of potential opportunities to improve the recovery of packaging, and provides a platform for assessing the impact of system interventions.

The MFA component of the project has been led by the Institute of Sustainable Futures at the University of Technology Sydney.

1.3 Project method

Data sources

Packaging consumption and recovery data was obtained from a combination of sources, primarily:

- Packaging manufacturers – National survey undertaken as part of this project.
- Packaging reprocessors – National survey undertaken as part of this project.
- Material recovery facilities (MRFs) – National survey undertaken by Blue Environment (2019).
- Container deposit scheme (CDS) operators – National survey undertaken by Blue Environment (2019).
- Australian import and export data (Australian Customs import/export Harmonized Tariff Item Statistical Code (HTISC) data extracts) (IndustryEdge, 2019a; 2019b).

Data collection and stakeholder consultation

Survey forms were prepared for packaging manufacturers and packaging reprocessing facilities. Copies of the forms are provided in Appendix E. An extensive stakeholder consultation plan was also developed for the project detailing the following tasks:

- Stakeholder communications development
- Initial contacts
- Face-to-face meetings
- Phone and e-mail based consultations
- Managing response gaps
- Consultation close-out

The detailed data collection and stakeholder consultation plan were documented in the project plan.

Packaging manufacturers, reprocessors and MRF operators were identified through previous survey contacts, APCO membership lists and the project team's industry knowledge. A summary of the packaging manufacturer and reprocessor survey outcomes by organisation type and response result is provided in Table 1. All major manufacturers and reprocessors that were identified were contacted.

Table 1 – Packaging manufacturer and reprocessor survey responses (company count)

Organisation type	Complete - interview/phone	Complete - estimated	No response or decline	Total
Manufacturer – fibre	3	3	0	**6**
Manufacturer – glass	2	0	0	**2**
Manufacturer – metals	3	3	0	**6**
Manufacturer – plastics	7	1	2	**10**
Reprocessor – fibre	4	4	0	**8**
Reprocessor – glass	1	8	0	**9**
Reprocessor – metals	3	2	0	**5**
Reprocessor – plastics	23	3	4	**30**
Total	**46**	**24**	**6**	**76**

Generally, where an organisation declined to provide a response, or did not respond within the survey period, it was possible to develop an estimate of activity based on publicly available data or through consultation with others in the industry.

For two non-responding plastic packaging manufacturers it was not possible to estimate production. However, whole of market estimates of packaging consumption in 2017–18 were available through the 2017–18 Australian Plastics Recycling Survey (Envisage Works, 2019), and the estimates of packaging consumption (POM) were scaled based on the data in this report.

For four non-responding (potential) plastic packaging reprocessors, it was not possible to estimate recovery. It is unknown if any of these reprocessors did accept scrap plastic packaging during 2017–18, and none of the four are understood to be particularly large in scale. For this reason, local recovery of scrap packaging may be a little understated in this report, by possibly 1 000–2 000 tonnes of plastic packaging recovery.

Determination of packaging consumption

Australian packaging consumption has been determined through a survey of packaging manufacturers nationally to obtain data on the following packaging attributes:

- Packaging placed on market (POM) by material type – see Appendix B for the consumption related material types list
- Location of material source – local or overseas
- Packaging manufacturing losses to recycling or landfill
- Packaging format – bottle, carton, closure, label, etc.
- Recycled content source – post-consumer, pre-consumer or virgin (primary) source
- Estimated potential post-consumer recycled content
- Packaging sector of use – consumer or business-to-business (B2B)
- Degradability rating

POM means that the packaging has been made available to the end-consumer (including business users). The subsequent disposal is following the intended use of the packaging and is considered 'post-consumer' disposal. Packaging losses prior to the point of POM are considered ‘pre-consumer’ losses.

Australian consumption of packaging through the import of finished goods and the import of semi-finished packaging (e.g. sheets of paperboards and rolls of plastic film for local filling) were determined through an extensive analysis of Australian import and export data for the 2017–18 financial year. For example, the import and export flows of plastic packaging were primarily determined through the review and analysis of 2 200 Customs import codes and 1 300 export codes, supported through manufacturer reports of their quantities of semi-finished imported packaging.

Determination of packaging recovery

Australian packaging recovery has been determined through a survey of packaging reprocessors nationally, to obtain data on the following packaging attributes:

- Recovery by material type – see Appendix B for the recovery related material types list
- Level of reprocessing undertaken by facility
- Packaging reprocessing losses to (downstream) recycling or landfill
- Post-consumer or pre-consumer material source
- Waste sector source by collection service – in terms of; municipal solid waste (MSW), commercial and industrial (C&I), construction and demolition (C&D), and container deposit scheme (CDS) collection services
- Rigid/flexible classification for reprocessed plastic packaging
- Material use application for processed product – packaging or non-packaging
- Stockpile estimates

Throughout this report the point of recovery measurement is stated in all cases. Recovery is generally measured at the out-going gate of the secondary processing facility for the used packaging. This is the point that the processed material is typically 'input ready' for the manufacture of new packaging or other products. Examples of secondary processing facilities include: paper mills, glass beneficiation facilities, plastics washing and flaking facilities, and metal smelting facilities.

The overseas processing losses associated with the export of sorted but unprocessed materials have been estimated based on the losses reported by local operators of secondary processing facilities.

Packaging recovery includes some relatively small quantities of plastic packaging sent to energy recovery in 2017–18 (approximately 2 000 – 4 000 tonnes).

Determination of packaging recovery rates

The packaging recovery rates determined in this report are based on the packaging POM by material group/type, and post-consumer packaging recovery measured at the out-going gate of the secondary processing facility for the used packaging.

It is important to note that in the determination of recovery rates packaging POM is assumed to be equivalent to post-consumer used packaging. That is, all packaging placed on the market in 2017–18, also reached end-of-life and was made available for recovery in 2017–18.

Scope limitations

Important scope limitations are:

- Plastic and steel containers of >20 L are excluded from packaging quantifications. This packaging type is almost entirely business-to-business (B2B) related only.
- Timber based packaging is excluded from packaging quantifications. This packaging type is typically B2B related only.
- Reusable packaging systems (e.g. returnable plastic crates and pallets) are excluded from packaging quantifications. This packaging type is B2B related only.

1.4 Comparability of 2017–18 data with previous years

The scope of the packaging flow quantifications undertaken in this report has been applied as consistently as possible across all packaging material types and formats. However, it is important to note that there are many scope and flow related method changes that have been adopted that may impact the comparability with previous studies. The major changes include:

- **This study has standardised packaging consumption to packaging placed on market (POM)** – Previous studies may have included pre-consumer manufacturing losses and recovered scrap in either consumption and/or recovery estimates. This standardisation may have the impact of decreasing apparent consumption and/or recovery estimates compared to prior work, with a corresponding impact on recovery rates.
- **This study has standardised packaging recovery to materials recovered at the out-going gate of secondary processing facilities** – Previous studies may have determined recovery at the incoming MRF gate or various points after that. This standardisation may have the impact of decreasing apparent recovery estimates compared to prior work, with different impacts on recovery rates depending on the recovery point previously adopted.

- **This study reports post-consumer recovery and recovery rates that do not include pre-consumer manufacturing scrap** – Previous studies largely did not consider pre-consumer manufacturing scrap and post-consumer packaging recovery separately. Pre-consumer manufacturing scrap recovery rates can be very high compared to post-consumer recovery rates, so excluding pre-consumer scrap and publishing a discrete post-consumer recovery rate may have the impact of lowering the previously reported (combined pre- and post-consumer) recovery rate.

1.5 Data limitations and interpretation

In the tables presented in this report, minor discrepancies may occur between summed totals presented in tables, and the apparent sums of the component items in tables, as summed totals are calculated using component item values prior to rounding.

Data in this report should be interpreted as having a maximum of three significant figures. However, to obtain a balance between the proper statement of the accuracy of the data, while minimising the apparent summation discrepancies previously mentioned, weight data in this report has generally been rounded to the nearest 1 000 tonnes.

The accuracy ranges provided in this report are weighted sum averages of packaging manufacturer and reprocessor reported estimates of the level of accuracy (±%) of packaging material placed onto the market or total reprocessing throughput respectively.

2 PACKAGING CONSUMPTION IN 2017–18

This section of the report provides estimates of packaging placed on market (POM) in Australia in 2017–18, with POM data reported at following levels:

- Packaging material groups and types
- Packaging formats
- Packaging material source locations
- Rigid/flexible plastic packaging
- Packaging degradability ratings
- Recycled content and potential recycled content

A summary of the data for each state and territory is provided in Appendix F.

2.1 Material group

Total packaging POM in Australia in 2017–18 is estimated at 5.45 million tonnes (±13%). Estimates for packaging POM by material group are provided in Table 2 and Figure 1. The aggregated accuracy range estimates for each of the material groups are also provided as error bars in Figure 1. The estimates include consumer and business-to-business (B2B) packaging.

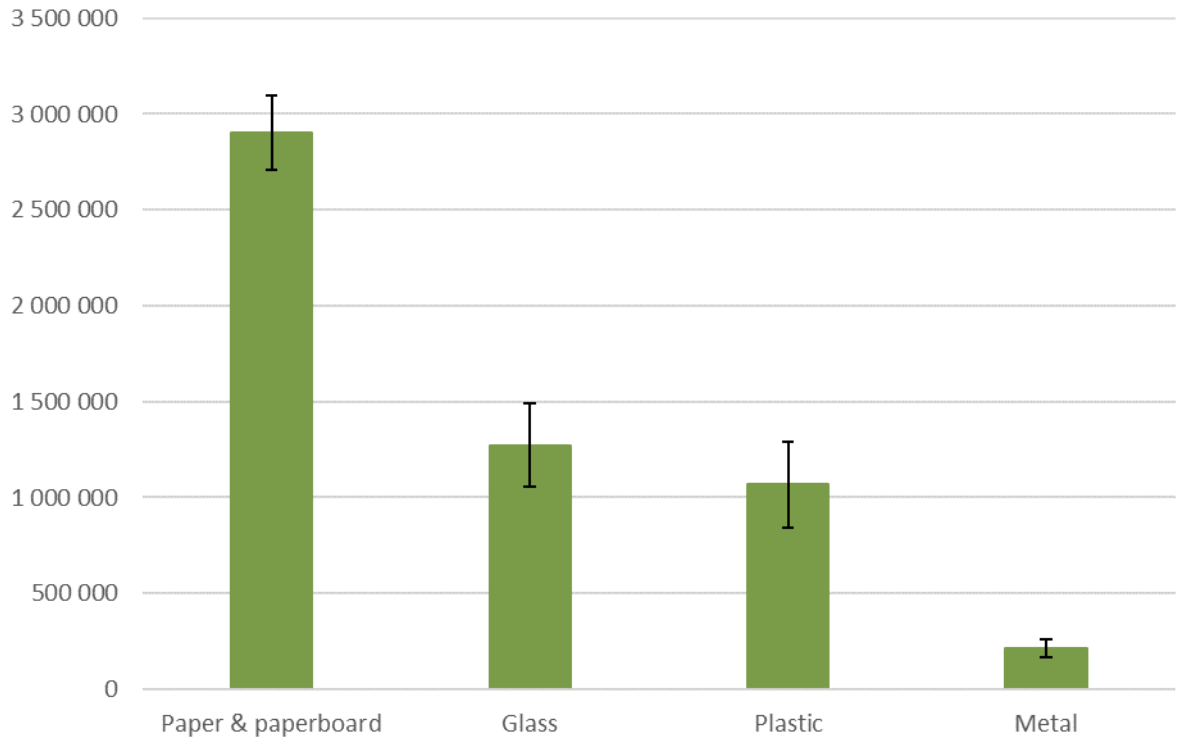
Of the 5.45 million tonnes of packaging POM in 2017–18, over half of this was paper and paperboard packaging (53.2%), followed by glass packaging (23.3%), plastic packaging (19.6%) and metal packaging (3.9%).

Refer to Appendix A (page 77) for the glossary of terms and abbreviations used throughout this report.

Table 2 – Packaging POM in 2017–18, by material group

Material group	Total POM		Accuracy range
	(tonnes)	(%)	(±%)
Paper and paperboard	2 901 000	53.2%	7%
Glass	1 273 000	23.3%	17%
Plastic	1 067 000	19.6%	21%
Metal	213 000	3.9%	23%
Total	**5 453 000**	**100.0%**	**13%**

Figure 1 – Packaging POM in 2017–18, by material group (tonnes)



POM means that the packaging has been made available to the end-consumer (including business users), and the subsequent disposal is following the intended use of the packaging and is considered 'post-consumer' disposal. Packaging losses prior to the point of POM are considered 'pre-consumer' losses and are not included in Table 2.

2.2 Material type

Paper and paperboard packaging

Paper and paperboard packaging POM in Australia in 2017–18 is estimated at 2.9 million tonnes (±7%), which is 53.2% of all packaging POM. Estimates for paper and paperboard packaging POM by material type, and sector of use are provided in Table 3 and Figure 2.

Around 83% of paper and paperboard packaging is cardboard cartons used in the business-to-business (B2B) sector. The other 16% of the corrugated cardboard is used in consumer applications.

Table 3 – Paper and paperboard packaging POM in 2017–18, by material type and sector of use

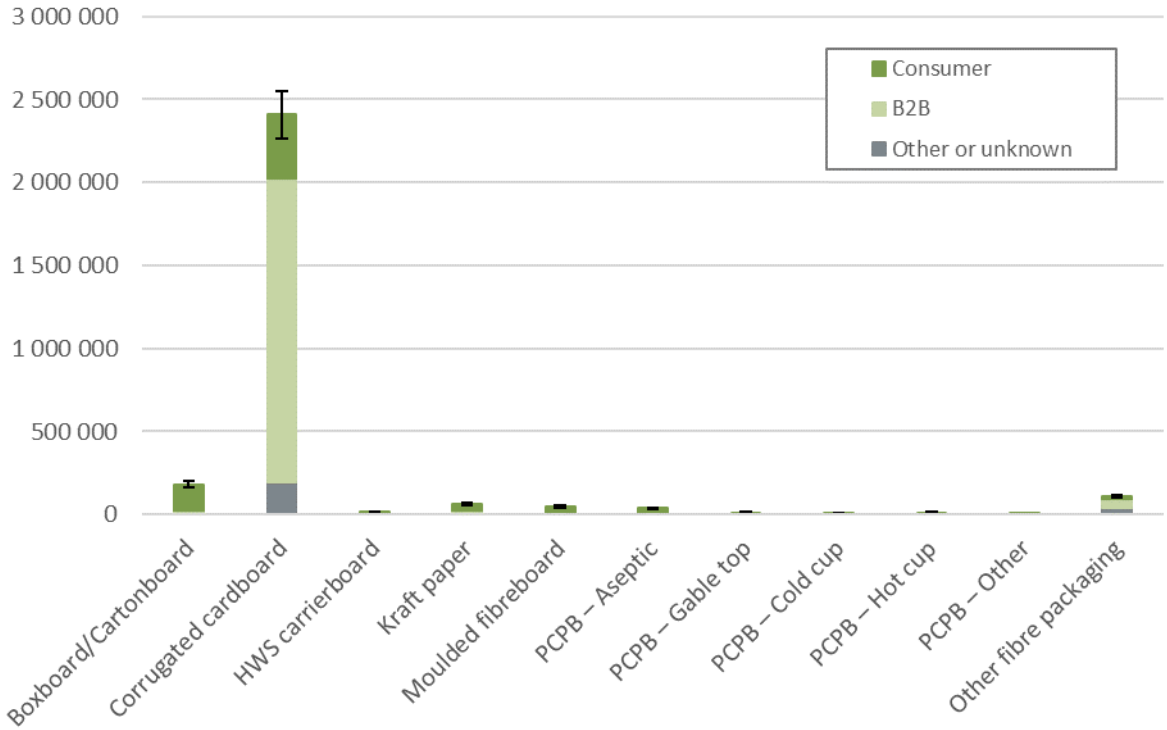
Material type	Consumer	B2B	Unknown	Total		Accuracy range
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)	(±%)
Boxboard/Cartonboard	154 000	27 000	0	181 000	6.2%	10%
Corrugated cardboard	384 000	1 828 000	197 000	2 409 000	83.0%	6%
HWS[a] carrierboard	15 000	0	0	15 000	0.5%	10%
Kraft paper	38 000	25 000	0	63 000	2.2%	10%
Moulded fibreboard	32 000	18 000	0	50 000	1.7%	18%
PCPB[b] – Aseptic	38 000	0	0	38 000	1.3%	6%
PCPB – Gable top	12 000	0	0	12 000	0.4%	10%
PCPB – Cold cup	6 000	0	0	6 000	0.2%	10%
PCPB – Hot cup	12 000	0	0	12 000	0.4%	10%
PCPB – Other	4 000	0	0	4 000	0.1%	10%
Other fibre packaging[c]	19 000	51 000	42 000	112 000	3.9%	8%
Total	**713 000**	**1 949 000**	**239 000**	**2 902 000**	**100.0%**	**7%**

a) HWS – High wet strength carrierboard.

b) PCPB – Polymer coated paperboard.

c) Examples of other fibre packaging include paper bags and food wraps.

Figure 2 – Paper and paperboard packaging POM in 2017–18, by material type and sector of use (tonnes)



Glass packaging

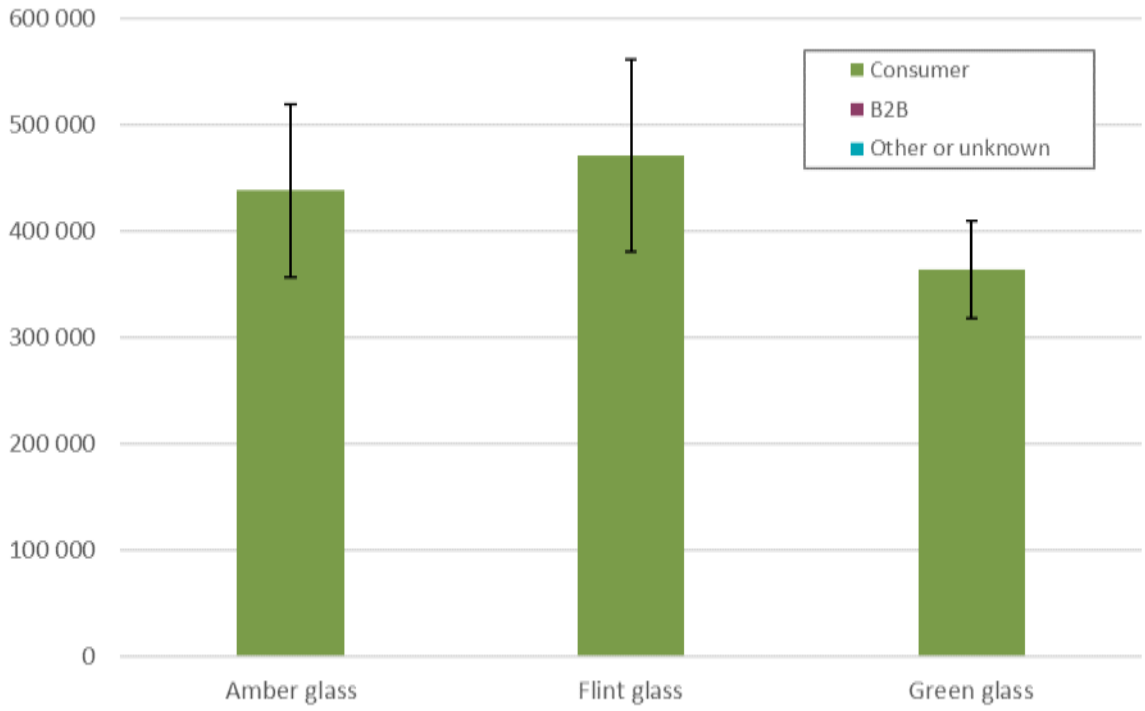
Glass packaging POM in Australia in 2017–18 is estimated at a little under 1.3 million tonnes (±17%), which is 23.4% of all packaging POM. Estimates for glass packaging POM by material type, and sector of use (consumer/B2B) are provided in Table 4 and Figure 3.

Glass packaging consumption is recorded for three main colours, which are amber, flint (clear) and green glass[1]. Flint glass makes up 37.0% of glass POM, followed by amber glass (34.4%) and green glass (28.6%). All glass packaging is used in consumer applications, with none reported as POM for the B2B sector.

Table 4 – Glass packaging POM in 2017–18, by material type and sector of use

Material type	Consumer	B2B	Unknown	Total		Accuracy range
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)	(±%)
Amber glass	438 000	0	0	438 000	34.4%	19%
Flint glass	471 000	0	0	471 000	37.0%	19%
Green glass	364 000	0	0	364 000	28.6%	13%
Total	**1 273 000**	**0**	**0**	**1 273 000**	**100.0%**	**17%**

Figure 3 – Glass packaging POM in 2017–18, by material type and sector of use (tonnes)



[1] Very small quantities of other glass colours are included in the data (e.g. blue glass).

Plastic packaging

Plastic packaging POM in Australia in 2017–18 is estimated at nearly 1.1 million tonnes (±21%), which is 19.6% of all packaging POM. Estimates for plastic packaging POM by material type, and sector of use (consumer/B2B) are provided in Table 5 and Figure 4.

Plastic packaging consumption is dominated by high density polyethylene (HDPE) (32.9%), low density polyethylene (LDPE) (23.8%), PP (15.4%) and polyethylene terephthalate (PET) (12.4%). Around 65% of plastic packaging is used in the consumer sector, with another 27% used in the B2B sector (this is dominated by LDPE films and HPDE in rigid packaging applications). The sector of use of the other 9% could not be identified.

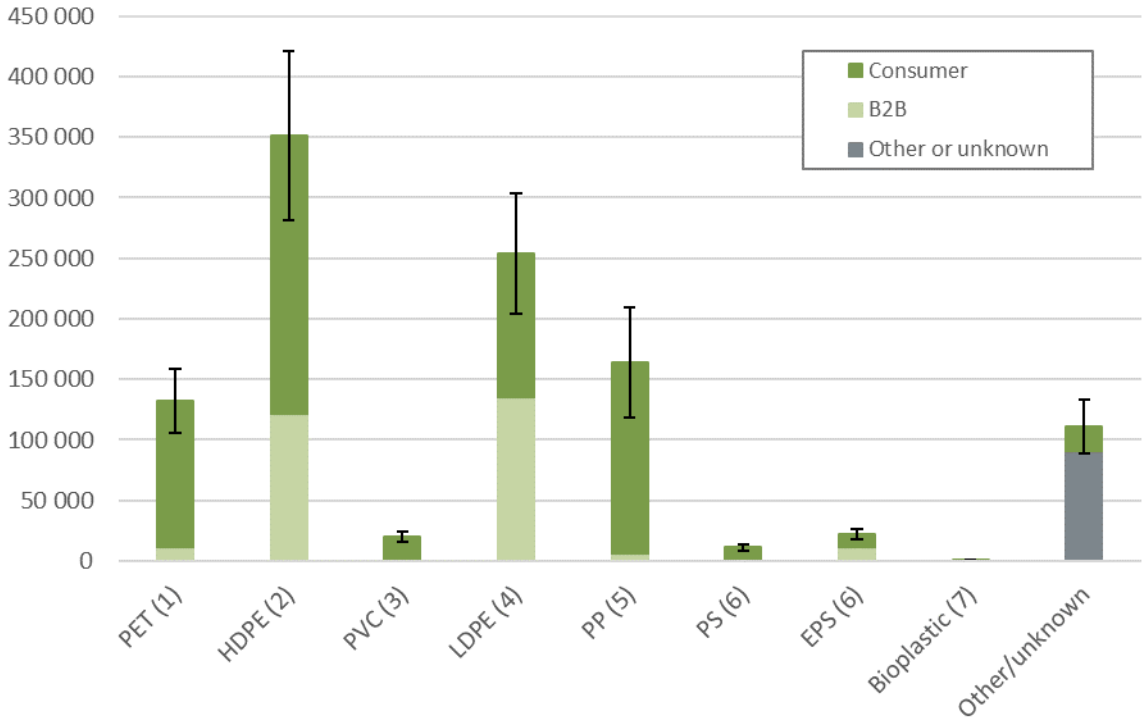
Table 5 – Plastic packaging POM in 2017–18, by material type and sector of use

Material type	Consumer	B2B	Unknown	Total		Accuracy range
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)	(±%)
PET (1)	121 000	11 000	0	132 000	12.4%	20%
HDPE (2)	229 000	122 000	0	351 000	32.9%	20%
PVC (3)	20 000	0	0	20 000	1.9%	20%
LDPE (4)	119 000	135 000	0	254 000	23.8%	20%
PP (5)	158 000	6 000	0	164 000	15.4%	28%
PS (6)	11 000	0	0	11 000	1.0%	20%
EPS (6)	10 000	12 000	0	22 000	2.1%	20%
Bioplastic (7)	1 000	0	0	1 000	0.1%	19%
Other/unknown	20 000	0	91 000	111 000	10.4%	20%
Total	**689 000**	**287 000**	**91 000**	**1 067 000**	**100.0%**	**21%**

B2B – Business-to-business packaging.

PET (1) – Polyethylene terephthalate (PIC 1) | HDPE (2) – High density polyethylene (PIC 2) | PVC (3) – Polyvinyl chloride (PIC 3) | LDPE (4) – Low density polyethylene (PIC 4) | PP (5) – Polypropylene (PIC 5) | PS (6) – Polystyrene (PIC 6) | EPS (6) – Expanded polystyrene (PIC 6).

Figure 4 – Plastic packaging POM in 2017–18, by material type and sector of use (tonnes)



Metal packaging

Metal packaging POM in Australia in 2017–18 is estimated at a little over 200 000 tonnes (±23%), which is 3.9% of all packaging POM. Estimates for metal packaging POM by material type, and sector of use (consumer/B2B) are provided in Table 6 and Figure 5.

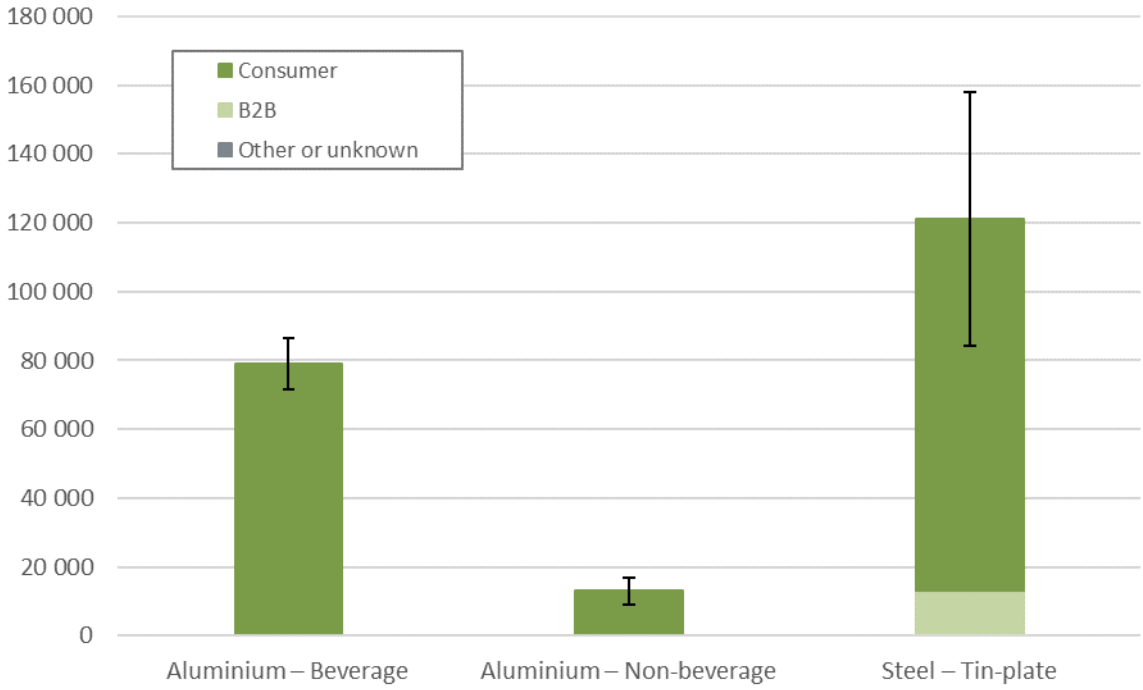
Metal packaging consumption is dominated by tin-plate steel can (56.8%) and aluminium beverage can (37.1%) consumption. Nearly 94% of metal packaging is used in the consumer sector, with the other 6% used in the B2B sector.

Table 6 – Metal packaging POM in 2017–18, by material type and sector of use

Material type	Consumer	B2B	Unknown	Total		Accuracy range
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)	(±%)
Aluminium – Beverage	79 000	0	0	79 000	37.1%	9%
Aluminium – Non-beverage	13 000	0	0	13 000	6.1%	30%
Steel – Tin-plate[a]	108 000	13 000	0	121 000	56.8%	30%
Total	**200 000**	**13 000**	**0**	**213 000**	**100.0%**	**23%**

a) Steel containers >20 L are excluded from the project scope.

Figure 5 – Metal packaging POM in 2017–18, by material type and sector of use (tonnes)



2.3 Packaging format

In this section of the report, estimates of packaging POM by packaging format are presented. Information on the format of the packaging material is useful as it relates to the recoverability of the material, and also supports the estimation of the quantities of rigid and flexible plastic packaging formats onto the market (Section 2.5). Estimates for packaging POM by material group and format are provided in Table 7 and Figure 6.

The major packaging formats are cartons and boxes (47.9%), which are entirely paper and paperboard based, and bottles and jars (30.2%), which are split approximately 4:1 between glass and plastic respectively.

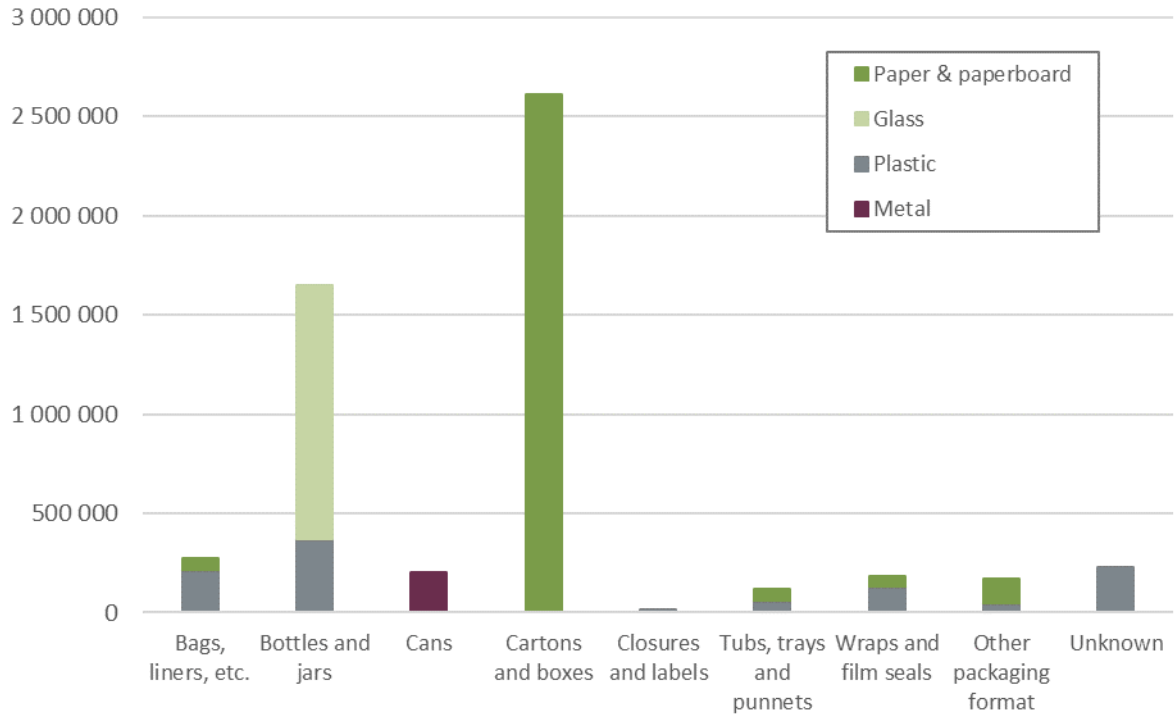
Table 7 – Packaging POM in 2017–18, by material group and format

Format	Paper and paperboard	Glass	Plastic	Metal	Total	
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)
Bags, liners, etc.	55 000	0	216 000	0	271 000	5.0%
Bottles and jars	0	1 273 000	373 000	0	1 646 000	30.2%
Cans	0	0	0	201 000	201 000	3.7%
Cartons and boxes[a]	2 612 000	0	0	0	2 612 000	47.9%
Closures and labels	0	0	19 000	0	19 000	0.3%
Tubs, trays and punnets	56 000	0	60 000	3 000	119 000	2.2%
Wraps and film seals[b]	52 000	0	130 000	0	182 000	3.3%
Other packaging format	125 000	0	27 000	9 000	161 000	3.0%
Unknown	0	0	243 000	0	243 000	4.5%
Total	**2 901 000**	**1 273 000**	**1 067 000**	**213 000**	**5 453 000**	**100.0%**

a) All polymer-coated paperboard packaging formats included under 'Cartons and boxes'.

b) Includes multi-pack wraps (typically made from paperboard or plastic film), food wraps (e.g. for butter, cheeses or hamburgers), pallet wrap, heat shrink seals and tamper evident seals, aseptic container film seals etc.

Figure 6 – Packaging POM in 2017–18, by material group and format (tonnes)



2.4 Packaging material source location

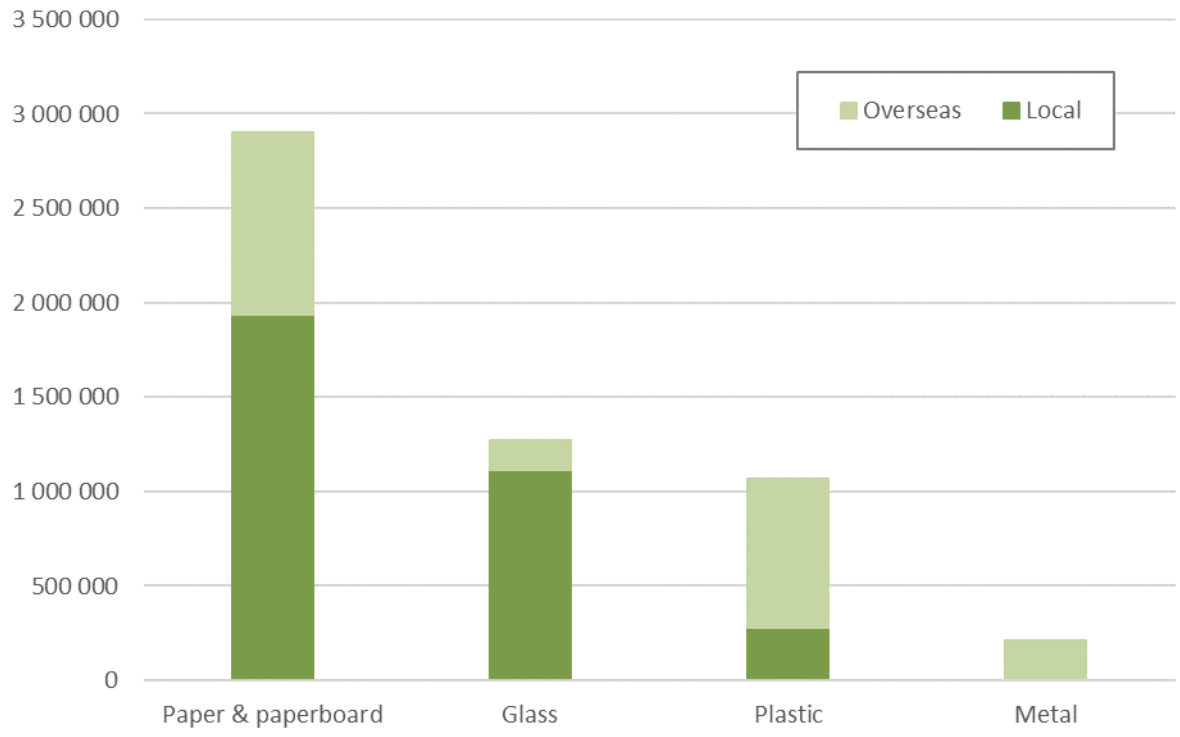
Estimates of the location of packaging material source, by local or overseas origin, are provided in Table 8 and Figure 7. In 2017-18, around 61% of packaging was manufactured locally and 39% was imported.

The manufacturing of paper and paperboard and glass-based packaging is dominated by the use of locally sourced materials (including recycled packaging inputs). The manufacturing of plastic and metal-based packaging is dominated by the use of imported materials, which includes imported filled or unfilled packaging and semi-finished packaging material for local packaging forming and filling.

Table 8 – Packaging POM in 2017–18, by material group and location of material source

Material group	Local	Overseas	Total
	(tonnes)	(tonnes)	(tonnes)
Paper and paperboard	1 937 000	964 000	2 901 000
Glass	1 114 000	158 000	1 273 000
Plastic	280 000	787 000	1 067 000
Metal	0	213 000	213 000
Total	**3 331 000**	**2 122 000**	**5 453 000**

Figure 7 – Packaging POM in 2017–18, by material group and location of material source (tonnes)



2.5 Rigid/flexible plastic packaging

In this section of the report, estimates of plastic packaging POM by rigid/flexible packaging format classification are presented. Information on the rigidity of plastic packaging is useful as it is related to the recoverability and value of the material. Estimates for packaging POM by plastic material type and rigid/flexible classification are provided in Table 9 and Figure 8.

The definitions of rigid and flexible plastic packaging adopted for this study are:

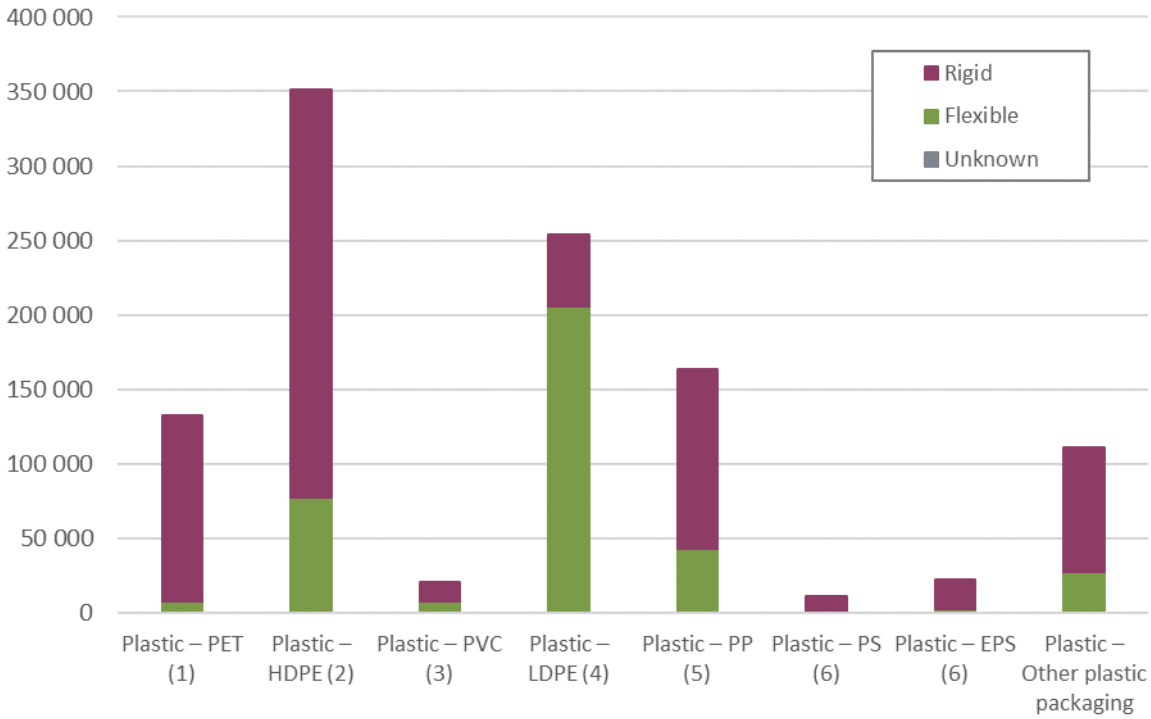
- Rigid plastic packaging are plastic goods such as bottles and tubs, which are (generally) moulded and hold their shape.
- Flexible (soft) plastics are plastic goods that can be scrunched into a ball.

Of the nearly 1.1 million tonnes of plastic packaging used in 2017–18, at least 484 000 tonnes (45%) were rigid plastic packaging, and at least 352 000 tonnes (33%) were flexible plastics. The format of the other 231 000 tonnes (22%) could not be identified in sufficient detail to classify this material as either rigid or flexible.

Table 9 – Plastic packaging POM in 2017–18, by material type and rigid/flexible classification

Format	Rigid	Flexible	Unknown	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
PET (1)	118 000	7 000	7 000	132 000
HDPE (2)	221 000	72 000	58 000	351 000
PVC (3)	7 000	7 000	7 000	21 000
LDPE (4)	5 000	201 000	48 000	254 000
PP (5)	103 000	41 000	20 000	164 000
PS (6)	10 000	1 000	0	11 000
EPS (6)	20 000	2 000	0	22 000
Bioplastic (7)	1 000	0	0	1 000
Other/unknown	0	20 000	91 000	111 000
Total	**484 000**	**352 000**	**231 000**	**1 067 000**

Figure 8 – Plastic packaging POM in 2017–18, by material type and rigid/flexible classification (tonnes)



2.6 Degradability rating

In this section of the report, estimates of packaging POM by degradability rating are provided in Table 10 and Figure 9.

Due to the extensive use of wood-fibre based packaging around 2.8 million tonnes of packaging POM in 2017–18 (51.4% of packaging) is rated as biodegradable. Around 2.6 million tonnes (48.1%) is not considered degradable.

Table 10 – Packaging POM in 2017–18, by material group and degradability rating

Material group	Not considered degradable	Certified compostable plastics or fibre	Biodegradable fibre-based	Oxo or photo-degradable plastics	Unknown	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Paper and paperboard	72 000[a]	0	2 805 000	0	24 000	2 901 000
Glass	1 273 000	0	0	0	0	1 273 000
Plastic	1 065 000	<1 000	0	2 000	0	1 067 000
Metal	213 000	0	0	0	0	213 000
Total	**2 622 000**	**<1 000**	**2 805 000**	**2 000**	**24 000**	**5 453 000**

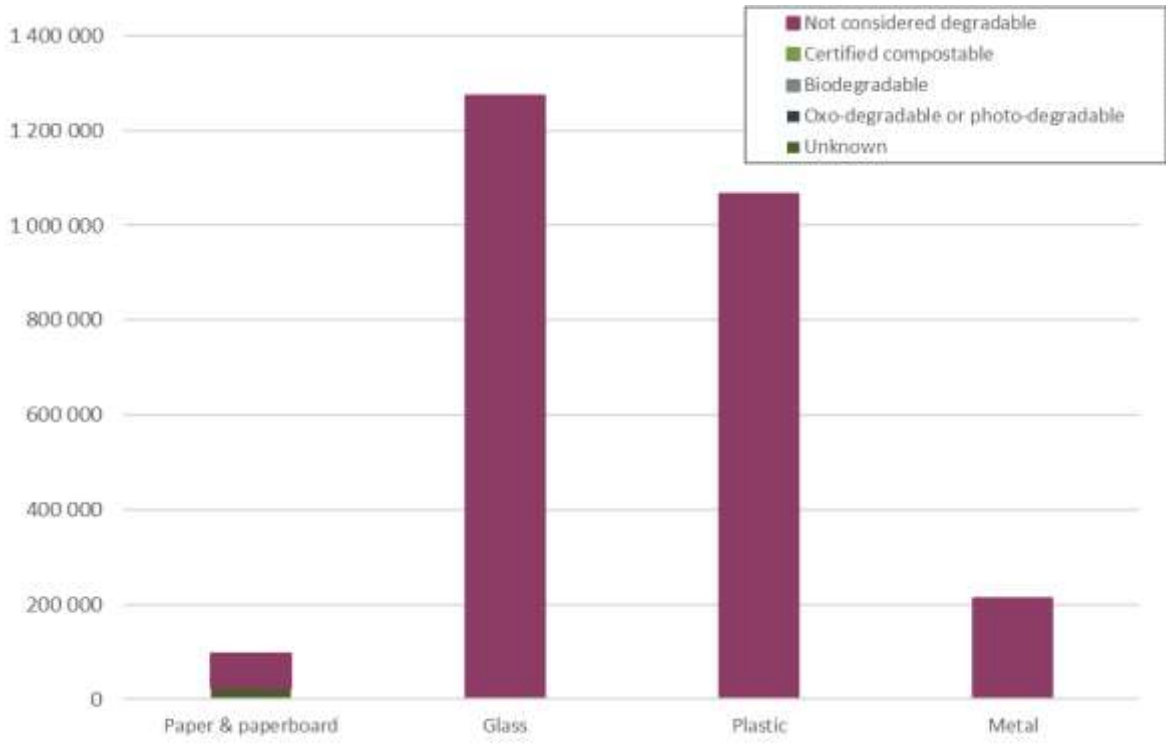
a) The 'Not considered degradable' paper and paperboard packaging formats are almost entirely PCPB material types

There was less than 1,000 tonnes of packaging POM in 2017–18 that was certified compostable.

There was around 2,000 tonnes of oxo-degradable and photo-degradable packaging POM in 2017–18. This estimate is indicative only. This packaging group is typically HDPE or LDPE film with a degradant additive blended into the film at a rate of around 2–3% by weight.

All the identified oxo-degradable and photo-degradable packaging was imported, with no local manufacture identified. There is no data (or controls) on the composition of imported oxo-degradable and photo-degradable packaging, so the rate of addition of the degradant additive to these imported packaging products is unknown.

Figure 9 – Packaging POM in 2017–18, by material group and degradability rating (tonnes)



2.7 Recycled content

Material group

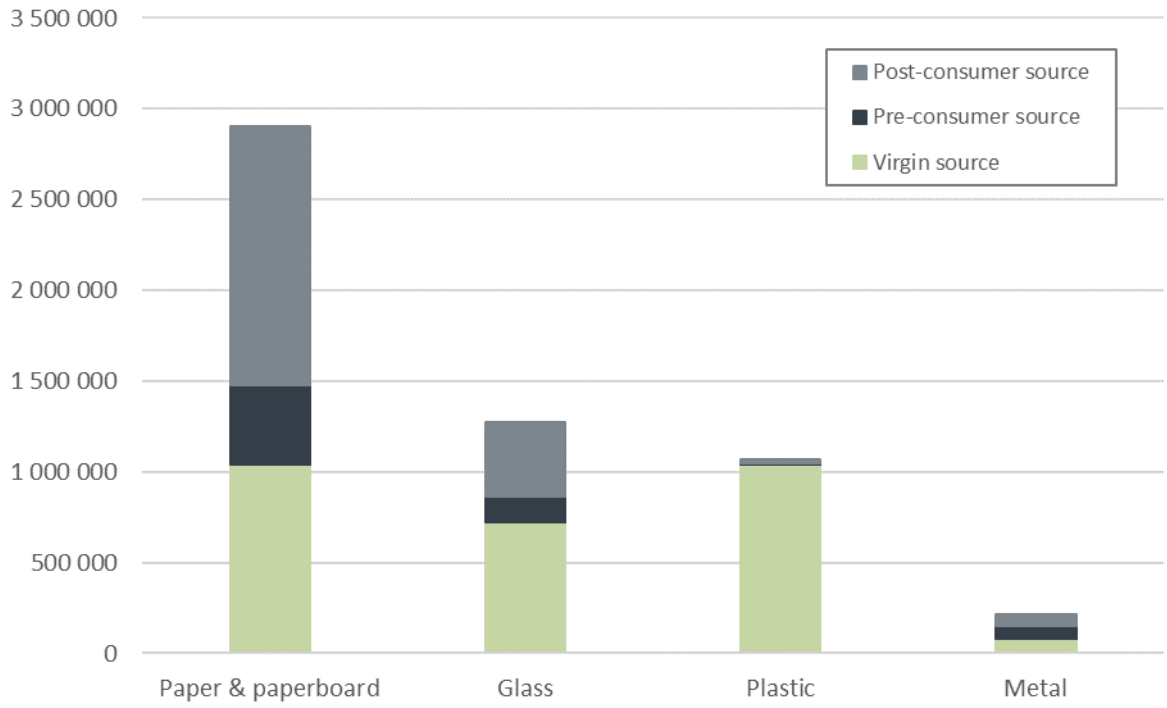
Estimates of the recycled content incorporated into packaging POM in 2017–18, by material group, are provided in Table 11 and Figure 10. The post-consumer recycled content across all packaging was 1.9 million tonnes, or 35% of total packaging POM, the pre-consumer recycled content was 0.7 million tonnes (12%), and nearly 2.9 million tonnes (53%) was sourced from virgin (primary) feedstocks.

Table 11 – Packaging POM in 2017–18, by material group and recycled content

Material group	Post-consumer source	Pre-consumer source	Virgin source	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Paper and paperboard	1 421 000	441 000	1 038 000	2 901 000
Glass	407 000	146 000	720 000	1 273 000
Plastic	23 000	7 000	1 037 000	1 067 000
Metal	64 000	68 000	81 000	213 000
Total (tonnes)	**1 915 000**	**661 000**	**2 876 000**	**5 453 000**
Total (%)	**35%**	**12%**	**53%**	**100%**

It is worth noting that the compositional profile of the pre-consumer recycled content component of the material is typically the same as that of the packaging material POM, and reflects the composition of the incoming material into the packaging manufacturing. That is, it can have a percentage of virgin, pre-consumer and post-consumer content.

Figure 10 – Packaging POM in 2017–18, by material group and recycled content (tonnes)



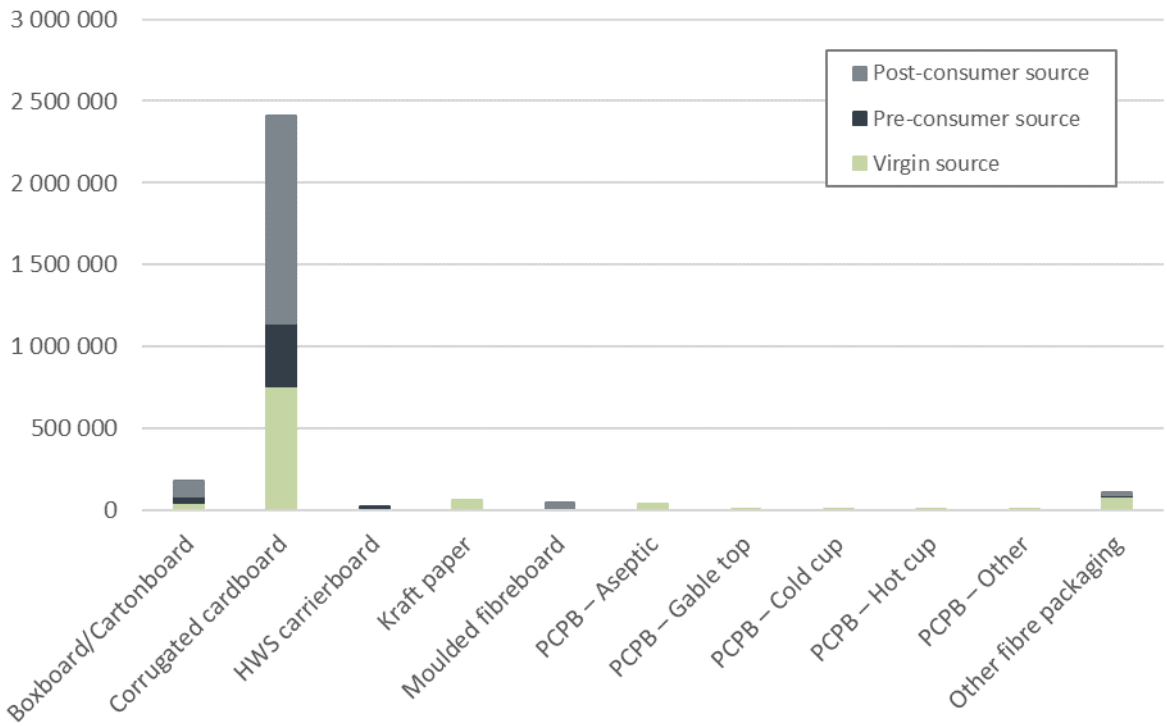
Paper and paperboard packaging

Estimates of the recycled content incorporated into paper and paperboard packaging POM in 2017–18 and by material type are provided in Table 12 and Figure 11. The post-consumer recycled content of paper and paperboard packaging was 1.4 million tonnes, or 49% of total paper and paperboard packaging POM, the pre-consumer recycled content was a little over 0.4 million tonnes (15%), and a little over 1.0 million tonnes (36%) was sourced from virgin (primary) feedstocks.

Table 12 – Paper and paperboard packaging POM in 2017–18, by material type and recycled content source

Material type	Post-consumer	Pre-consumer	Virgin	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Boxboard/Cartonboard	91 000	45 000	45 000	181 000
Corrugated cardboard	1 263 000	385 000	760 000	2 408 000
HWS carrierboard	0	2 000	14 000	15 000
Kraft paper	0	0	63 000	63 000
Moulded fibreboard	50 000	0	0	50 000
PCPB – Aseptic	0	0	38 000	38 000
PCPB – Gable top	0	0	12 000	12 000
PCPB – Cold cup	0	0	6 000	6 000
PCPB – Hot cup	0	0	12 000	12 000
PCPB – Other	0	0	4 000	4 000
Other fibre packaging	18 000	9 000	85 000	112 000
Total (tonnes)	**1 421 000**	**441 000**	**1 038 000**	**2 901 000**
Total (%)	**49%**	**15%**	**36%**	**100%**

Figure 11 – Paper and paperboard packaging POM in 2017–18, by material type and recycled content (tonnes)



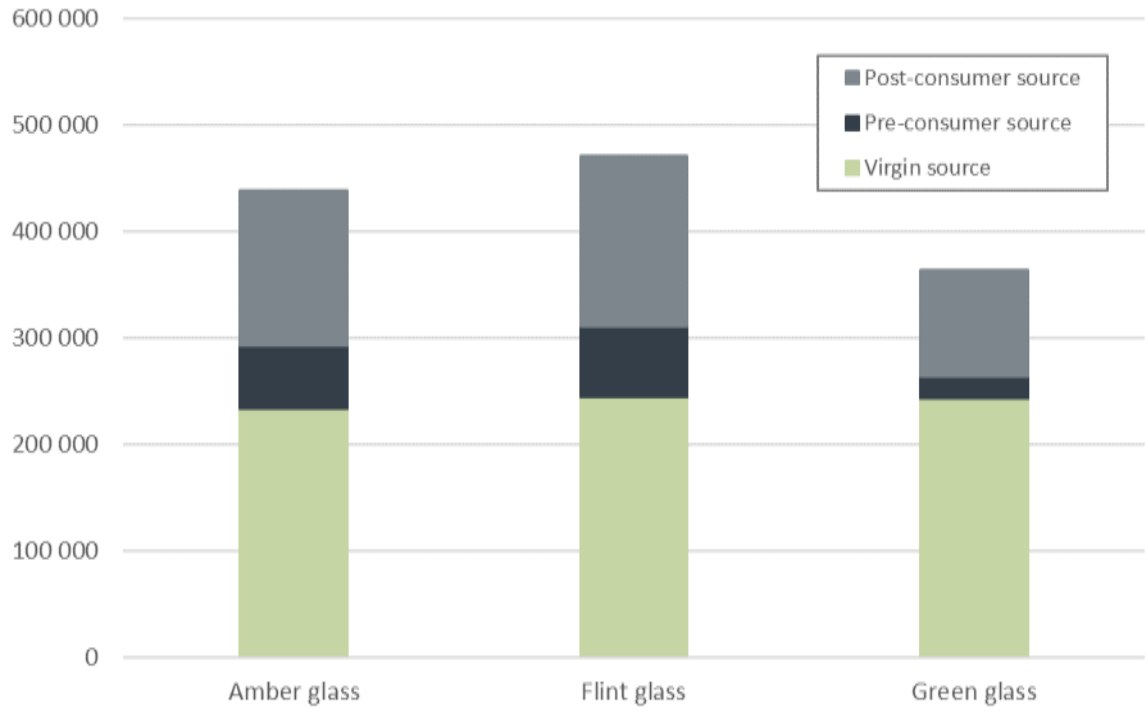
Glass packaging

Estimates of the recycled content incorporated into glass packaging POM in 2017–18 and by material type are provided in Table 13 and Figure 12. The post-consumer recycled content of glass packaging was 0.4 million tonnes, or 32% of total glass packaging POM, the pre-consumer recycled content was 0.15 million tonnes (11%), and a little over 0.7 million tonnes (57%) was sourced from virgin (primary) feedstocks.

Table 13 – Glass packaging POM in 2017–18, by material type and recycled content source

Material type	Post-consumer	Pre-consumer	Virgin	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Amber glass	146 000	59 000	233 000	438 000
Flint glass	160 000	67 000	244 000	471 000
Green glass	101 000	20 000	243 000	364 000
Total (tonnes)	**407 000**	**146 000**	**720 000**	**1 273 000**
Total (%)	**32%**	**11%**	**57%**	**100%**

Figure 12 – Glass packaging POM in 2017–18, by material type and recycled content (tonnes)



Plastic packaging

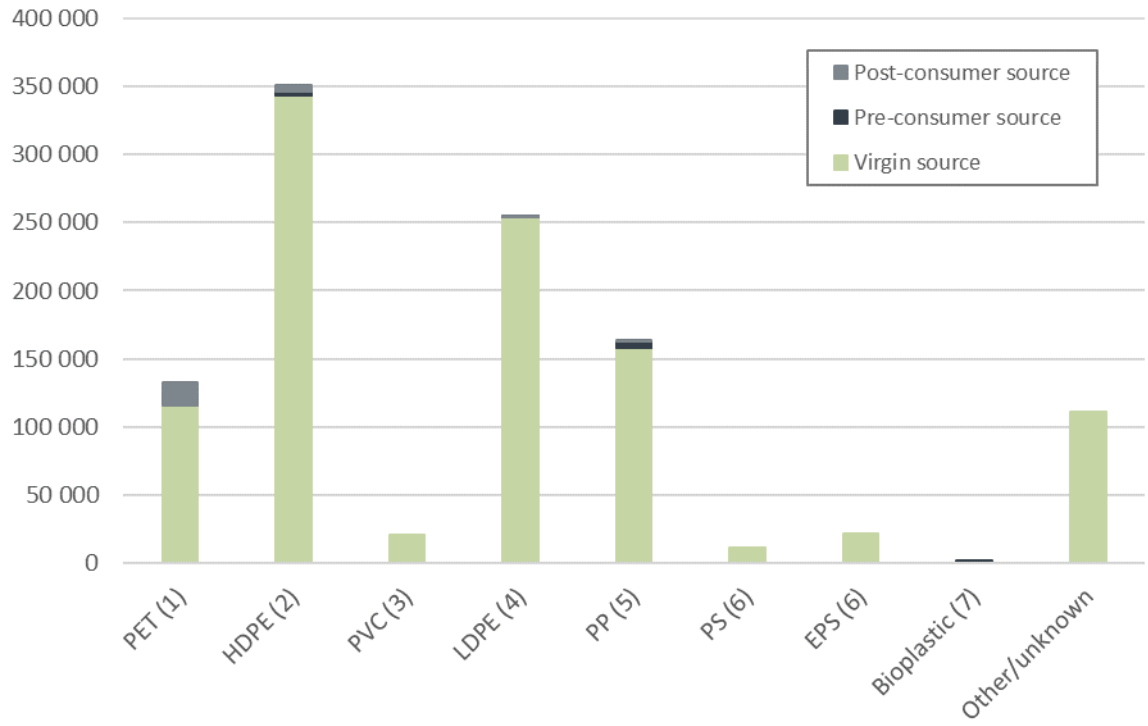
Estimates of the recycled content incorporated into plastic packaging POM in 2017–18 and by material type are provided in Table 14 and Figure 13. The post-consumer recycled content of plastic packaging

was 23 000 tonnes, or 2% of total plastic packaging POM, the pre-consumer recycled content was 7 000 tonnes (1%), and virgin (primary) resin feedstock dominated supply at a little over 1.0 million tonnes or 97% of source material.

Table 14 – Plastic packaging POM in 2017–18, by material type and recycled content source

Material type	Post-consumer	Pre-consumer	Virgin	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
PET (1)	16 000	0	116 000	132 000
HDPE (2)	5 000	3 000	343 000	351 000
PVC (3)	0	0	20 000	20 000
LDPE (4)	0	0	254 000	254 000
PP (5)	1 000	4 000	158 000	164 000
PS (6)	0	0	11 000	11 000
EPS (6)	0	0	22 000	22 000
Bioplastic (7)	0	0	1 000	1 000
Other/unknown	0	0	111 000	111 000
Total (tonnes)	**23 000**	**7 000**	**1 037 000**	**1 067 000**
Total (%)	**2%**	**1%**	**97%**	**100%**

Figure 13 – Plastic packaging POM in 2017–18, by material type and recycled content (tonnes)



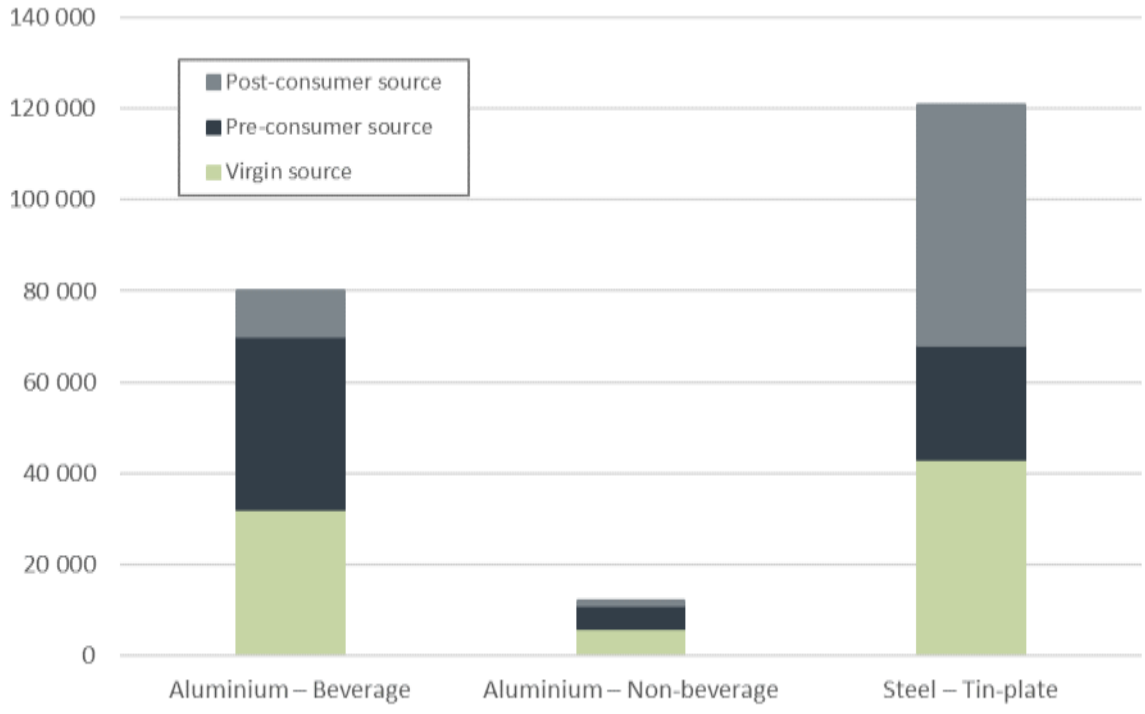
Metal packaging

Estimates of the recycled content incorporated into metal packaging POM in 2017–18 and by material type are provided in Table 15 and Figure 14. The post-consumer recycled content of metal packaging was 64 000 tonnes, or 30% of total metal packaging POM, the pre-consumer recycled content was 68 000 tonnes (32%), and 81 000 tonnes (38%) was sourced from virgin (primary) feedstocks.

Table 15 – Metal packaging POM in 2017–18, by material type and recycled content source

Material type	Post-consumer	Pre-consumer	Virgin	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Aluminium – Beverage	10 000	38 000	32 000	79 000
Aluminium – Non-beverage	1 000	5 000	6 000	13 000
Steel – Tin-plate	53 000	25 000	43 000	121 000
Total (tonnes)	**64 000**	**68 000**	**81 000**	**213 000**
Total (%)	**30%**	**32%**	**38%**	**100%**

Figure 14 – Metal packaging POM in 2017–18, by material type and recycled content (tonnes)



Due to the nature of aluminium goods manufacturing, which typically involves relatively large quantities of pre-consumer scrap generation, the proportion of pre-consumer recycled content in aluminium based packaging is relatively high compared to other packaging material types.

3 PACKAGING RECOVERY IN 2017–18

This section of the report provides estimates of post-consumer packaging recovery in Australia in 2017–18. Recovery estimates are measured at the out-going gate of the secondary processing facility for the used packaging. This is the point that the processed material is typically 'input ready' for the manufacture of new packaging or other products.

Examples of secondary processing facilities include; paper mills, glass beneficiation facilities, plastics flaking and washing facilities, and metal smelting facilities.

Recovery data is reported at the following levels:

- Packaging material groups and types
- Recovered material use application (packaging/non-packaging)
- Recovered material use location (local/overseas)
- Rigid/flexible plastic packaging
- Recovery rates by material groups and types
- Recyclability

A summary of the data for each state and territory is provided in Appendix F.

3.1 Material group

Total Australian post-consumer packaging recovery in 2017–18 is estimated at 2.67 million tonnes (±14%). This recovery estimate is measured at the out-going gate of the secondary processing facility for the used packaging. The overseas processing losses associated with the export of sorted but unprocessed materials have been estimated based on the losses reported by local operators of secondary processing facilities.

Of the packaging recovered in 2017–18, over two thirds of this was paper and paperboard packaging (68.0%), followed by glass packaging (21.8%), plastic packaging (6.5%) and metal packaging (3.8%).

Estimates for post-consumer packaging recovery by material group are provided in Table 16 and Figure 15. The aggregated accuracy range estimates for each of the material groups are also provided. The estimates include post-consumer packaging collected through municipal, commercial and industrial (C&I) and container deposit scheme (CDS) collection service types, and are presented in terms of the collection service in Table 17 and Figure 16.

Table 16 – Post-consumer packaging recovery in 2017–18, by material group

Material group	Recovery		Accuracy range
	(tonnes)	(%)[a]	(±%)
Paper and paperboard	1 817 000	68.0%	11%
Glass	582 000	21.8%	23%
Plastic	173 000	6.5%	15%
Metal	102 000	3.8%	21%
Total	**2 673 000**	**100.0%**	**14%**

a) Percent contribution to the total amount of packaging recovered, and not the recovery rate.

Figure 15 – Post-consumer packaging recovery in 2017–18, by material group (tonnes)

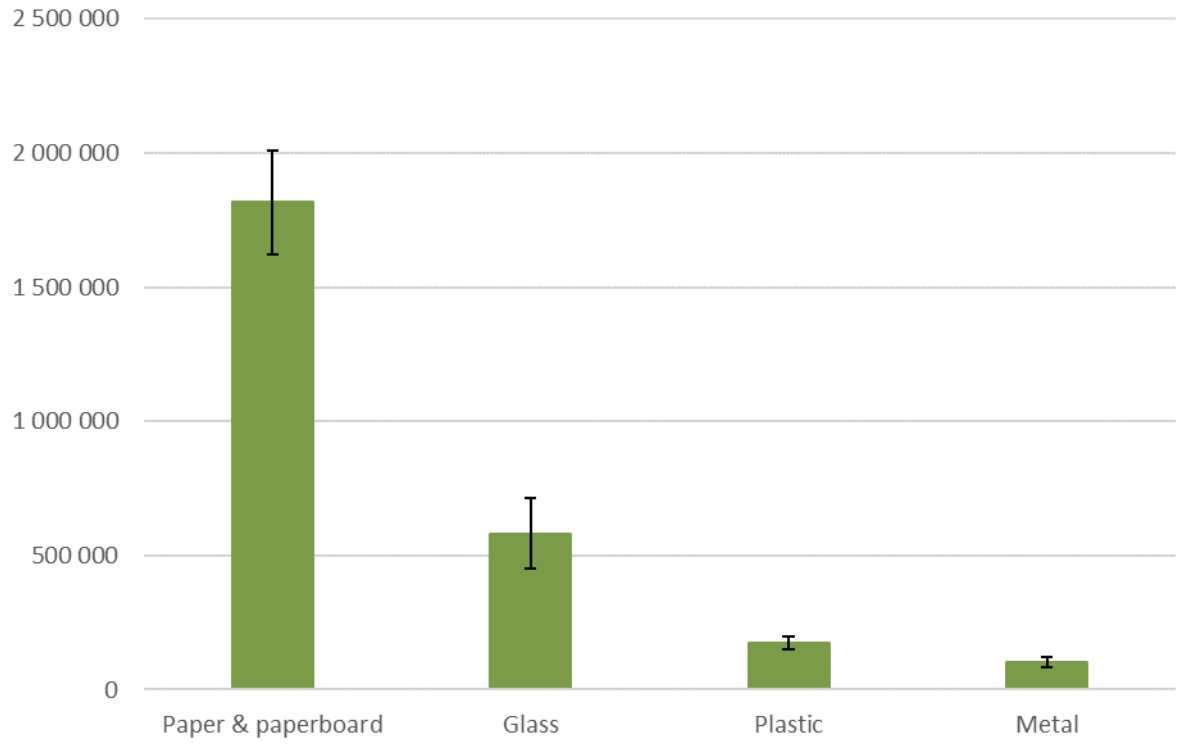
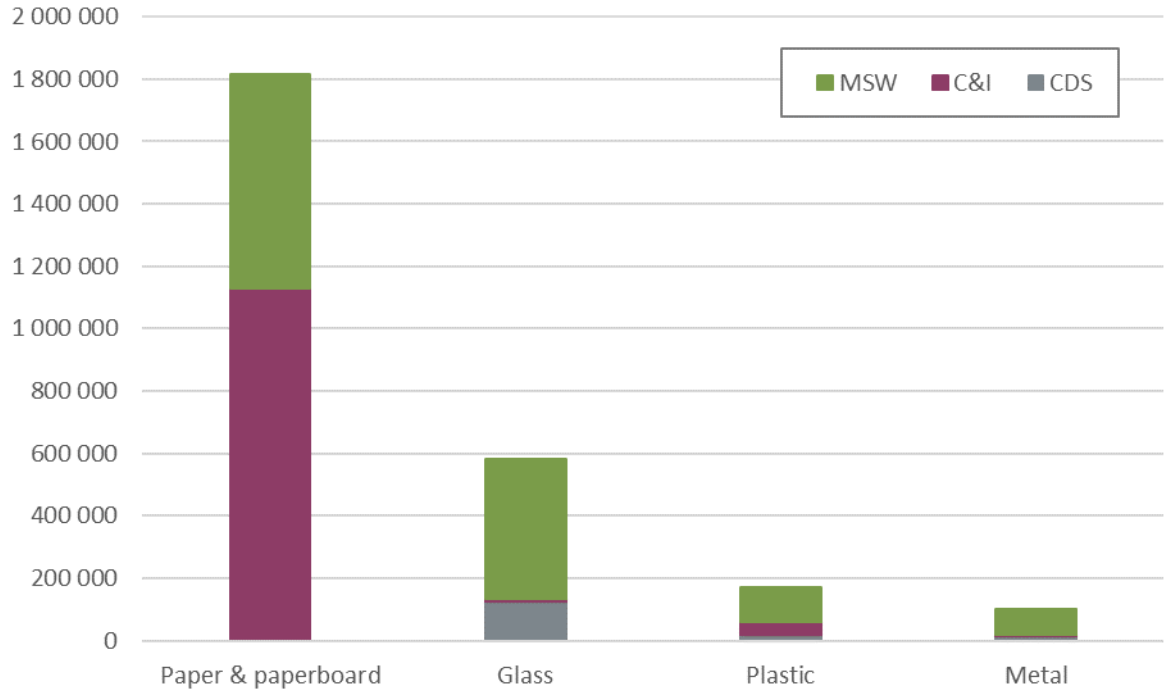


Table 17 – Post-consumer packaging recovery in 2017–18, by material group and collection service

Material type	MSW[a]	C&I[a]	CDS[a]	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Paper & paperboard	687 000	1 130 000	1 000	98 000
Glass	450 000	7 000	126 000	1 663 000
Plastic	113 000	42 000	17 000	42 000
Metal	83 000	4 000	14 000	14 000
Total	**1 332 000**	**1 183 000**	**158 000**	**1 817 000**

a) MSW – municipal solid waste / C&I – commercial and industrial / CDS – container deposit scheme.

Figure 16 – Post-consumer packaging recovery in 2017–18, by material group and collection service (tonnes)



3.2 Material type

Paper and paperboard packaging

Post-consumer paper and paperboard packaging recovery in Australia in 2017–18 is estimated at 1.8 million tonnes (±11%), which is 68.0% of all post-consumer packaging recovery. Estimates for paper and paperboard packaging recovery, by material type and collection service, are provided in Table 18 and Figure 17.

Data is for post-consumer packaging recovered out-the-gate of the secondary processing facility. Overseas processing losses associated with the export of sorted but unprocessed materials have been estimated based on the losses reported by local operators of secondary processing facilities.

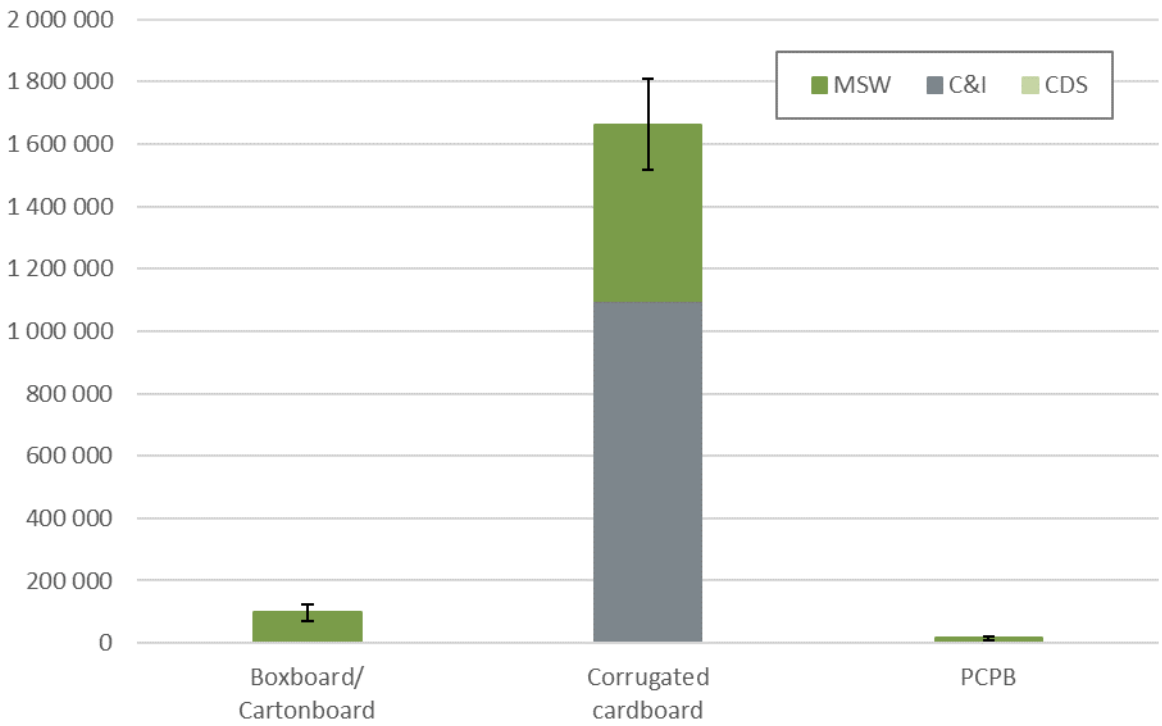
Nearly 1.7 million tonnes (92%) of recovered paper and paperboard packaging is corrugated cardboard. It is estimated that around 1.1 million tonnes (61%) of this corrugated cardboard recovery is from C&I collections, and a little under 0.6 million tonnes (31%) is from municipal collections.

Table 18 – Paper and paperboard packaging recovery in 2017–18, by material type and collection service

Material type	Collection service			Total		Accuracy range
	MSW	C&I	CDS			
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)	(±%)
Boxboard/Cartonboard	98 000	0	0	98 000	5.4%	27%
Corrugated cardboard	563 000	1 100 000	0	1 663 000	91.5%	9%
Other fibre packaging	12 000	30 000	0	42 000	2.3%	38%
PCPB[a]	14 000	0	<1 000	14 000	0.8%	48%
Total	**687 000**	**1 130 000**	**<1 000**	**1 817 000**	**100.0%**	**11%**

a) PCPB – Polymer coated paperboard.

Figure 17 – Paper and paperboard packaging recovery in 2017–18, by material type and collection service (tonnes)



Glass packaging

Post-consumer glass packaging recovery in Australia in 2017–18 is estimated at around 0.58 million tonnes (±23%), which is 21.8% of all post-consumer packaging recovery. Estimates for glass packaging recovery, by material type and collection service, are provided in Table 19 and Figure 18.

Note that a significant proportion of recovered glass is not recycled back into packaging but is diverted into other applications, mainly in road construction. See Section 3.3 for estimates of recovered packaging materials use applications.

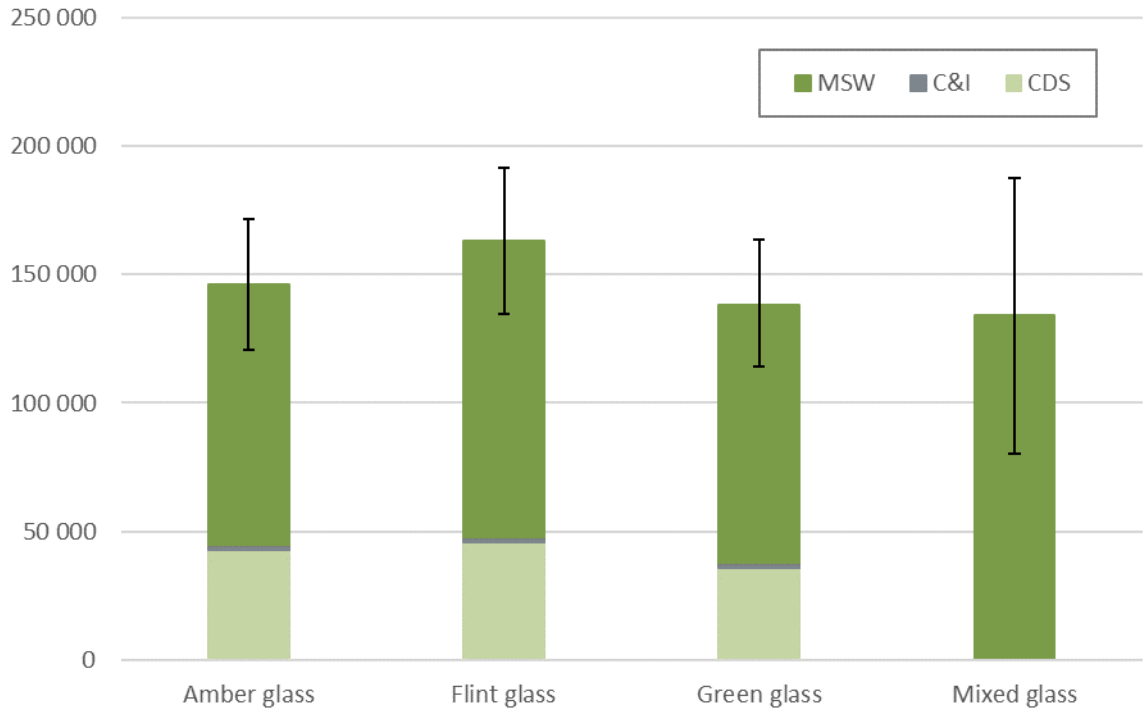
Data is for post-consumer packaging recovered out-the-gate of the secondary processing facility. Overseas processing losses associated with the export of sorted but unprocessed materials have been estimated based on the losses reported by local operators of secondary processing facilities.

Around 450 000 tonnes (77%) of glass packaging is recovered through kerbside collections, with another 126 000 tonnes (22%) recovered through CDS related collections. Only around 1% was reported as recovered through C&I related collections.

Table 19 – Glass packaging recovery in 2017–18, by material type and collection service

Material type	Collection service			Total		Accuracy range
	MSW	C&I	CDS			
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)	(±%)
Amber glass	101 000	2 000	43 000	146 000	25.1%	17%
Flint glass	115 000	2 000	46 000	163 000	28.0%	17%
Green glass	100 000	2 000	36 000	139 000	23.9%	18%
Mixed glass	134 000	0	0	134 000	23.0%	40%
Total	**450 000**	**7 000**	**126 000**	**582 000**	**100.0%**	**23%**

Figure 18 – Glass packaging recovery in 2017–18, by material type and collection service (tonnes)



Plastic packaging

Post-consumer plastic packaging recovery in Australia in 2017–18 is estimated at around 173 000 tonnes (±15%), which is 6.5% of all post-consumer packaging recovery. Estimates for plastic packaging recovery, by material type and collection service, are provided in Table 20 and Figure 19.

Data is for post-consumer packaging recovered out-the-gate of the secondary processing facility. Overseas processing losses associated with the export of sorted but unprocessed materials have been estimated based on the losses reported by local operators of secondary processing facilities.

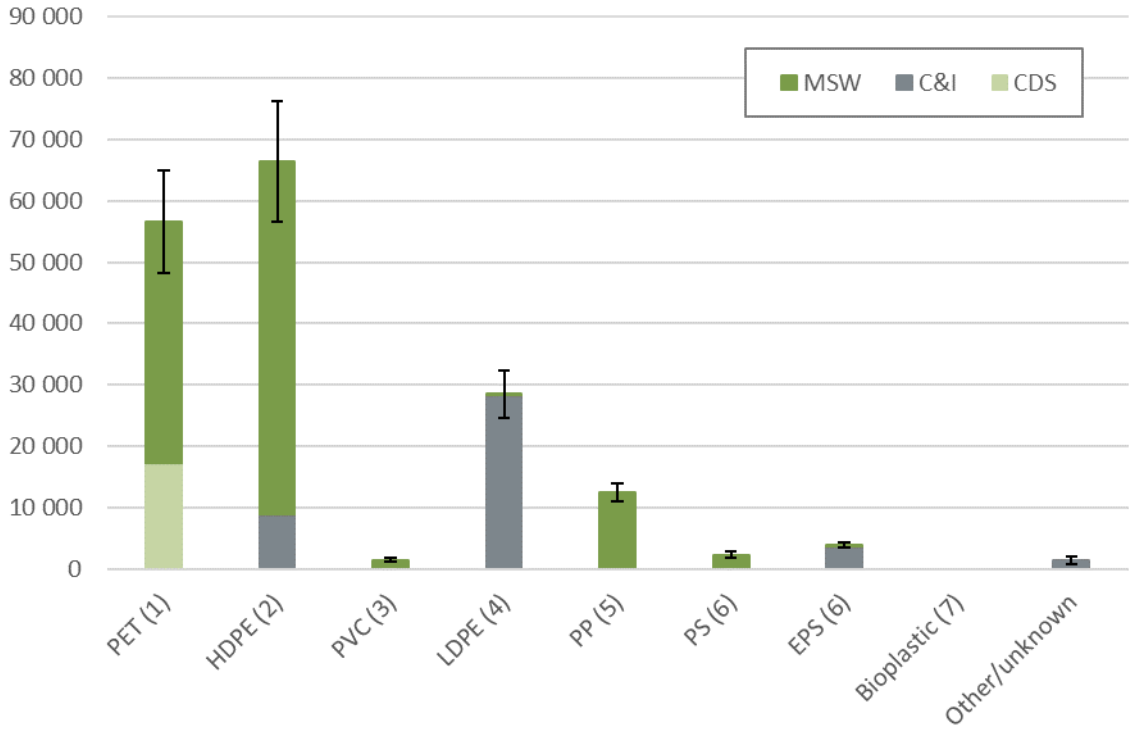
Around 113 000 tonnes (65%) of plastic packaging is recovered through kerbside collections, with another 42 000 tonnes (25%) recovered through C&I collections, and 17 000 tonnes (10%) recovered through CDS related collections.

Table 20 – Plastic packaging recovery in 2017–18, by material type and collection service

Material type	Collection service			Total		Accuracy range
	MSW	C&I	CDS			
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)	(±%)
PET (1)	39 000	0	17 000	57 000	32.7%	15%
HDPE (2)	58 000	9 000	<500	66 000	38.4%	15%
PVC (3)	1 000	0	0	1 000	0.8%	20%
LDPE (4)	0	28 000	0	28 000	16.5%	14%
PP (5)	12 000	0	0	12 000	7.2%	12%
PS (6)	2 000	0	0	2 000	1.3%	19%
EPS (6)	0	4 000	0	4 000	2.2%	12%
Bioplastic (7)	0	0	0	0	0.0%	0%
Other/unknown	0	1 000	0	1 000	0.8%	49%
Total	**113 000**	**42 000**	**17 000**	**173 000**	**100.0%**	**15%**

Collections of packaging film, both from B2B related collections and householder drop-off of flexible plastic packaging at supermarkets, are included under the C&I collection service in the table above.

Figure 19 – Plastic packaging recovery in 2017–18, by material type and collection service (tonnes)



Metal packaging

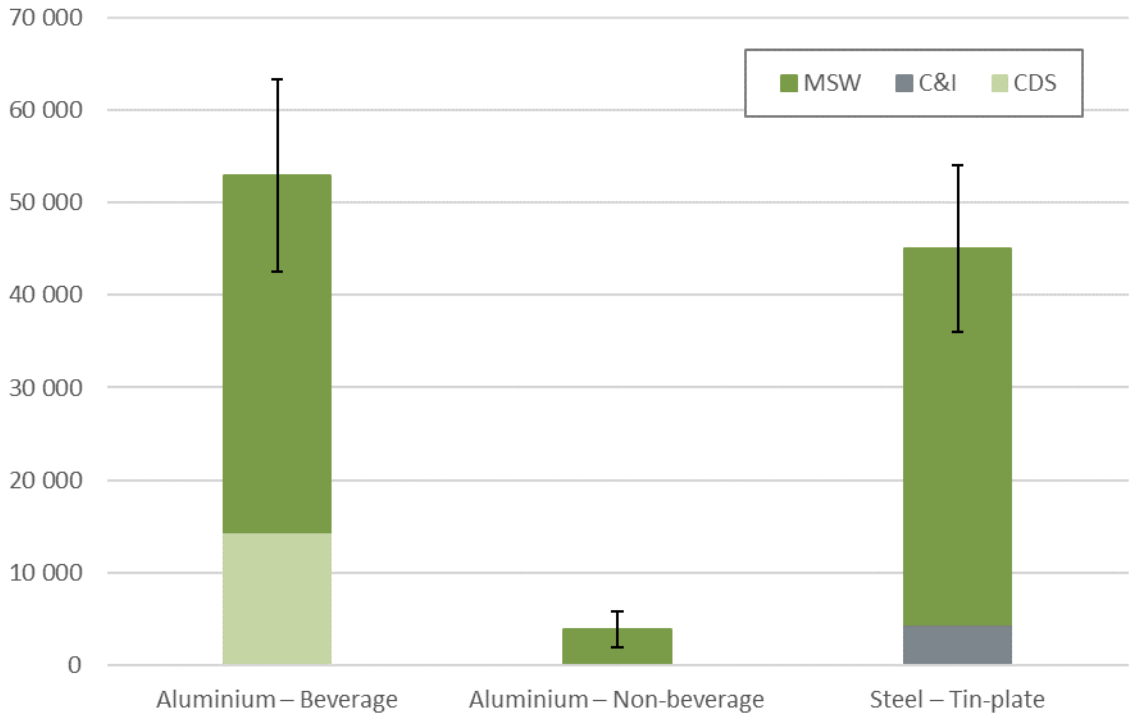
Post-consumer metal packaging recovery in Australia in 2017–18 is estimated at around 102 000 tonnes (±21%), which is 3.8% of all post-consumer packaging recovery. Estimates for metal packaging recovery, by material type and collection service, are provided in Table 21 and Figure 20.

Around 83 000 tonnes (81%) of metal packaging is recovered through kerbside collections, with another 4 000 tonnes (4%) recovered through C&I collections, and 14 000 tonnes (14%) recovered through CDS related collections.

Table 21 – Metal packaging recovery in 2017–18, by material type and collection service

Material type	Collection service			Total		Accuracy range
	MSW	C&I	CDS			
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)	(±%)
Aluminium – Beverage	38 000	0	14 000	52 000	51.1%	20%
Aluminium – Non-beverage	5 000	0	0	5 000	4.7%	50%
Steel – Tin-plate	41 000	4 000	0	45 000	44.2%	20%
Total	**83 000**	**4 000**	**14 000**	**102 000**	**100.0%**	**21%**

Figure 20 – Metal packaging recovery in 2017–18, by material type and collection service (tonnes)



Data is for post-consumer packaging recovered out-the-gate of the secondary processing facility. Overseas processing losses associated with the export of sorted but unprocessed materials have been estimated based on IAI (2009, p. 26) and Antrekowitsch (2014) for aluminium and steel packaging losses respectively.

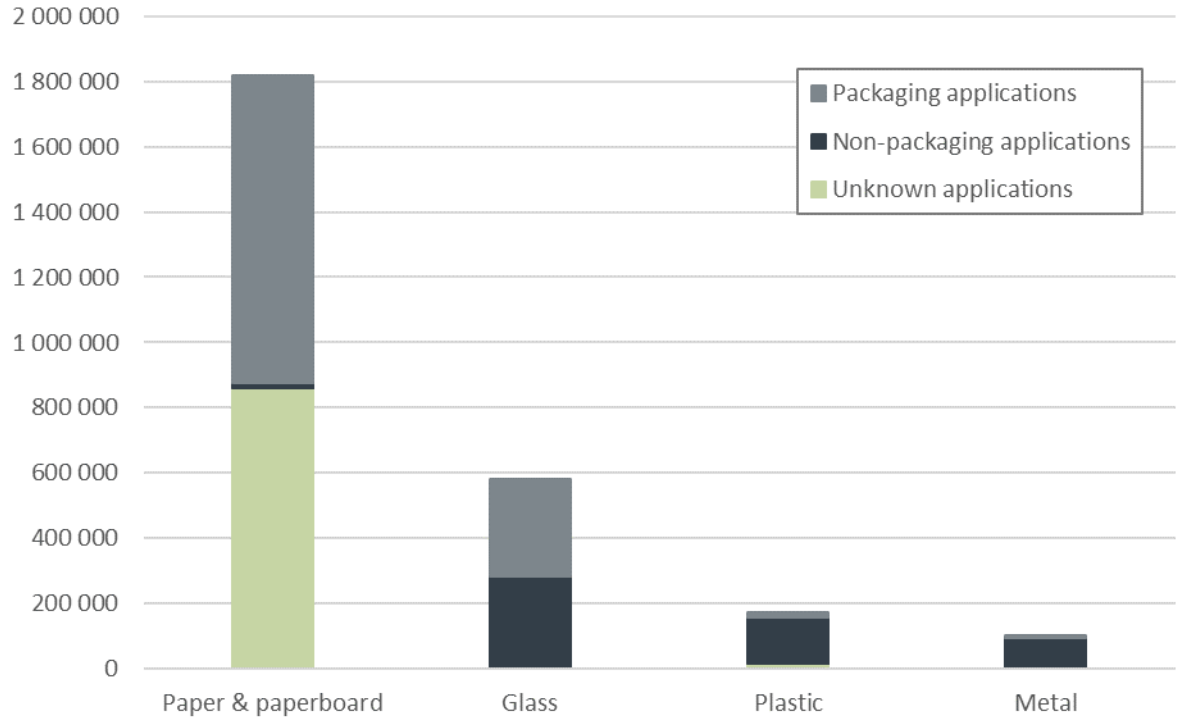
3.3 Material use application

Estimates of recovered post-consumer packaging material use in 2017–18, by packaging or non-packaging application, are provided in Table 22 and Figure 21.

Table 22 – Packaging recovery in 2017–18, by material group and material use application

Material group	Packaging applications	Non-packaging applications	Unknown applications	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Paper & paperboard	940 000	19 000	858 000	1 817 000
Glass	298 000	284 000	0	582 000
Plastic	17 000	140 000	16 000	173 000
Metal	8 000	94 000	0	102 000
Total	**1 263 000**	**536 000**	**874 000**	**2 673 000**

Figure 21 – Packaging recovery in 2017–18, by material group and material use application (tonnes)



The use of recovered paper and paperboard is dominated by use in packaging applications. The application fate of much of the exported scrap paper and paperboard could not be determined with any certainty (the large 'Unknown' quantity), however, much of this would be used as an input into packaging manufacture, and corrugated cartons in particular.

The use of recovered glass packaging is split fairly evenly between packaging and non-packaging applications, with large quantities of packaging glass crushed and used in construction activities locally.

The use of recovered plastic packaging is dominated by use in non-packaging applications, with relatively little returned back into packaging applications. Many of the typical applications are summarised in the following table.

Table 23 – Typical uses of recycled plastics in Australia

Polymer	Major uses of recycled polymer	Minor uses of recycled polymer
PET	Beverage bottles	Timber substitutes, geo-textiles, pallets and fence posts.
HDPE	Films, pallets, wheelie bins, irrigation hose and pipes	Cable covers, extruded sheet, moulded products, shopping and garbage bags, slip sheets, drip sheets for water, wood substitutes and mixed plastics products (e.g. fence posts, bollards, kerbing, marine structures and outdoor furniture), materials handling and roto-moulded water tanks.
PVC	Pipe, floor coverings	Hose applications and fittings, pipes including foam core pipes, profiles and electrical conduit, general extrusion and injection moulding, clothing, fashion bags and shoes.

Polymer	Major uses of recycled polymer	Minor uses of recycled polymer
LDPE / LLDPE	Film (incl. builders' and agricultural film, concrete lining, freight packaging, garbage bags, shopping bags), agricultural piping	Binder additive to asphalt, Trickle products, vineyard cover, pallets, shrink wrap, roto-moulding, slip sheets, irrigation tube, timber substitutes, cable covers, builders' film, garbage bags, carry bags, and other building industry applications.
PP	Crates boxes and plant pots	Electrical cable covers, building panels and concrete reinforcement stools (bar chairs and shims), furniture, irrigation fittings, agricultural and garden pipe, drainage products (such as drain gates) and tanks, builders' film, kerbing, bollards, concrete reinforcing and a wide variety of injection moulded products.
PS	Bar chairs and industrial spools	Office accessories, coat hangers, glasses, building components, industrial packing trays, wire spools and a range of extrusion products.
EPS	Waffle pods for under slab construction of buildings	Synthetic timber applications (including photo frames, decorative architraves, fence posts), XPS (extruded polystyrene) insulation sheeting, and lightweight concrete.

Only around 8% of recovered metal packaging is returned back into packaging applications. This is a consequence of the large international markets for the many sources of aluminium and steel scrap, and the relatively small contribution of scrap metal packaging to these scrap metal markets.

Packaging recovery through energy recovery

There is a small amount of plastic packaging sent to energy recovery included in the reported plastics recovery data. This is estimated to be somewhere in the range of 2 000–4 000 tonnes of plastic packaging in 2017–18.

Packaging recovery through composting

It was estimated by Blue Environment (2019) through a survey of composting facilities nationally that approximately 1 500 tonnes of compostable packaging was composted in 2017–18. This included both fibre-based and compostable plastic based packaging formats.

It is noted that certified compostable plastic packaging consumption in Australia in 2017–18 was well under 1 000 tonnes, so most of the 1 500 tonnes reported above is assumed to be fibre-based packaging.

3.4 Material use destination

Estimates of recovered post-consumer packaging material use in 2017–18, by local or overseas destination, are provided in Table 24 and Figure 22.

The use of recovered paper and paperboard is fairly evenly split between export (54%) and local manufacturers (46%). It is worth noting that scrap paper and paperboard import restrictions by overseas trading partners, starting with China's national sword program in early 2018, will have reduced scrap paper and paperboard exports from Australia across 2017–18 and into 2018–19.

Recovered glass packaging is almost entirely used locally, with only around 3% exported overseas during 2017–18.

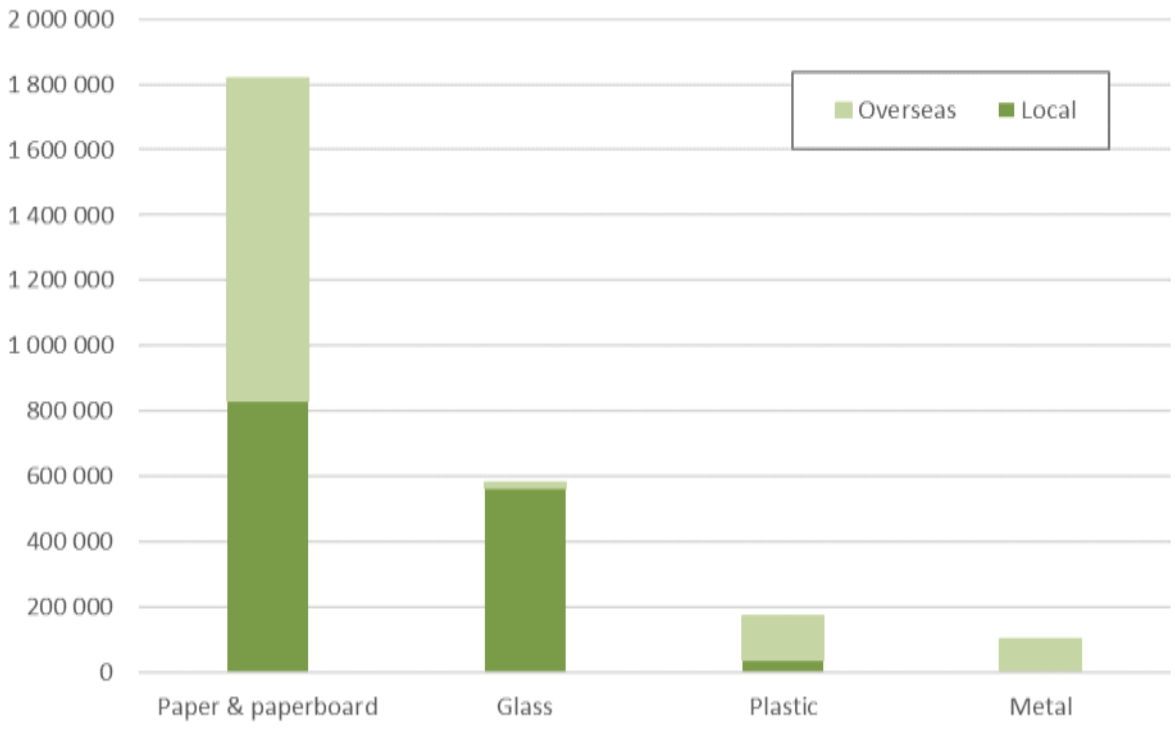
Recovered plastic packaging was largely exported in 2017–18, with 77% sent offshore. Exports of plastic packaging have also been affected by import restrictions in overseas markets.

Recovered metal packaging is almost entirely exported, with only around 1% used locally during 2017–18.

Table 24 – Packaging recovery in 2017–18, by material group and location of material use

Material group	Local	Overseas	Total
	(tonnes)	(tonnes)	(tonnes)
Paper and paperboard	830 000	987 000	1 817 000
Glass	563 000	18 000	582 000
Plastic	39 000	134 000	173 000
Metal	1 000	101 000	102 000
Total	**1 433 000**	**1 240 000**	**2 673 000**

Figure 22 – Packaging recovery in 2017–18, by material group and location of material use (tonnes)



3.5 Rigid/flexible plastic packaging

Estimates of plastic packaging post-consumer recovery by rigid/flexible format are provided in Table 25 and Figure 23. This recovery estimate is measured at the out-going gate of the secondary processing facility for the used packaging.

The definitions of rigid and flexible plastic packaging adopted for this study are:

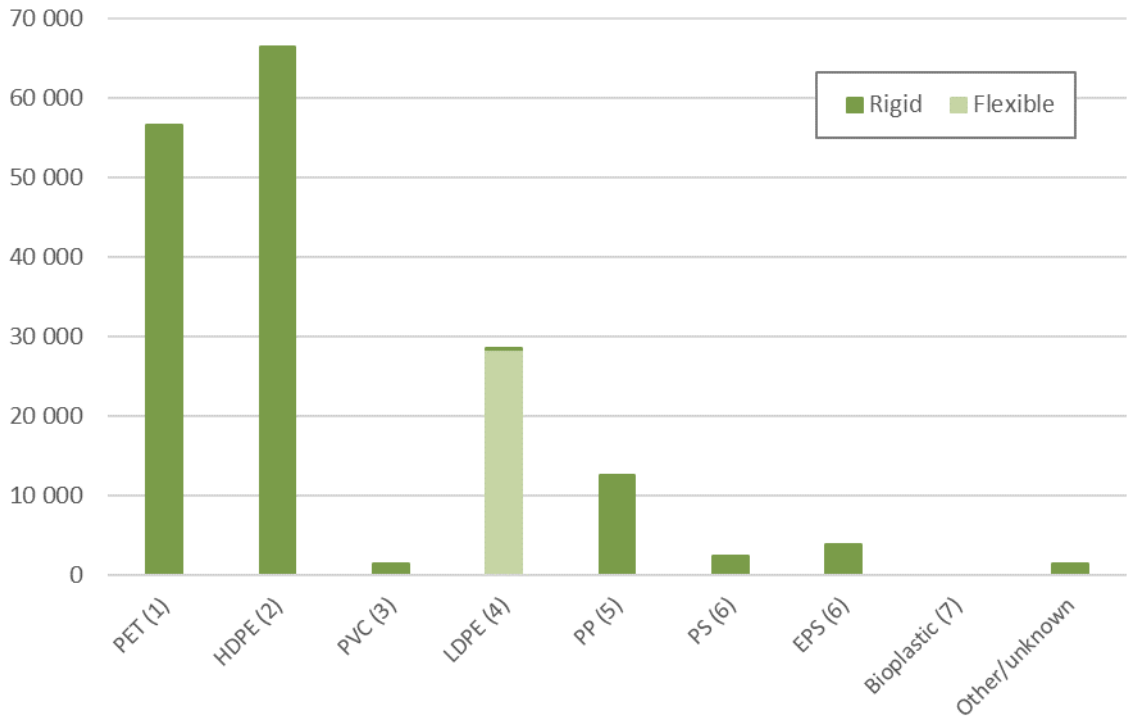
- Rigid plastic packaging are plastic goods such as bottles and tubs, which are (generally) moulded and hold their shape.
- Flexible (soft) plastics are plastic goods that can be scrunched into a ball.

Of the 173 000 tonnes of plastic packaging recovered in 2017–18, around 144 000 tonnes (83%) were rigid plastic packaging, and 29 000 tonnes (17%) flexible packaging. Recovery of flexible plastic packaging is dominated by LDPE film recovery from B2B applications.

Table 25 – Plastic packaging recovery in 2017–18, by material type and rigid/flexible classification

Material type	Rigid	Flexible	Total
	(tonnes)	(tonnes)	(tonnes)
PET (1)	57 000	0	57 000
HDPE (2)	66 000	<500	66 000
PVC (3)	1 000	0	1 000
LDPE (4)	0	28 000	28 000
PP (5)	12 000	<500	12 000
PS (6)	2 000	0	2 000
EPS (6)	4 000	0	4 000
Bioplastic (7)	0	0	0
Other/unknown	1 000	0	1 000
Total	**144 000**	**29 000**	**173 000**

Figure 23 – Plastic packaging recovery in 2017–18, by material type and rigid/flexible classification (tonnes)



3.6 Recovery rates by material group

Australian estimates for post-consumer packaging recovery rates by material group are provided in Table 26 and Figure 24.

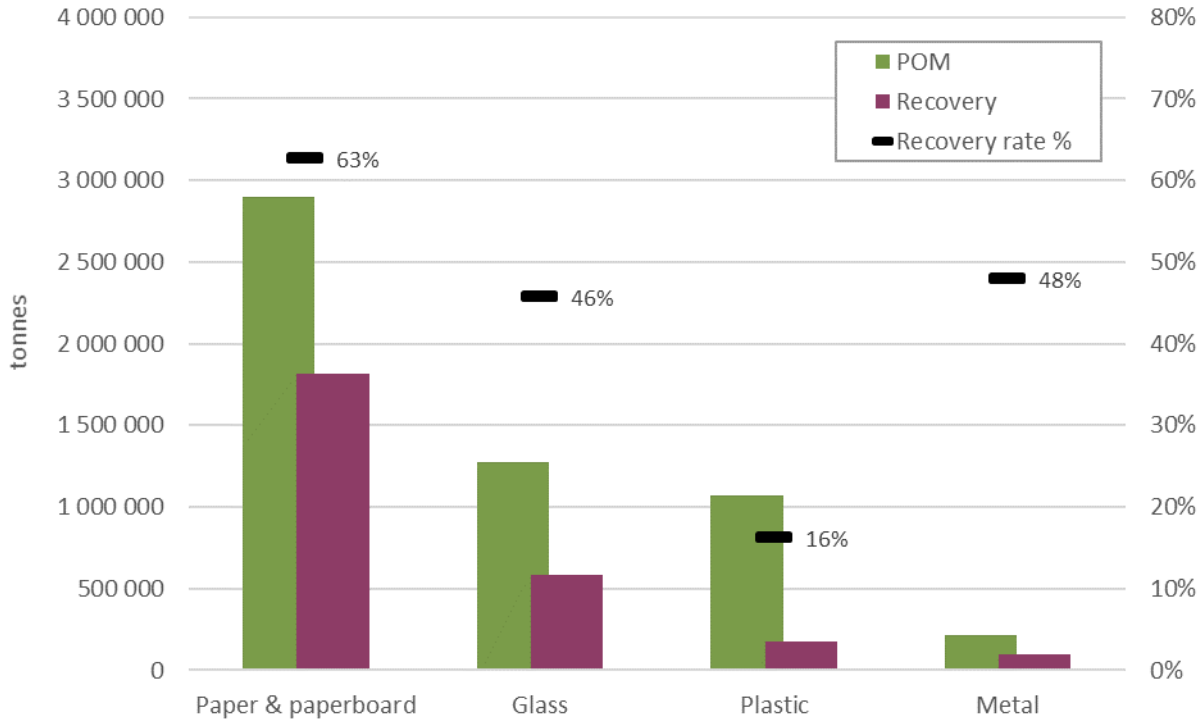
The Australian post-consumer packaging recovery rate in 2017–18 is estimated at 49%. This is based on the packaging POM by material group, and recovery as measured at the out-going gate of the secondary processing facility for the used packaging.

Paper and paperboard has the highest recovery rate at 63%, followed by metal packaging at 48%, glass packaging at 46% and plastic packaging at the low level of only 16%.

Table 26 – Post-consumer packaging recovery rates in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	2 901 000	1 817 000	63%
Glass	1 273 000	582 000	46%
Plastic	1 067 000	173 000	16%
Metal	213 000	102 000	48%
Total	**5 453 000**	**2 673 000**	**49%**

Figure 24 – Post-consumer packaging recovery rates in 2017–18, by material group



3.7 Recovery rates by material type

Paper and paperboard packaging

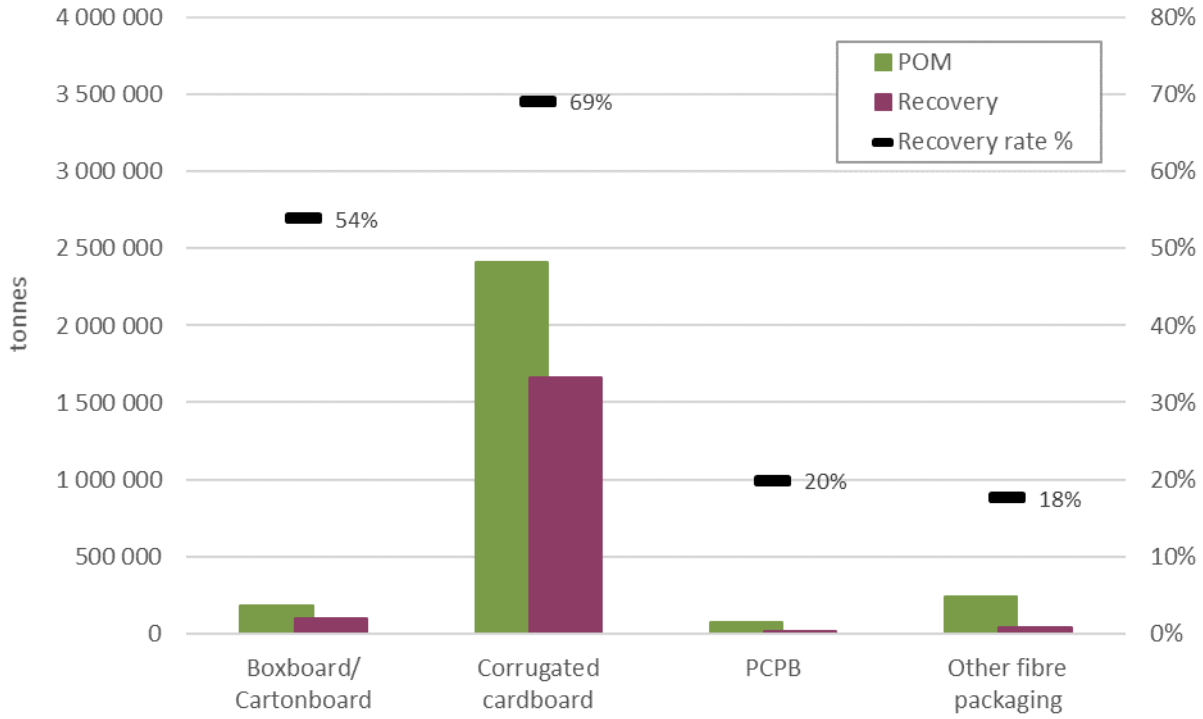
Estimates for post-consumer paper and paperboard packaging recovery rates in 2017–18, by material type, are provided in Table 27 and Figure 25.

The relatively high post-consumer paper and paperboard packaging recovery rate in 2017–18 of 63% is underpinned by the recovery of corrugated cardboard (69% recovery rate), of which two thirds is B2B material collected through C&I collections.

Table 27 – Post-consumer paper and paperboard packaging recovery rates in 2017–18, by material type

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Boxboard/Cartonboard	181 000	98 000	54%
Corrugated cardboard	2 408 000	1 663 000	69%
Polymer coated paperboard	71 000	14 000	20%
Other fibre packaging	240 000	42 000	18%
Total	**2 901 000**	**1 817 000**	**63%**

Figure 25 – Post-consumer paper and paperboard packaging recovery rates in 2017–18, by material type



Glass packaging

Estimates for post-consumer glass packaging recovery rates in 2017–18, by material type, are provided in Table 28 and Figure 26. The packaging group recovery rate is 46%.

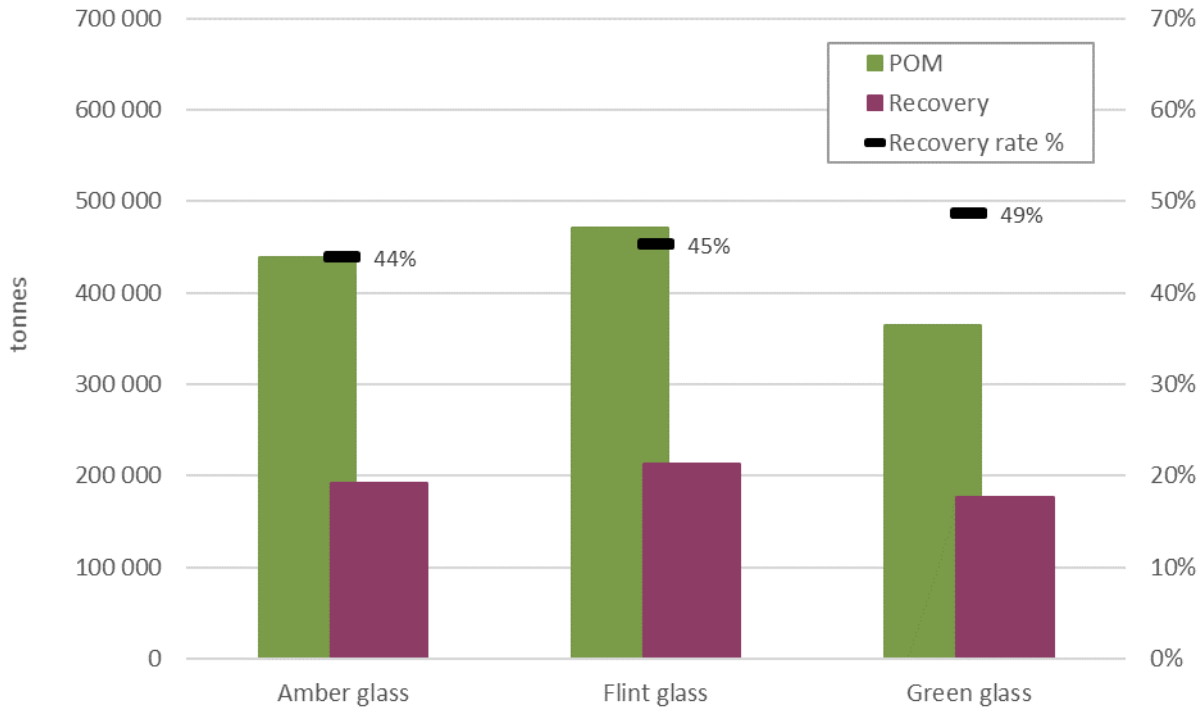
The post-consumer glass packaging recovery rates for all of the colours is fairly similar. The green glass recycling rate is somewhat elevated due to this colour being more sought after for wine bottle production to, in part, service the significant wine export market.

Approximately 30% of recovered glass is recovered into sand and aggregate substitutes for use in the construction sector.

Table 28 – Post-consumer glass packaging recovery rates in 2017–18, by material type

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Amber glass	438 000	192 000	44%
Flint glass	471 000	213 000	45%
Green glass	364 000	177 000	49%
Total	**1 273 000**	**582 000**	**46%**

Figure 26 – Post-consumer glass packaging recovery rates in 2017–18, by material type



Plastic packaging

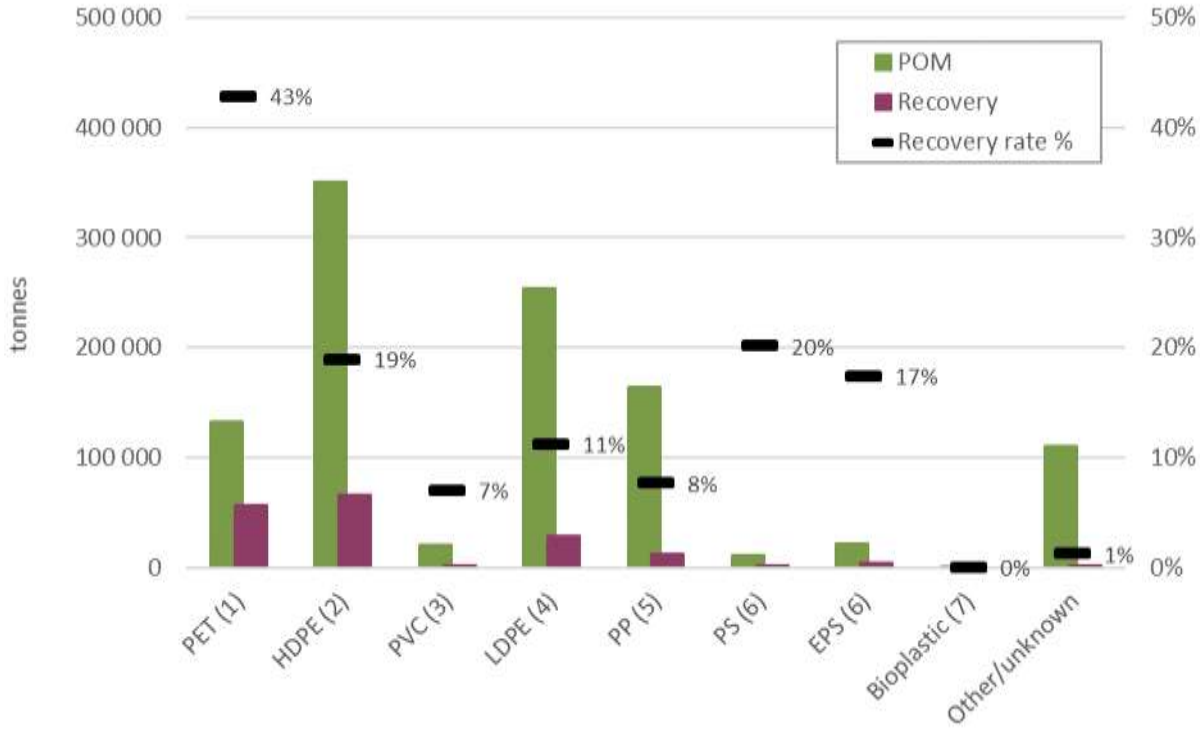
Estimates for post-consumer plastic packaging recovery rates in 2017–18, by material type, are provided in Table 29 and Figure 27. The packaging group recovery rate is estimated at 16%.

The post-consumer PET packaging recovery rate is the highest by a large margin, reflecting the concentration of use in beverage packaging that has high levels of recovery both through kerbside and CDS related collection systems. The HDPE packaging recovery rate is underpinned by the kerbside collection of milk bottles. However, its diverse range of packaging formats, including flexible formats, results in a relatively low recovery rate.

Table 29 – Post-consumer plastic packaging recovery rates in 2017–18, by material type

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
PET (1)	132 000	57 000	43%
HDPE (2)	351 000	66 000	19%
PVC (3)	20 000	1 000	7%
LDPE (4)	254 000	28 000	11%
PP (5)	164 000	12 000	8%
PS (6)	11 000	2 000	20%
EPS (6)	22 000	4 000	17%
Bioplastic (7)	1 000	<100	0%
Other/unknown	111 000	1 000	N/A
Total	**1 067 000**	**173 000**	**16%**

Figure 27 – Post-consumer plastic packaging recovery rates in 2017–18, by material type



Provided in Table 30 below is more detailed data on the recovery of plastic packaging at the rigid/flexible classification level.

Table 30 – Post-consumer plastic packaging recovery rates in 2017–18, by material type and rigid/flexible classification (tonnes)

Material group	Rigid plastics			Flexible plastics		
	POM	Recovery	Recovery rate	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)			
PET (1)	122 000	57 000	46%	10 000	0	0%
HDPE (2)	255 000	66 000	26%	97 000	<1 000	<1%
PVC (3)	11 000	1 000	13%	10 000	0	0%
LDPE (4)	33 000	0	0%	222 000	28 000	13%
PP (5)	115 000	12 000	11%	49 000	<1 000	<1%
PS (6)	10 000	2 000	22%	1 000	0	0%
EPS (6)	20 000	4 000	19%	2 000	0	0%
Bioplastic (7)	1 000	0	0%	0	0	0%
Other/unknown	53 000	1 000	3%	58 000	0	0%
Total	**618 000**	**144 000**	**23%**	**449 000**	**29 000**	**6%**

Almost half of rigid PET packaging was recovered in 2017–18, followed by rigid HDPE packaging at 26%. The overall rigid plastic packaging recovery rate is estimated at 23%.

The flexible plastic packaging recycling rate is estimated at only 6% across both the consumer and B2B sectors. Flexible plastic packaging recovery was dominated by LDPE recovery from the B2B sector (e.g. pallet wrap).

Metal packaging

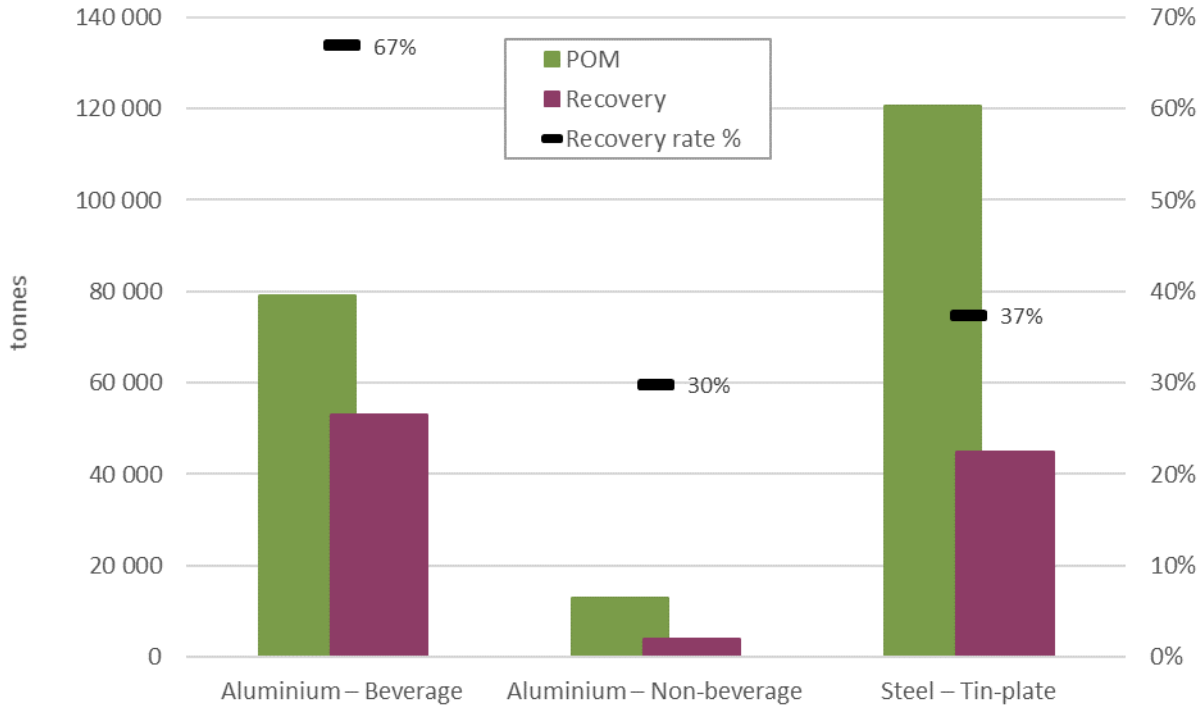
Estimates for post-consumer metal packaging recovery rates in 2017–18, by material type, are provided in Table 31 and Figure 28. The packaging group recovery rate is 48%.

The post-consumer aluminium beverage can recovery rate is the highest by a large margin, reflecting the high material value, and the concentration of use in beverage packaging that has high levels of recovery both through kerbside and CDS related collection systems. The tin-plate steel can recovery rate is relatively low, even though this material is highly recyclable and separable from kerbside recycling.

Table 31 – Post-consumer metal packaging recovery rates in 2017–18, by material type

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Aluminium – Beverage	79 000	53 000	67%
Aluminium – Non-beverage	13 000	4 000	30%
Steel – Tin-plate	121 000	45 000	37%
Total	**213 000**	**102 000**	**48%**

Figure 28 – Post-consumer metal packaging recovery rates in 2017–18, by material type



3.8 Packaging recyclability

In this section of the report the quantities of packaging placed on market (POM) in 2017–18 that are classified as either *recyclable packaging* or *compostable packaging* are quantified. *Reusable packaging* POM has not been quantified. See Appendix A for the definitions of these three terms.

Throughout this section of the report, the term *packaging recyclability* is used as an umbrella term for recyclable, compostable or reusable packaging.

This assessment supports the evaluation of progress against the following *National Packaging Target*:

- **100% of all Australia's packaging will be reusable, recyclable or compostable by 2025 or earlier**

The classification of packaging as either recyclable or compostable has been undertaken in line with the definitions provided in Appendix A. Note that there was very little certified compostable packaging placed onto the market in 2017–18, so effectively the quantifications undertaken here are for *recyclable packaging* only.

The agreed determination of the recyclability, compostability and reusability of all packaging formats is a developing area, and the estimates provided here are indicative only.

Further investigation and consultation is required to resolve an agreed method and packaging classifications to improve the determination of this evaluation measure. For example, the reusability, recyclability or compostability classifications could be systematically aligned with the related Packaging Recyclability Evaluation Portal (PREP) classification algorithms.

Provided in Table 32 below is an outline of packaging recyclability classifications and definitions that have been adopted for the purpose of this report. Note that the data collected for this project did not include specific requests for information on packaging components and/or composition (shapes, inks, colour) which may influence recyclability.

Table 32 – Packaging recyclability classifications and definitions

Classification	Description	Scope
Good recyclability	Technically recyclable and recycling services widely available.	All bottles and jars (excluding PVC), all cans, fibre-based cartons and boxes (excluding PCPBs), tubs, trays and punnets (excluding PCPBs), LDPE film, fibre-based 'other'.
Poor recyclability	Recyclable with lost value and/or more limited recycling services and/or may contaminate other recycling streams.	PCPBs, PVC, all wraps and film seals (except for LDPE film), EPS.
Not recyclable	Not technically recyclable and/or no recycling service available.	Remaining material (except for 'Unknown').
Unknown recyclability	Insufficient information to determine recoverability.	-

Note: All classifications are applied at June 2018.

Estimates of packaging recyclability by recyclability classification and material group are provided in Table 33 and Figure 29.

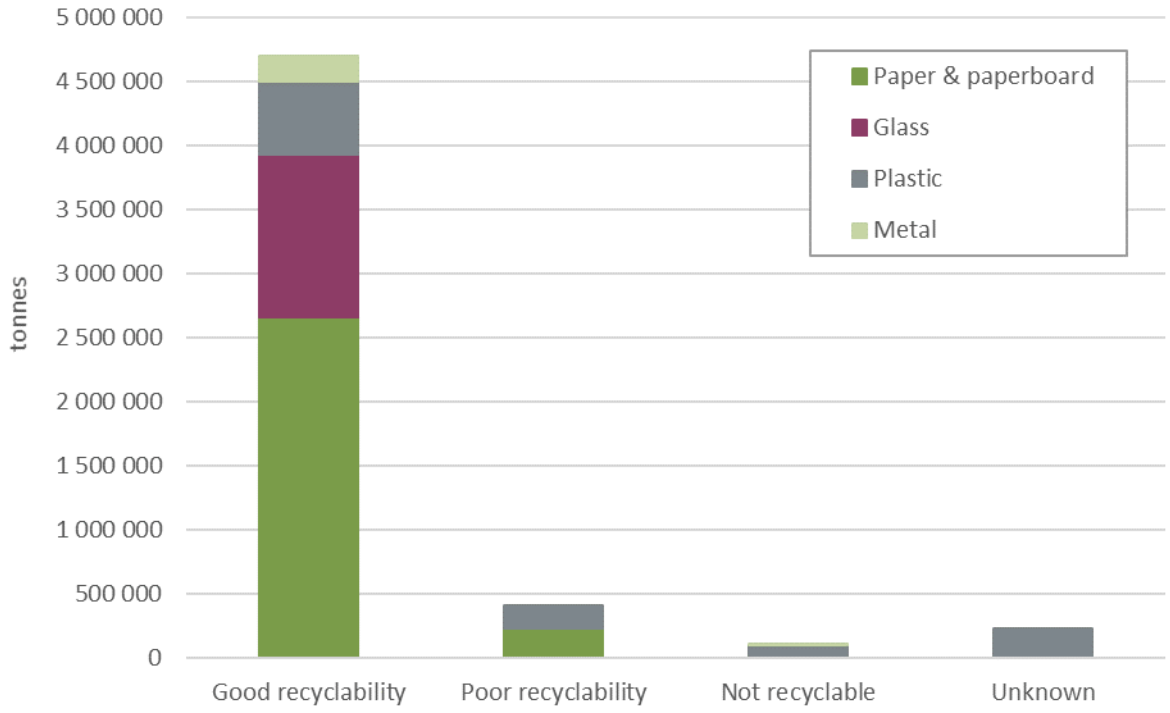
It is estimated that 4.7 million tonnes (86%) of packaging POM in 2017–18 has good recyclability. This is dominated by paper & paperboard (of which 92% has good recyclability) and glass (of which 100% has good recyclability). 96% of metal packaging is classified as having good recyclability, but only 54% of plastic packaging is classified as having good recyclability.

Around 0.5 million tonnes (10%) of packaging is classified as having poor recyclability or not being recyclable. Around 51% of these quantities is plastic packaging, and another 47% is paper & paperboard packaging.

Table 33 – Recyclable or compostable packaging POM in 2017–18, by recyclability classification

Material group	Good recyclability	Poor recyclability	Not recyclable	Unknown	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Paper & paperboard	2 658 000	227 000	15 000	0	2 901 000
Glass	1 273 000	0	0	0	1 273 000
Plastic	572 000	181 000	83 000	231 000	1 067 000
Metal	204 000	0	9 000	0	213 000
Total (tonnes)	**4 707 000**	**408 000**	**107 000**	**231 000**	**5 453 000**
Total (%)	**86%**	**8%**	**2%**	**4%**	**100%**

Figure 29 – Recyclable or compostable packaging POM in 2017–18, by recyclability classification



4 PACKAGING FLOWS TO 2024–25

4.1 Introduction

This section of the report presents the material flow analysis (MFA) undertaken to characterise packaging flows through all stages of the packaging lifecycle.

The MFA complements and builds on the 2017–18 data presented in the previous sections of this report by quantifying the flows of packaging materials at all points through the system from consumption through to material recovery or disposal.

The purpose of the MFA is to:

- Provide information on packaging material flows at all points of the packaging system, not just at the points of consumption and recovery.
- Aid the identification and quantification of the points of material losses at different points of the packaging life cycle.
- Provide additional information on percentage error estimates across the packaging life cycle.
- Provide a whole of system flow model that can be updated in the future, and interrogated as needs arise.
- Provide estimates about the performance of the waste packaging system against resource recovery performance indicators.
- Support the identification of potential opportunities to improve the recovery of packaging by identifying material losses at each stage of the recovery process
- Provide a platform for assessing the impact of system interventions on material flows through the packaging system.

The MFA modelling has been undertaken by the Institute for Sustainable Futures (ISF) at the University of Technology Sydney in a specialised MFA modelling software packaging called STAN (a contraction of subSTance flow ANalysis).

What is MFA?

Material flow analysis (MFA) is a method that involves the quantitative assessment of the state and change of flows and stocks of materials within a system that is defined in space and time (Brunner & Rechberger, 2017). 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 traced.

A *system* is defined as a set of material flows, stocks and processes within the system boundaries defined in space and time (Brunner & Rechberger, 2017). For this study, the system is the Australian packaging consumption and resource recovery system for the financial year 2017–18.

Elements of the system are categorised as *flows*, *processes*, and *stocks.* A *flow* is the rate of material transfer through the system between processes and can be considered an exchange of mass between two or more connected processes (e.g. mixed recyclables collected from the kerbside and delivered to MRFs).

A *process* is defined as an activity that can involve transformation, transport, or storage of materials that enter the process. For example, a MRF is an example of a transformation process where mixed recyclables are sorted into marketable streams.

Transfer coefficients describe how a flow of materials is apportioned (e.g. the amount that is sorted or processed or exported) in a transformation process, either for a single input or for the sum of all inputs entering a process (Brunner & Rechberger, 2017) (e.g. the proportion of the flow of materials received at the MRF that is considered to be a contaminant).

Finally, a *stock* (or *reservoir*) is type of process activity where a portion of the flow remains within the process as an 'accumulation[2]' (e.g. stockpiling or landfill).

System description

The material system under investigation is the Australian packaging consumption and waste management system for the 2017–18 financial year.

The previous MFA conducted by ISF for APCO (ISF, 2019) only considered the waste management system. However, the boundaries for this study have been expanded to include packaging manufacturing. Figure 30 presents the material system modelled for this analysis.

[2] An 'accumulating process' (defined as a stock or reservoir) is one where some portion of the flow of material entering the process accumulates in the system (e.g. a stockpile).

Figure 30 – System diagram of the Australian packaging flows in 2017–18, all material types

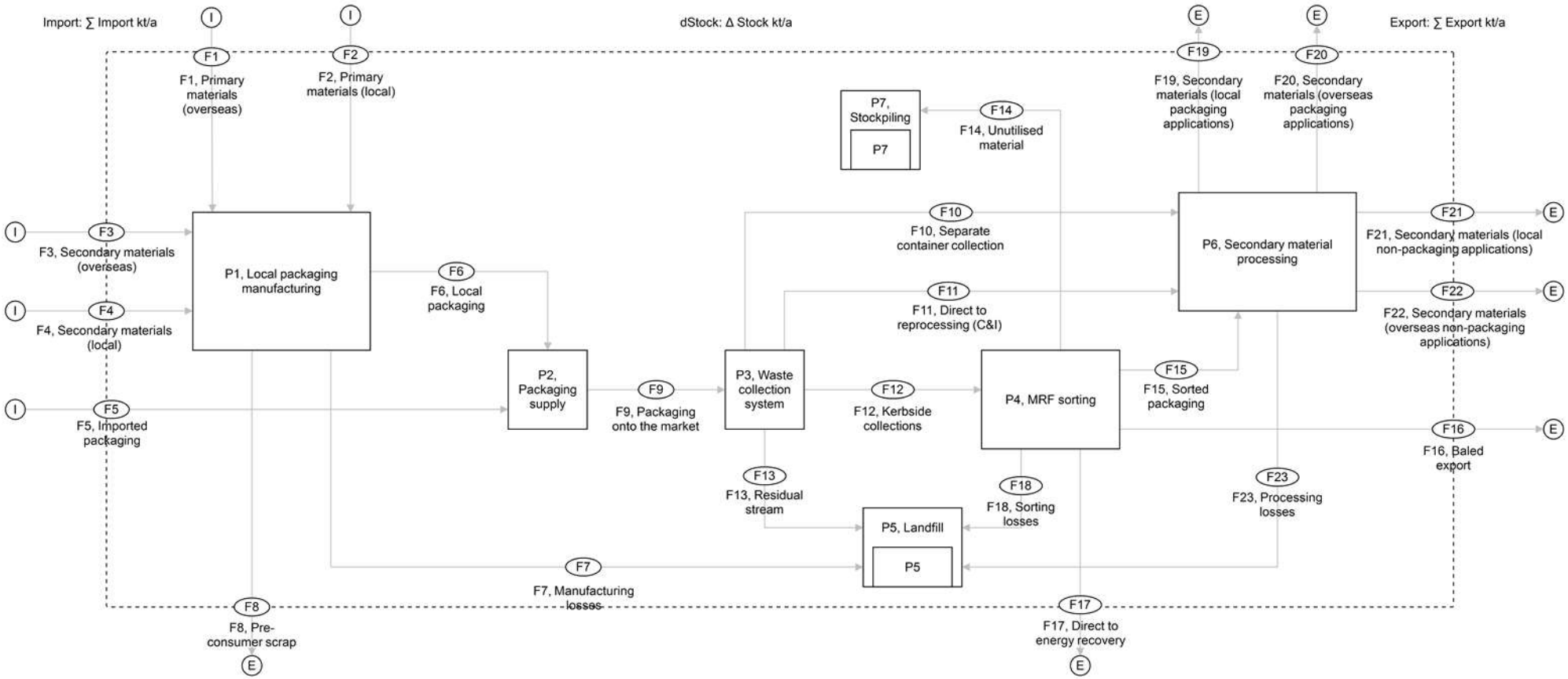


Table 34 summarises the packaging materials included in the MFA scope.

Table 34 – Material groups and sub-groups investigated in the MFA

Material groups	Material types
Paper and paperboard packaging	Boxboard and cartonboard
	Corrugated cardboard
	Polymer-coated paperboard (PCPB)
	Other fibre packaging [a]
Glass packaging	Amber glass
	Flint glass
	Green glass
Plastic packaging	PET
	HDPE
	Other polymers [b]
Metal packaging	Aluminium
	Steel

a) 'Other fibre' packaging includes high wet strength carrier board, kraft paper, moulded fibreboard, and other fibreboard packaging categories.

b) 'Other polymer' packaging includes PVC, LDPE, PP, PS, EPS, Bioplastic, and 'other' plastic packaging categories

The system was described and modelled by drawing on a number of data sources. The main data source is the new dataset provided in previous sections of this report, derived from survey responses from Australian packaging manufacturers and reprocessors, and Australian import and export data. Auxiliary data derived from the previous MFA study (ISF, 2019) was used to fill gaps where data was not available, specifically for flows related to the residual waste stream, MRF sorting, stockpiling and energy recovery. Appendix D.1 contains a table describing the auxiliary data sources used in this analysis.

There are seven main processes in the system, including five non-accumulating processes and two accumulating processes. An 'accumulating process' is one where some portion of the flow of material entering the process accumulates in the system e.g. as a stockpile. The five non-accumulating processes are:

- Local packaging manufacturing (P1), which is all local packaging manufacturers across the materials investigated.
- Packaging supply (P2), referring to the total supply of packaging on the market from local and overseas sources.
- Used packaging collection system (P3), corresponding to all waste collection systems, including kerbside municipal collections, commercial and industrial (C&I) collections, and separate container collection systems (e.g. container deposit returns).
- MRF sorting (P4), referring to all Australian MRFs that receive used packaging.
- Secondary material processing (P6), corresponding to all secondary material processors in Australia that receive sorted and pre-sorted packaging material.

The two accumulating processes are:

- Landfill (P5), corresponding to all landfills across Australia.
- Stockpiling (P7), referring to the stockpiling of waste material.

There are 23 material flows through the system, which are described in detail in Table 35. The 'data source' column provides details on how each flow was derived, from raw data from this study, or from auxiliary data and estimated parameters derived from (ISF, 2019).

Table 35 – Description of flows characterised in this analysis

Flow	Description	Data source
F1, Primary materials (overseas)	Inputs of virgin (primary) materials into local packaging manufacturing from overseas sources	Data collected for this project
F2, Primary materials (local)	Inputs of virgin (primary) materials into local packaging manufacturing from local sources	Data collected for this project
F3, Secondary materials (overseas)	Inputs of secondary materials into local packaging manufacturing from overseas sources	Data collected for this project
F4, Secondary materials (local)	Inputs of secondary materials into local packaging manufacturing from local sources	Data collected for this project
F5, Imported packaging	Packaging imported from overseas (empty or filled)	Data collected for this project
F6, Locally manufactured packaging	Packaging manufactured locally	(F1 + F2 + F3 + F4) – (pre-consumer scrap + manufacturing losses)
F7, Manufacturing losses	Material losses from the manufacturing process destined for landfill	Data collected for this project
F8, Pre-consumer scrap	Material losses from the manufacturing process used as secondary material	Data collected for this project
F9, Packaging placed on market (POM)	Total packaging put on the market from local and overseas sources (including consumer and B2B packaging)	Data collected for this project
F10, Separate container collection	Packaging directed to reprocessing from container deposit systems	Data collected for this project
F11, Direct to reprocessing (C&I)	Packaging directed from the C&I collection stream to reprocessing. Refers primarily B2B flows, e.g. corrugated cardboard and mixed plastics	Data collected for this project
F12, Kerbside collections	Used packaging collected and directed to MRF sorting	F9 - F10 - F12
F13, Residual stream	Packaging waste disposed of to the residual stream and directed to landfill	(CDS collection / CDS sorting rate) + ([F9 - F10] × residual rate)
F14, Unutilised material	Sorted used packaging that is stockpiled	(F11 - F14 - F17) × stockpiling rate
F15, Sorted packaging	Sorted used packaging from the MRF	Data collected for this project

Flow	Description	Data source
F16, Baled export	Sorted used packaging exported overseas from the MRF	(F11 - F14 - F17) × baled export rate
F17, Direct to energy recovery	Packaging directed to any energy recovery processes from MRF sorting	(F11 - F14 - F17) × energy recovery rate
F18, Sorting losses	Material losses from the MRF sorting process	(F14 / sorting rate) - F14
F19, Secondary materials (local packaging applications)	Secondary materials from reprocessors used in local packaging manufacturing	Data collected for this project
F20, Secondary materials (overseas packaging applications)	Secondary materials exported for packaging applications	Data collected for this project
F21, Secondary materials (local non-packaging applications)	Secondary materials from reprocessors used locally for non-packaging applications	Data collected for this project
F22, Secondary materials (overseas non-packaging applications)	Secondary materials exported for non-packaging applications	Data collected for this project
F23, Processing losses	Material losses from secondary materials reprocessing	(F10 + F14) × reprocessing residual rate

Data accuracy

Assessing data accuracy, or 'data uncertainty', is a key step in the MFA methodology that gives an indication of data quality, and provides a measure of how accurately the MFA results can be stated with reasonable confidence. All flows are reported within a 95 % confidence range.

For this analysis, a method developed by (ISF, 2019) has been applied, as adapted from Laner, et al., (2015). The method used combines both a qualitative assessment of underlying data used in estimating the MFA flow values, and direct measurements of uncertainty on reprocessor and manufacturing flows from this study. Uncertainty on each data input flow are estimated, then applied through the system. MFA flow estimates are reported as mean values with percentage errors that indicate upper and lower limits accounting for the applied uncertainty (at 95% confidence). A more detailed discussion on data uncertainty is provided in Appendix D.

Performance metrics

In order to evaluate the performance of the packaging consumption and waste management system, five system performance indicators were used (Table 36). These metrics allow comparison between packaging systems (e.g., comparing the recovery rate of paper versus plastic), and can highlight where in the system there are opportunities for improving performance.

Table 36 – Performance indicators used in this analysis

Performance indicator	Definition	Significance
Collection efficiency	Used packaging that is collected (not directed to landfill), divided by total packaging onto the market *Calculation from MFA flow values:* *F13 / F9*	This indicator describes the performance of the collection system. Low efficiency means a high proportion of packaging isn't separated from material flows at the household or business and is directed to landfill, e.g., owing to limited source separation and/or poor disposal practices
Sorting efficiency	Waste destined for re-processing/downstream recovery, divided by total packaging onto the market *Calculation from MFA flow values:* *(F10 + F11 + F15 + F16 + F17) / F9*	This metric describes the performance of the MRF/sorters. Low sorting efficiency highlights opportunities to reduce contamination of collected materials received and/or improve sorting processes at the MRF/sorters, e.g. by investing in automated sorting, increasing manual sorting, or reducing the rate of throughput at MRFs
Post-consumer recovery rate (excl. stockpiling)	Total waste recovered (excluding stockpiling), divided by total packaging onto the market. Here, only secondary material recovery, energy recovery, and exports of secondary materials are considered for recovery. Materials that are directly exported from MRFs are considered assuming reprocessing losses based on local estimates (av. 7 %) *Calculation from MFA flow values:* *(F16 + F17 + F19 + F20 + F21 + F22) / F9*	The performance of the whole system for recovering used packaging material. Stockpiling is excluded, as this waste is not utilised
Local secondary material utilisation rate	Secondary material produced (excluding stockpiled amounts) to be utilised locally for manufacturing, divided by total packaging onto the market *Calculation from MFA flow values:* *(F19 + F21) / F9*	The performance of the local secondary material utilisation system. Low material utilisation rates indicate that a high proportion of waste is not recovered, exported, or stockpiled

4.2 MFA results

Packaging material flows in 2017–18

The modelled material flows are presented in Figure 31 as a material flow diagram for total packaging flows through the packaging consumption and waste management system. Results for packaging consumption (packaging POM) and the composition of the packaging stream are given in Table 37. Appendix D contains material flow diagrams for each packaging material group.

Table 37 – MFA results for total packaging placed on market (POM) by material type, and composition of the total stream by material type

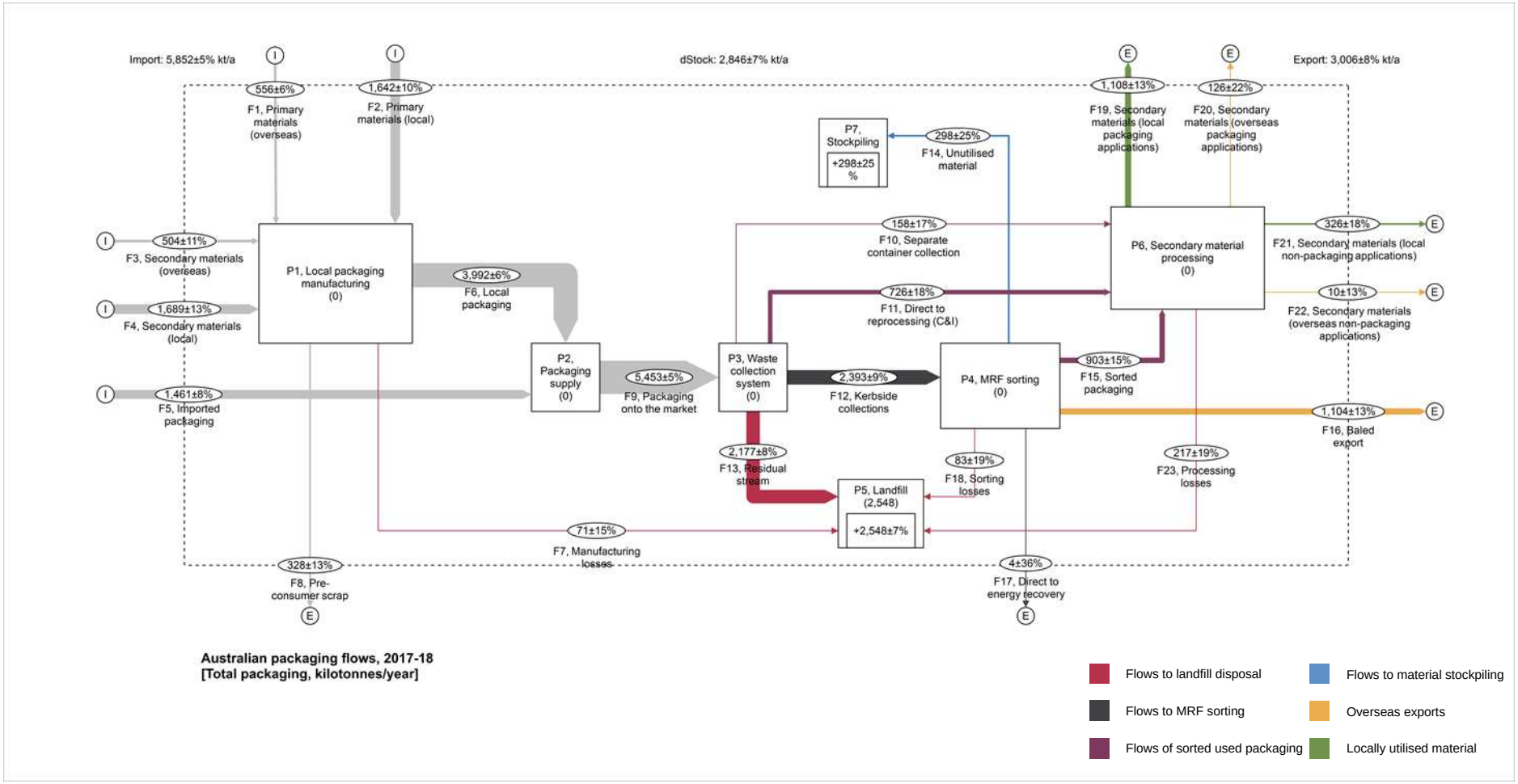
Packaging material	Packaging POM 2017–18 [kt]		Packaging composition	
Total paper packaging	**2 901**	**±10%**	**53%**	**±10%**
Boxboard/cartonboard	*181*	*±17%*	*3%*	*±17%*
Corrugated cardboard	*2 408*	*±10%*	*44%*	*±10%*
PCPB	*71*	*±14%*	*1%*	*±14%*
Other fibre	*240*	*±8%*	*4%*	*±8%*
Total glass packaging	**1 273**	**±11%**	**23%**	**±11%**
Total plastic packaging	**1 067**	**±11%**	**19%**	**±11%**
PET	*132*	*±12%*	*2%*	*±12%*
HDPE	*351*	*±11%*	*6%*	*±11%*
Other polymers	*584*	*±12%*	*11%*	*±12%*
Total metal packaging	**213**	**±11%**	**4%**	**±11%**
Aluminium packaging	*92*	*±12%*	*2%*	*±12%*
Steel packaging	*121*	*±11%*	*2%*	*±11%*
Total packaging	**5 453**	**±11%**	**100%**	**-**

Approximately 5.4 million tonnes of packaging was put on the market in 2017–18, as estimated by the MFA model.

Note that there are discrepancies between POM flows from the MFA model, and from POM figures reported in Section 2 of this report. Appendix D.13 compares POM flows from both sources. These discrepancies are minor, with the POM value given in this report falling within the uncertainty bounds of the MFA estimates. This difference can be attributed to the MFA data reconciliation process performed in the MFA software STAN (see www.stan2web.com), which attempts to reconcile inconsistencies in flow estimates and data inputs when uncertainties are considered.

There are also inconsistencies between the uncertainties reported in Table 37 and elsewhere in the report where direct estimates of uncertainty are given. In Table 37, the uncertainties are calculated by the MFA software that applies uncertainties throughout the entire system and provides a more accurate characterisation of uncertainties when taking into consideration other system flows and flow uncertainties simultaneously.

Figure 31 – Results of the MFA for total packaging flows through the Australian packaging system. Values are given as mean values (in kilotonnes of material) and relative percentage error



Packaging recovery in 2017–18

The modelled material flows for recovered used packaging is presented in Table 38, along with the composition of the recovered packaging by material type.

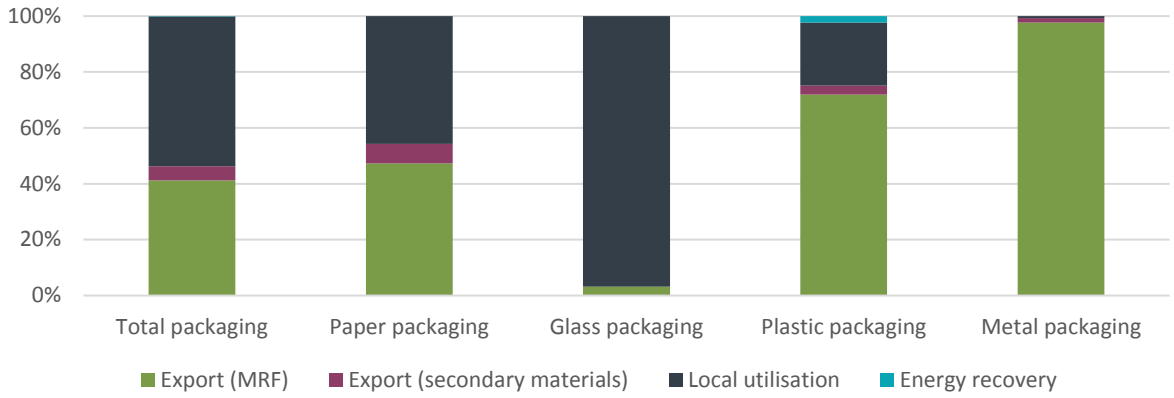
Approximately 2.7 million tonnes of used packaging was recovered in 2017–18 from secondary material processing occurring locally and overseas, and energy recovery.

Table 38 – MFA results for used packaging recovered by material type and composition of the recovered packaging stream

Packaging material	Used packaging recovered [kt]		Packaging composition	
Total paper packaging	**1 817**	**±18%**	**68%**	**±18%**
Boxboard/cartonboard	*98*	*±21%*	*4%*	*±21%*
Corrugated cardboard	*1 663*	*±18%*	*62%*	*±18%*
PCPB	*14*	*±27%*	*1%*	*±27%*
Other fibre	*42*	*±29%*	*2%*	*±29%*
Total glass packaging	**582**	**±21%**	**22%**	**±21%**
Total plastic packaging	**178**	**±26%**	**7%**	**±26%**
PET	*57*	*±23%*	*2%*	*±23%*
HDPE	*66*	*±29%*	*2%*	*±29%*
Other polymers	*54*	*±27%*	*2%*	*±27%*
Total metal packaging	**102**	**±18%**	**4%**	**±18%**
Aluminium packaging	*57*	*±15%*	*2%*	*±15%*
Steel packaging	*45*	*±23%*	*2%*	*±23%*
Total packaging	**2 678**	**±20%**	**100%**	**-**

Figure 32 shows the breakdown of recovered material by recovery activity for each material stream as estimated from the MFA. Approximately 46% of total used packaging recovered was exported in 2017–18. Of this amount, approximately 89% was exported directly from MRFs as baled material to be recovered as secondary materials overseas, with the remainder exported as secondary materials from reprocessors. With the exception of glass packaging, export of recovered material was the dominant recovery activity across all streams.

Figure 32 – Breakdown of used packaging recovery by material stream for 2017–18



Packaging disposal in 2017–18

Table 39 shows the amount of used packaging disposed to landfill for each material stream, and composition. Approximately 2.5 million tonnes of used packaging was disposed to landfill in 2017–18. Of this, approximately 44% was paper-based packaging—primarily corrugated packaging.

Table 39 – MFA results for used packaging disposed to landfill by material type, and composition of the total stream by material type

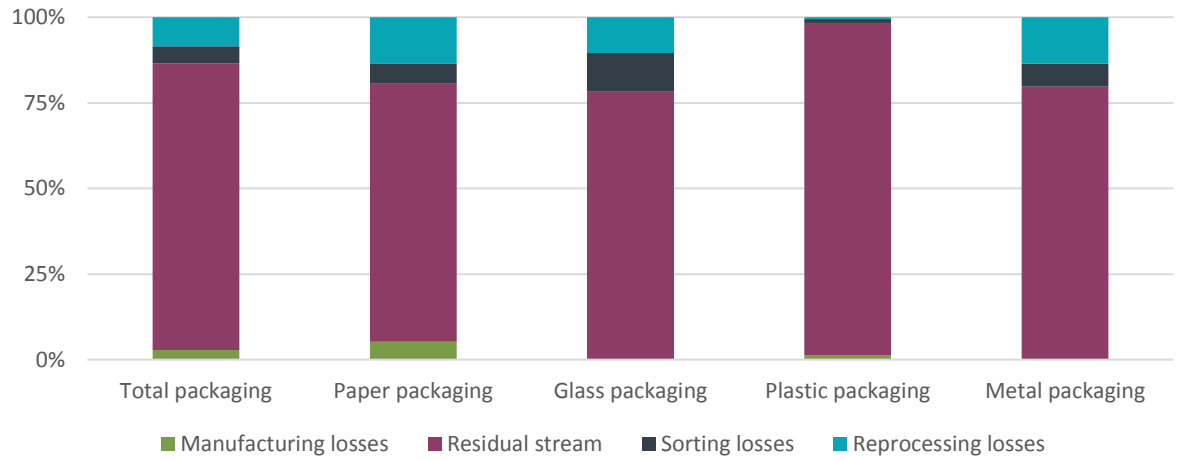
Packaging material	Used packaging disposed 2017–18 [kt]		Packaging composition	
Total paper packaging	**1 083**	**±22%**	**44%**	**±22%**
Boxboard/cartonboard	*84*	*±28%*	3%	*±28%*
Corrugated cardboard	*745*	*±25%*	30%	*±25%*
PCPB	*57*	*±16%*	2%	*±16%*
Other fibre	*198*	*±11%*	8%	*±11%*
Total glass packaging	**393**	**±26%**	**16%**	**±25%**
Total plastic packaging	**889**	**±13%**	**36%**	**±13%**
PET	*75*	*±19%*	3%	*±19%*
HDPE	*285*	*±13%*	11%	*±13%*
Other polymers	*530*	*±12%*	21%	*±12%*
Total metal packaging	**111**	**±20%**	**4%**	**±20%**
Aluminium packaging	*35*	*±23%*	1%	*±23%*
Steel packaging	*75*	*±18%*	3%	*±18%*
Total packaging	**2 477**	**±19%**	**100%**	**-**

Figure 33 gives a breakdown of landfill disposal by source of loss (i.e., where in the system the losses occur). Sources of these losses are:

- **Manufacturing losses**, occurring during the manufacturing of new packaging locally.
- **Losses to the residual stream**, occurring due to incorrect disposal of used packaging into non-recyclable bins.
- **Sorting losses**, occurring during MRF sorting.
- **Reprocessor losses**, occurring during secondary material processing.

Losses to the residual waste are significant across all material streams. This indicates that limiting these losses through, for example, improved source collection practices, may have the most impact on improving used packaging recovery. Losses from reprocessing was the second largest source of landfill disposal of used packaging. Disposal from reprocessing accounted for 14% of all paper packaging disposed, and 10% of all glass packaging.

Figure 33 – Breakdown of used packaging disposed to landfill by material stream for 2017–18



Packaging management performance in 2017–18

Table 40 and Figure 36 show the calculated performance metrics for used packaging across all material types. Table 36 includes descriptions and methodologies for estimating these performance metrics. Excluding stocks of unutilised material (that is, material that is neither exported nor utilised locally through any recovery process), the approximate recovery rate of used packaging for 2017–18 was 49%. Of this amount, approximately half was utilised locally as secondary material.

The best performing system in terms of recovery rate was the paper stream. Recovery rates are high across the major paper sub-types (i.e., boxboard/cartonboard and corrugated cardboard), however exports from MRFs for polymer-coated paperboard and exports from reprocessors for the other paper sub-types dominate as recovery pathways, leading to poor local utilisation of secondary materials. Both the metal stream and the plastic stream also have poor local utilisation of materials, owing to exports being the primary recovery pathways. In the case of glass, local utilisation of materials is high

relative to recovery, likely due to there being well-established end-markets for recovered glass material locally.

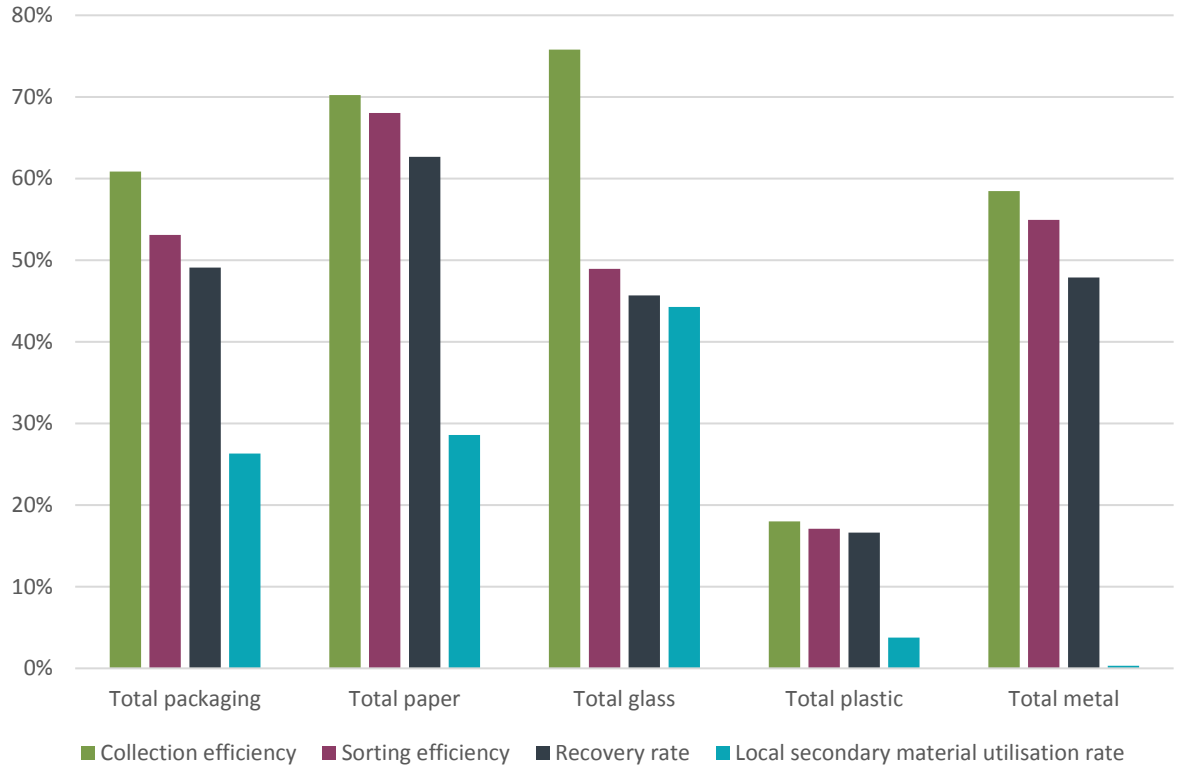
From

Figure 34, the drop in the local material utilisation rate relative to the recovery rate is consistent with the fact that the current used packaging management system in Australia is heavily geared towards export. A significant efficiency loss is shown for the glass system between collection and sorting. This suggests that the inefficient sorting of used glass packaging, likely owing to breakages during collection, significantly limits the overall glass recovery and local utilisation.

Table 40 – Used packaging performance indicators for 2017–18

Packaging material	Collection efficiency		Sorting efficiency		Recovery rate		Local secondary material utilisation rate	
Total paper packaging	**70%**	**±6%**	**68%**	**±21%**	**63%**	**±18%**	**29%**	**±16%**
Boxboard/cartonboard	*64%*	*±12%*	*60%*	*±22%*	*54%*	*±21%*	*0%*	*±0%*
Corrugated cardboard	*77%*	*±5%*	*75%*	*±21%*	*69%*	*±18%*	*34%*	*±16%*
PCPB	*23%*	*±8%*	*22%*	*±28%*	*20%*	*±27%*	*0%*	*±0%*
Other fibre	*20%*	*±1%*	*19%*	*±29%*	*18%*	*±29%*	*4%*	*±34%*
Total glass packaging	**76%**	**±6%**	**49%**	**±19%**	**46%**	**±21%**	**44%**	**±21%**
Total plastic packaging	**18%**	**±6%**	**17%**	**±27%**	**17%**	**±26%**	**4%**	**±26%**
PET	*47%*	*±5%*	*45%*	*±23%*	*43%*	*±23%*	*12%*	*±22%*
HDPE	*20%*	*±4%*	*19%*	*±29%*	*19%*	*±29%*	*4%*	*±34%*
Other polymers	*10%*	*±10%*	*9%*	*±27%*	*9%*	*±27%*	*2%*	*±21%*
Total metal packaging	**58%**	**±6%**	**55%**	**±19%**	**48%**	**±18%**	**0%**	**±0%**
Aluminium packaging	*82%*	*±9%*	*77%*	*±16%*	*62%*	*±15%*	*1%*	*±26%*
Steel packaging	*41%*	*±2%*	*38%*	*±23%*	*37%*	*±23%*	*0%*	*±0%*
Total packaging	**61%**	**±6%**	**53%**	**±21%**	**49%**	**±19%**	**26%**	**±18%**

Figure 34 – Used packaging performance indicators for 2017–18 (see Table 36 for description of performance metrics)



4.3 Estimated packaging flows in 2024–25

In order to project packaging flows to 2024–25, data on the year-on-year POM growth and the assumed corresponding capacity changes to the Australian packaging system were used. The raw data was derived from manufacturers' survey responses on assumed market growth and capacity changes by material type and format. A constant growth rate model was estimated for the 7-year projection, with year-on-year growth rates used and applied to 2017-18 POM estimates. These growth rates by material are shown in Table 41.

Table 41 – Year-on-year growth rates by material used to estimate packaging flows for 2024-25

Material group	Year-on-year growth rate
Paper – boxboard/cartonboard	2.9%
Paper – corrugated cardboard	2.9%
Paper – PCPB	2.8%
Paper – Other fibres	3.0%
Glass	1.7%
Plastic – PET	5.2%
Plastic – HDPE	2.0%
Plastic – other polymers	2.2%
Metal – aluminium	1.7%
Metal – steel	1.3%

For the 2024–25 projection, only the amount of packaging placed on market was modelled, assuming all other system flows and processes are consistent with the 2017–18 system specification, including composition of the used packaging stream, and proportion of imported packaging.

Results from the MFA are shown in Table 42. Total packaging placed on market for 2024–25 is estimated to be approximately 6.5 million tonnes—a relative increase of approximately 19% on total POM in 2017–18. Similar to the 2017–18 estimates, paper packaging is the dominant form of packaging material on the market, increasing its share of total packaging by 2-percentage points in 2024–25.

Table 42 – Forward projections for the amount and composition of packaging waste put on the market in 2024–25

Packaging material	Packaging POM 2024–25 [kt]		Packaging composition		Packaging recovered 2024-25 [kt]		Packaging composition	
Total paper packaging	**3 545**	**±10%**	**55%**	**±10%**	**2 220**	**±18%**	**69%**	**±19%**
Boxboard/cartonboard	*222*	*±17%*	*3%*	*±17%*	119	*±21%*	*4%*	*±17%*
Corrugated cardboard	*2 941*	*±10%*	*45%*	*±10%*	2 032	*±18%*	*63%*	*±18%*
PCPB	*87*	*±14%*	*1%*	*±14%*	17	*±27%*	*1%*	*±25%*
Other fibre	*295*	*±8%*	*5%*	*±8%*	52	*±29%*	*2%*	*±29%*
Total glass packaging	**1 432**	**±11%**	**22%**	**±11%**	**655**	**±21%**	**20%**	**±19%**
Total plastic packaging	**1 272**	**±11%**	**20%**	**±11%**	**221**	**±26%**	**7%**	**±25%**
PET	*189*	*±12%*	*3%*	*±12%*	82	*±23%*	*3%*	*±20%*
HDPE	*403*	*±11%*	*6%*	*±11%*	76	*±29%*	*2%*	*±28%*
Other polymers	*680*	*±12%*	*10%*	*±12%*	63	*±27%*	*2%*	*±29%*
Total metal packaging	**236**	**±11%**	**4%**	**±11%**	**113**	**±18%**	**4%**	**±17%**
Aluminium packaging	*104*	*±12%*	*2%*	*±12%*	64	*±15%*	*2%*	*±14%*
Steel packaging	*132*	*±11%*	*2%*	*±11%*	49	*±23%*	*2%*	*±21%*
Total packaging	**6 484**	**±11%**	**100%**	**-**	**3 208**	**±19%**	**100%**	**-**

Projections have also been made for used packaging recovered for 2024–25, solely based on projected POM in 2024–25, and does not consider any improvements to process efficiency, or substantial changes to the packaging management process chain. As such, assumed recovery rates are consistent with those used in the 2017–18 system. Total packaging recovered 'out-the-gate' (i.e., from secondary material processing and MRF exports) for 2024–25 is estimated to be approximately 3.2 million tonnes. This value represents future recovery amounts, assuming no changes to the packaging management system, and can be used as a baseline for the capacity requirements to maintain current recovery rates given increasing volumes of future waste entering the market.

4.4 MFA findings

The MFA shows that the major losses to landfill are owing to the disposal of used packaging in residual waste bins. Reprocessing losses are the next biggest source of losses, and sorting losses are significant for glass.

The MFA results also highlight the significant reliance on export markets, with almost half of the total material recovered exported, and this is mostly as baled materials directly from MRFs. Metals are almost entirely reliant on export markets, more than half of the recovered paper, and about three quarters of recovered plastics.

Improving consumer waste practices for all packaging materials, but especially for plastic, is critical given the substantial losses to residual waste bins. Increasing collection services for soft plastics will also reduce these losses, assuming good end-markets for the material are developed in parallel.

The significant sorting losses for glass suggest there may be merit in improved collections to reduce breakage losses and increase sorting rates.

The significant dependence on export markets for metals, paper and glass recovery reinforces the need to develop new large-volume local end-markets for these materials.

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APPENDIX A – GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Definition
Beneficiation (of glass)	Processing of used glass packaging. The beneficiation process includes sorting (including colour sorting), cleaning, crushing and sizing. Beneficiated glass is considered “furnace-ready” for sale to glass product manufacturers.
Biodegradable	A generic term that indicates a polymer is biologically available for microbial decomposition, with no detail on breakdown products, time or extent of degradation or end environments.
Bioplastics	Plastics that are biobased, biodegradable or both. Bioplastics fall into three broad groupings, which are: biobased (but not biodegradable); biodegradable (but not biobased); or biobased and biodegradable. Conventional polymers (e.g. PET and HDPE) can also be fully or partially ‘biobased’.
Business-to-business (B2B) packaging	Packaging used for the containment, protection or handling of product. Typically includes the secondary and tertiary packaging that is used to move products between businesses prior to sale to the end-consumer, but excludes primary packaging. Also see 'Packaging' and 'Business-to-business (B2B) packaging'.
Certified compostable	Means that claims of compliance with Australian Standard 4736-2006, compostable and biodegradable plastics – “Biodegradable plastics suitable for composting and other microbial treatment” and Australian Standard AS 5810-2010 Home Composting – “Biodegradable plastics suitable for home composting” have been verified.
Circular economy	The circular economy concept is a systems approach to material/energy flows that extends significantly on the ‘waste hierarchy’, with the objective being to decouple economic growth/development from the use of non-renewable resources (including energy). It is a concept that extends to cover the entire life cycle of products and services, including design. It assumes that the current approach of incremental and fractured improvements in materials and energy efficiency are not sufficient to achieve the potential (much larger) economic and environmental gains that are available.
Closed-loop recycling	Material from a product system is recycled in the same product system, and is of the same quality and functionality as the original material. In terms of end-of-life fates, closed-loop recycling will typically provide greatest environmental benefits, with the key attribute being the displacement (competition with) virgin resource extraction. Also see 'Open-loop recycling' and 'Downcycling'.
Collection	Packaging materials collected for recycling.
Collection efficiency	Materials collected for recycling divided by total packaging waste entering the collection system.
Commercial and industrial (C&I) waste	Solid inert waste generated from trade, commercial and industrial activities including the government sector. It includes waste from offices, manufacturing, factories, schools, universities, state and government operations and small to medium enterprises e.g. food waste.
Commingled recyclables	Materials combined generally for the purposes of collection, mainly through municipal collection services. Includes plastic bottles, other plastics, paper, glass and metal containers. Commingled recyclable materials require sorting after collection before they can be reprocessed. Can also be called commingled materials.
Compostable packaging	A packaging or packaging component (1) is compostable if it is certified to AS4736 or a similar standard for commercial composting, and if its successful post-consumer (2) collection, (sorting), and composting is proven to work in practice and at scale (3). Also see the related ‘Recyclable packaging’ and ‘Reusable packaging’ definitions. Supporting notes:

Term	Definition
	1. ISO 18601:2013: A packaging component is a part of packaging that can be separated by hand or by using simple physical means (e.g. a cap, a lid and (non in-mould) labels). 2. ISO 14021 clarifies post-consumer material as material generated by households or by commercial, industrial and institutional facilities in their role as end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. 3. 'At scale' implies that there are significant and relevant geographical areas, as measured by population size, where the packaging is actually composted in practice.
Composted (packaging)	Packaging that underwent degradation by biological processes during composting to yield CO2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and leaves no visible, distinguishable or toxic residue, in accordance with accepted industry standards (1). Supporting notes: 1. Accepted industry standards include standards referred in the above definitions 'Compostable packaging – industrial' and 'Compostable packaging – home'. Reference to accepted industry standards is to ensure packaging can fully degrade within specified periods of time in the conditions of standard composting system and does not alter the quality of compost.
Construction and demolition (C&D) waste	Solid inert waste generated from residential and commercial construction and demolition activities e.g. bricks and concrete.
Consumer packaging	Packaging used for the containment, protection, marketing or handling of product. Includes the primary packaging that is sold to end-consumer. Also see 'Packaging' and 'Business-to-business (B2B) packaging'.
Consumption	Total use of product by Australian industry and consumers. Includes locally made and used product, imported product and locally utilised recyclate. Does not include locally made product that is exported.
Consumption of packaging	Packaging put onto the market in Australia from local and imported sources. Because most packaging is single-use, it is assumed that packaging consumed equates to packaging waste generated. Does not include locally made product that is exported for sale.
Container deposit scheme (CDS) collection	Separate collection system for paper, plastic and metal containers.
Contaminants – Out throws	A sorted scrap (bale) related term. Recyclable materials that are unsuitable for inclusion in the sorted grade (product) in which they are present, but can be sorted, separated and/ or removed easily during the recycling process. Out throws generally have significantly higher allowable thresholds, compared to prohibited materials, in bale specifications for sorted recycled material commodities. Also see 'Contaminants – Prohibited materials' entry.
Contaminants – Prohibited materials	A sorted scrap (bale) related term. Unrecyclable materials that are unsuitable for inclusion in the sorted grade (product) in which they are present, and cannot be sorted, separated and/or removed during the recycling process. Prohibited materials cause adverse impacts on end-products and may damage the recycling facilities. Prohibited materials generally have significantly lower allowable thresholds, compared to out throws, in bale specifications for sorted recycled material commodities. Also see 'Contaminants – Out throws' entry.
Converter	Company which converts material inputs into a finished packaging product (whether filled or unfilled).
Cullet	Sorted glass feedstock resulting from the beneficiation process of mixed container glass. Generally consists of sorted streams of amber, flint and green glass of particle size greater that 5–10 mm depending on the capacity of the beneficiation plant.

Term	Definition
Delamination	The process of splitting a composite material into its component parts e.g. laminated glass.
Disposal	Discarding solid waste to landfill or incineration (without energy recovery).
Diversion rate	Recovery (at a defined point) as a percentage of end-of-life disposal. Also see 'Recovery rate' and 'Recycling rate'.
Domestic	Material from domestic (household) sources.
Downcycling	Recycled material is of lower quality and functionality than the original material(s). Materials are recycled into different applications with less stringent performance specifications, and where the recycled materials are typically substituting for (competing with) materials other than the original high quality virgin materials. Examples of this include the recycling of mixed polymer rigid plastics, e.g. a mixture of HDPE, low-density polyethylene (LDPE) and polypropylene (PP) into timber substitute products (e.g. outdoor furniture, pallets and fencing), where the recovered plastics are competing primarily with timber as the alternative material. Down-cycled materials are potentially more difficult to recycle at end-of-life (although they often have long functional lifespans), and are more likely to be disposed to landfill at end-of-life. Also see 'Closed-loop recycling' and 'Open-loop recycling'.
Drop off centre/site	A facility where households can drop off selected materials and household items for recycling and reuse. Also called drop off facilities.
End user (of recycled content raw materials)	A user of raw materials that have a recycled content. Examples of end users include plastic product manufacturers that use recycled polymer in their products, or agricultural producers that purchased composted organics as a soil conditioner/fertiliser.
Energy from waste (EfW)	The terms ‘energy recovery from waste’, ‘waste to energy’ or ‘energy from waste’ can be used interchangeably to describe a number of treatment processes and technologies used to generate a usable form of energy from waste materials. Examples of usable forms of energy include electricity, heat and transport fuels.
Energy recovery	A waste fate in which a substantial portion of energy value in a waste is recovered.
Energy recovery facility	A facility that captures, on average, more than 20% of the embodied energy in the waste it receives for beneficial use.
Export for reprocessing	Material sent for reprocessing overseas.
Feedstock	Raw material used to manufacture products. Material varies depending on what is being produced.
Feedstock (chemical) recycling	The use of chemical processes such as pyrolysis to convert scrap plastics into a hydrocarbon gas or liquid (often a polymer to monomer conversion) that is usable as a fuel or as an input for manufacturing plastics resins.
Fines (glass)	Unsorted sub 5–10 mm glass material left over from the glass beneficiation process. It can contain contamination including plastics and small pieces of metals. These fines can be further processed to produce a glass sand product which has a number of uses.
Flexible packaging	Soft (flexible) plastics are generally defined as plastics that can be scrunched into a ball, unlike ‘rigid’ plastics such as bottles and tubs, which are moulded and hold their shape. Also refer to the 'Rigid packaging' entry.
Food organics	Food waste from households or industry, including food processing waste, out- of-date or off-specification food, meat, fruit and vegetable scraps. Excludes liquid wastes.
Garden organics	Organics derived from garden sources e.g. grass clippings, tree prunings. Also known as green organics.
Generated material/waste	Materials or waste originating from a point source or source of origin.
Green organics	See garden organics.

Term	Definition
Greenhouse gases	Gases, including carbon dioxide and methane, that trap heat in the earth's atmosphere, affecting weather and climate patterns.
Hard waste	The term applied to household garbage that is not usually accepted in kerbside garbage bins by local councils e.g. old fridges and mattresses.
Hazardous waste	Waste with potentially adverse impacts on human health and the environment.
Household	Material from domestic (household) sources.
In the gate	Material entering a facility for reprocessing. This may include material that is unusable due to contamination. In the gate material that is subsequently sent to landfill is generally either a combination of gross contamination (i.e. materials that should not have been presented and are not recyclable at the receiving facility) and/or designated scrap plastics that were not recovered into product due to cross contamination with unrecyclable materials or losses due to other types of production inefficiencies (e.g. losses to trade waste). Also see 'Out the gate'.
Incinerator	A site and/or process that facilitates disposal of waste streams through burning, without producing another useful end product or capturing value from the waste material.
Internal use	Recyclate processed and used within the one company.
In-vessel composting	Composting technology involving the use of a fully enclosed chamber or vessel in which the composting process is controlled by regulating the rate of mechanical aeration. Aeration assists in heat removal, temperature control and oxygenation of the mass. Aeration is provided to the chamber by a blower fan which can work in a positive (blowing) and/or negative (sucking) mode. Rate of aeration can be controlled with temperature, oxygen or carbon dioxide feedback signals.
Kerbside waste/ collection	Waste collected by local councils from residential properties, including garbage, commingled recyclables and garden organics, but excluding hard waste.
Kraft paper	Kraft paper is paper or paperboard (cardboard) produced from chemical pulp produced in the kraft process. It is commonly used in paper sacks, food and other paper based wraps (including burger wraps and similar). Kraft pulp is normally darker than other wood pulps, but it can be bleached to make white papers.
Landfill	Discharge or deposit of solid wastes onto land that cannot be practically removed from the waste stream.
Liquid paperboard (LPB)	Liquid paperboard (LPB) is a fibre-based packaging board that is designed to hold a liquid. It is commonly comes in two main types, which are gable-topped LPB (plastic polymer layer / paperboard layer / plastic polymer layer), and aseptic LPB (plastic polymer layer / paperboard layer / aluminium foil layer / plastic polymer layer). Also see Polymer-coated paperboard (PCPB).
Local material utilisation	Materials recovered and reprocessed (recyclate) for use within Australia for the manufacture of new products.
Local material utilisation rate	Materials recovered for local manufacturing of new product divided by total packaging waste entering the system.
Local use	Recyclate used within Australia by an Australian company in the manufacture of a new product.
Local/Locally	In Australia.
Material flow analysis (MFA)	Material flow analysis (MFA) is a mass balanced based analytical method to quantify flows and stocks of materials or substances for a well-defined system and time period. MFA is also referred to as substance flow analysis (SFA).
Material recycling	Reprocessing, by means of a manufacturing process, of a used packaging material into a product, a component incorporated into a product, or a secondary (recycled) raw material

Term	Definition
Materials recovered	Materials diverted from landfill for use or reprocessing irrespective of where the recovery or reprocessing takes place.
Materials recovery facility (MRF)	A centre for the receipt, sorting and transfer of materials recovered from the waste stream prior to transport to another facility for recovery and management. At a MRF materials may undergo mechanical treatment for sorting by characteristics such as weight, size, magnetism and optical density and may include cleaning and compression. Materials may be received as mixed streams such as commingled recyclables from households and businesses or single streams such as metals.
Mechanical recycling	The use of physical processes such as sorting, chipping, grinding, washing and extruding to convert scrap plastics to a usable input for the manufacture of new products.
Mixed paper	Post-consumer kerbside mix of fibre based packaging and non-packaging papers. Includes materials such as magazine, newspaper, marketing, some OCC and others fibre based formats. Typically has high levels of contamination, of which broken glass is a particular issue.
Mixed plastics	Post-consumer kerbside mix of plastics based packaging and non-packaging plastic items. Includes materials such as bottles, containers and other packaging formats consisting of all the major polymer groups. Often undergoes a polymer sort at MRFs or post-MRFs to positively recover a limited range of polymer types, typically PET and HDPE. Often has moderate to high levels of contamination.
MRF	Material Recovery Facility – a facility for the sorting of recyclables (typically packaging) into various product streams.
Municipal solid waste (MSW)	Solid waste generated from municipal and residential activities, and including waste collected by, or on behalf of, a municipal council. Excludes dedicated container deposit scheme (CDS) collections or drop-off by consumers or businesses.
Non-packaging / durable	Long-term use item; not designed to be single use or disposable within a 12-month period.
OCC	Old corrugated cardboard (unbleached kraft).
ONP	Old newsprint.
Open-loop recycling	Material from a product system is recycled into a different product system, and may be of lower quality and functionality than the original material. Importantly, the recycled materials substitute for, and avoid the use of virgin materials in the new applications. Examples of this in Australia include the recycling of PET bottles into fibre for use in clothing and other textiles, and high-density polyethylene (HDPE) milk bottles into mobile garbage bins and milk crates. Open-loop recycling can be as environmental beneficial as closed-loop recycling. Also see 'Closed-loop recycling' and 'Downcycling'.
Optical sorting	Technologies used to sort glass by colour type, and plastics by polymer type.
Organic material	Plant or animal matter, e.g. grass clippings, tree prunings and food waste, originating from domestic or industrial sources.
Organics recycling	The treatment of separately collected organics waste by anaerobic digestion, composting or vermiculture.
Out the gate	Material leaving a facility following reprocessing and excluding most contamination. Also see 'In the gate'.
Oxo-degradable or photo-degradable	Conventional fossil-based polymers (usually polyethylene or polypropylene) that have additives incorporated into the polymer at low rates (2-3%) to provide highly accelerated fragmentation of the plastic in sunlight or in the presence of oxygen or in an anaerobic environment.

Term	Definition
Packaging	Material used for the containment, protection, marketing or handling of product. Includes primary, secondary and tertiary/freight packaging in both consumer and industrial packaging applications.
Paper & paperboard	Paperboard is a group term related to papers (including multi-ply papers) that have been manufactured specifically for packaging purposes. Paper is both an input into paperboard manufacturing and can be a packaging product in its own right.
PE-HD or HDPE	High density polyethylene (PIC 2). Typically referred to as HDPE.
PE-LD or LDPE	Low density polyethylene (PIC 4). Typically referred to as LDPE.
PE-LLD or LLDPE	Linear low density polyethylene (PIC 4). Typically referred to as LLDPE.
PET	Polyethylene terephthalate (PIC 1).
PIC	Plastic identification code. Also referred to as the resin identification code (RIC) in some other countries.
Placed on market (POM)	Packaging is defined as being 'placed on market' (POM) when it is first made available to the end-consumer, and disposal is following the intended full use of the packaging, and can be considered 'post-consumer'. Packaging losses prior to the point of POM are considered pre-consumer losses.
Polymer coated paperboard (PCPB)	Paper-based packaging with a polymer coating for water resistance and structural integrity, generally, polyethylene (PE) or polylactic acid (PLA). Aseptic PCPB containers also contain a foil/metallised film layer.
Post-consumer domestic	Used material from household sources. Mostly packaging material from kerbside recycling collections.
Post-consumer industrial	Used material from non-household sources.
Post-consumer used packaging	ISO 14021 defines post-consumer material as material generated by households or by commercial, industrial and institutional facilities in their role as end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. It excludes pre-consumer material (e.g. production scrap).
PP	Polypropylene (PIC 5).
Pre-consumer scrap packaging	Scrap off-cuts and off-specification materials in the manufacturing industry which are collected for reprocessing at a different facility. Does not include material that is recycled directly back into manufacturing processes at the same facility. Does not include material that has reached the end-consumer, whether domestic, commercial or industrial.
Primary material	See ‘Virgin material’.
Problematic	Can be considered a ‘contaminant’ in the recycling facility because it is either 1) not one of the requested materials 2) causes problems e.g. getting entangled in machinery 3) reduces the quality of the recyclate or some other reason.
Process derived fuels	Also called process engineered fuel (PEF) or refuse derived fuel (RDF), is a fuel produced after basic processing in a MRF or MBT to increase the calorific value and remove recyclable materials and contaminants of municipal solid waste, commercial and industrial waste and construction and demolition waste.
Processing facilities	Facilities which either receive materials directly from collection systems or from recovery facilities for further sorting and/or processing to provide material for use in the generation of new products.
Product stewardship	A concept of shared responsibility by all sectors involved in the manufacture, distribution, use and disposal of products, which seeks to ensure value is recovered from products at the end of life.
PS-E or EPS	Expanded polystyrene (PIC 6). Typically referred to as EPS.

Term	Definition
Public place recycling	Recycling facilities found in public areas, such as parks, reserves, transport hubs, shopping centres and sport and entertainment venues, that allow the community to recycle when away from home.
Putrescible waste	Waste that readily decomposes, including food waste and organic waste from gardens.
PVC	Polyvinyl chloride (PIC 3).
Pyrolysis	Thermal breakdown of waste in the absence of air, to produce char, pyrolysis oil and syngas e.g. the conversion of wood into charcoal.
Recover / recovery / resource recovery	The process of recovering resources from waste for reuse or reprocessing. This includes collection, sorting and aggregation of materials. To convert waste into a reusable material.
Recovery rate	Recovery (at a defined point) as a percentage of end-of-life disposal. Similar meaning to 'Recycling rate' but can include material into composting and energy recovery. Excludes reused products. Also see 'Diversion rate' and 'Recycling rate'.
Recyclable packaging	A packaging (1) or packaging component (2,3) is recyclable if its successful post-consumer (4) collection, sorting, and recycling is proven to work in practice and at scale. Also see the related 'Compostable packaging' and 'Reusable packaging' definitions. Supporting notes: 1. A package can be considered recyclable if its main packaging components, are recyclable according to the above definition, and if the remaining minor components are compatible with the recycling process and do not hinder the recyclability of the main components. The PREP design tool provides information on recyclability of packaging through kerbside collection services. 2. A packaging component is a part of packaging that can be separated by hand or by using simple physical means (ISO 18601), e.g. a cap, a lid and (non in-mould) labels. 3. A packaging component can only be considered recyclable if that entire component, excluding minor incidental constituents (5), is recyclable according to the definition above. If just one material of a multi-material component is recyclable, one can only claim recyclability of that material, not of the component as a whole (in line with ISO 14021). 4. ISO 14021 defines post-consumer material as material generated by households or by commercial, industrial and institutional facilities in their role as end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. It excludes pre-consumer material (e.g. production scrap). 5. ISO 18601:2013: A packaging constituent is a part from which packaging or its components are made and which cannot be separated by hand or by using simple physical means (e.g. a layer of a multi-layered pack or an in-mould label).
Recyclate	Scrap material either before or after reprocessing.
Recycle/Recyclables/Recycling	In common practice the term is used to cover a wide range of activities, including collection, sorting, reprocessing and reuse.
Recycled (packaging)	Packaging is recycled if at least 70% of its weight is recycled into a product, a component incorporated into a product, or a secondary (recycled) raw material.
Recycled content	Is the proportion, by mass, of pre-consumer and post-consumer recycled material in packaging (AS/ISO 14021). 'Pre-consumer' material is material diverted from the waste stream during manufacturing (excluding rework). 'Post-consumer' material is material waste generated by households or by commercial, industrial and institutional facilities. The amount of renewable or recycled material is expressed as a percentage of the quantity of packaging material put onto the market.

Term	Definition
Recycling	Activities in which solid wastes are collected, sorted, processed (including through composting), and converted into raw materials to be used in the production of new products (the amount of solid waste recycled is net of any residuals disposed). Excludes energy recovery and stockpiles.
Recycling rate	Recovery (at a defined point) as a percentage of end-of-life disposal. Similar meaning to 'Recovery rate' but excludes material into energy recovery and reused products. Also see 'Diversion rate' and 'Reprocessing rate'.
Refuse derived fuels	Refer to Process derived fuels.
Reprocess / reprocessing	To put a material that has been used through an industrial process to change it so that it can be used again.
Reprocessor / reprocessing facility / reprocessing infrastructure	Facility that uses an industrial process to change the physical structure and properties of a waste material so it can be used again. This can include facilities that dismantle products, such as tyres, e-waste and mattresses, and energy from waste facilities that use materials to generate energy.
Resale centre / shop	A centre/shop that enables the sale and subsequent reuse of good quality, saleable products and materials that were disposed of by their previous owner.
Residual waste	Residual material that remains after any source separation or reprocessing activities of recyclable materials or garden organics. Waste that is left over after suitable materials have been recovered for reuse and recycling. This generally means the environmental or economic costs of further separating and cleaning the waste are greater than any potential benefit of doing so.
Resin	Raw plastic polymer material.
Resource recovery	Total materials recovered including materials sent to recycling and energy recovery, including export and stockpiling, net of contaminants and residual wastes sent to disposal.
Resource recovery infrastructure	Facility that receives and manages materials to enable them to be reused or reprocessed. This includes drop off points, resale centres, resource recovery centres, transfer stations and materials recovery facilities.
Resource recovery rate	The proportion calculated by dividing resource recovery by waste generation (also referred to as the 'recovery rate').
Reusable packaging	Packaging which has been designed to accomplish or proves its ability to accomplish a minimum number of trips or rotations (1,2) in a system for reuse (3,4). Also see the related 'Compostable packaging' and 'Recyclable packaging' definitions. Supporting notes: 1. A trip is defined as transfer of packaging, from filling/loading to emptying/unloading. A rotation is defined as a cycle undergone by reusable packaging from filling/loading to filling/loading (ISO 18603). 2. The minimum number of trips or rotations refers to the fact that the 'system for reuse' in place should be proven to work in practice, i.e. that a significant share of the package is actually reused (measured e.g. by an average reuse rate or an average number of use-cycles per package). 3. A system for reuse is defined as established arrangements (organisational, technical or financial) which ensure the possibility of reuse, in closed-loop, open-loop or in a hybrid system (ISO 18603). 4. Reuse is an operation by which packaging is refilled or used for the same purpose for which it was conceived, enabling the packaging to be refilled (ISO 18603).
Reuse	Recovering value from a discarded resource without processing or remanufacture e.g. garments sold though opportunity shops.
Rigid packaging	Rigid plastic packaging such as bottles and tubs, which are (generally) moulded and hold their shape. Also refer to the 'Flexible packaging' entry.

Term	Definition
Scrap packaging	Used packaging that has been recovered for reprocessing, but has not yet been reprocessed.
Secondary processing	A process undertaken after sorting in which a recovered material is put through an industrial process to change it so that it can be used as an input for the manufacture of new products. Also see 'Reprocessor'.
Sectors / industry sectors	Groupings of industries used to generalise patterns in waste generation and disposal e.g. construction and demolition, food services including food retail and food manufacturing, small to medium enterprises.
Soft plastics packaging	Soft (flexible) plastics are generally defined as plastics that can be scrunched into a ball, unlike 'rigid' plastics such as bottles and tubs, which are moulded and hold their shape.
Solid industrial waste (SIW)	Solid waste generated from commercial, industrial or trade activities, including waste from factories, offices, schools, universities, state and federal government operations and commercial construction and demolition work. Excludes MSW and hazardous wastes.
Solid inert waste	Solid inert waste is hard waste that has a negligible activity or effect on the environment. The waste may be either a municipal or industrial waste.
Solid waste	Non-hazardous, non-prescribed, solid waste materials, ranging from municipal garbage to industrial waste.
Sorting / primary sorting	A process typically between collection (recovery) and reprocessing in which collected end-of-life materials are sorted (or disassembled) into more usable and economically valuable material fractions. Material recovery facilities (MRFs) are sorting facilities.
Sorting efficiency	Material processed at MRF or CDS divided by total packaging waste entering the system.
Source separation	The practice of segregating materials into discrete material streams prior to collection by, or delivery to, processing facilities.
Source stream	Either MSW, C&I, C&D or CDS.
Stockpile	Unprocessed or processed material where 500 tonnes or more of the same material has been held for more than six months.
Stockpiling	Storage of materials in line with the 'stockpile' definition.
Transfer coefficient	A derived factor that defines the partitioning of an input entering a process into a transformed material stream (e.g., the separation of PET from kerbside recycling materials at MRF).
Transfer station	Facility which receives materials from the waste stream for possible segregation, consolidation or compaction for bulk transport for resource recovery, treatment or disposal facilities.
Unprocessed material	Material that is unrefined and has not been through any process of recycling.
Virgin material	Material that has been sourced through primary resource extraction. Virgin materials are often referred to as primary materials. Virgin materials are not sourced from recycled materials (sometimes called secondary materials). For example, 'virgin' steel is manufactured from iron ore, and 'virgin' paper is manufactured from plantation sourced wood fibre.
Waste	Any discarded, rejected, unwanted, surplus or abandoned matter, including where intended for recycling, reprocessing, recovery, purification or sale. Anything that is no longer valued by its owner for use or sale and which is, or will be, discarded. In this document, the term 'solid waste' refers to non-hazardous, solid waste materials ranging from municipal garbage to industrial waste.
Waste management industry	Applies to those involved in managing waste e.g. collectors, sorters, processors and landfill operators.

Term	Definition
Waste minimisation	The concept of, and strategies for, waste generation to be kept to a minimum level in order to reduce the requirement for waste collection, handling and disposal to landfill. Also referred to as waste avoidance.
Waste packaging export	Export of (typically baled) scrap packaging materials sent off-shore for reprocessing.
Waste to energy	Refer to Energy from waste.

APPENDIX B – PACKAGING MATERIAL TYPES LISTS

The lists of packaging material (type) labels applied during data collection, analysis and reporting are provided in the following table.

Two separate lists are provided for the consumption and recovery/disposal life cycle stages. These are as consistent as possible, while reflecting the difficulties of disaggregating data collection, particularly at the recovery/disposal stage.

A separate more highly aggregated list is provided for the MFA modelling, reflecting the difficulty of forecasting consumption and recycling at a more disaggregated level.

Table B-1 – Packaging types lists

Material types – Consumption related	Material type list – Collection or sorting output related	Material types – MFA related	Material group
Boxboard/Cartonboard	Boxboard/Cartonboard	Boxboard/Cartonboard	Paper and paperboard
Corrugated cardboard	Corrugated cardboard	Corrugated cardboard	Paper and paperboard
High wet strength carrier board	Other fibre packaging	Other fibre packaging	Paper and paperboard
Kraft paper	Other fibre packaging	Other fibre packaging	Paper and paperboard
Moulded fibreboard	Other fibre packaging	Other fibre packaging	Paper and paperboard
Polymer coated paperboard – Aseptic	Polymer coated paperboard	Polymer coated paperboard	Paper and paperboard
Polymer coated paperboard – Gable top	Polymer coated paperboard	Polymer coated paperboard	Paper and paperboard
Polymer coated paperboard – Cold cup	Polymer coated paperboard	Polymer coated paperboard	Paper and paperboard
Polymer coated paperboard – Hot cup	Polymer coated paperboard	Polymer coated paperboard	Paper and paperboard
Polymer coated paperboard – Other	Polymer coated paperboard	Polymer coated paperboard	Paper and paperboard
Other fibre packaging	Other fibre packaging	Other fibre packaging	Paper and paperboard
N/A	Mixed paper and paperboard	Mixed paper and paperboard	Paper and paperboard
Newsprint and magazine	Newsprint and magazine	Newsprint and magazine	Paper and paperboard
Other fibre non-packaging	Other fibre non-packaging	Other fibre non-packaging	Paper and paperboard
Glass – Amber	Glass – Amber	Glass	Glass
Glass – Flint	Glass – Flint	Glass	Glass
Glass – Green	Glass – Green	Glass	Glass
N/A	Glass – Mixed	Glass	Glass
Glass – Other	Glass – Other	Glass	Glass
Plastic – PET (1)	Plastic – PET (1)	Plastic – PET (1)	Plastic
Plastic – HDPE (2)	Plastic – HDPE (2)	Plastic – HDPE (2)	Plastic
Plastic – PVC (3)	Plastic – PVC (3)	Plastic – Other plastic packaging	Plastic
Plastic – LDPE (4)	Plastic – LDPE (4)	Plastic – Other plastic packaging	Plastic
Plastic – PP (5)	Plastic – PP (5)	Plastic – Other plastic packaging	Plastic
Plastic – PS (6)	Plastic – PS (6)	Plastic – Other plastic packaging	Plastic
Plastic – EPS (6)	Plastic – EPS (6)	Plastic – Other plastic packaging	Plastic
Plastic – Bioplastic	Plastic – Bioplastic	Plastic – Other plastic packaging	Plastic
N/A	Plastic – Mixed (1–7)	Plastic – Other plastic packaging	Plastic
N/A	Plastic – Mixed (3–7)	Plastic – Other plastic packaging	Plastic
N/A	Plastic – Mixed	Plastic – Other plastic packaging	Plastic
Plastic – Other plastic packaging	Plastic – Other plastic packaging	Plastic – Other plastic packaging	Plastic

Material types – Consumption related	Material type list – Collection or sorting output related	Material types – MFA related	Material group
Plastic – Non-packaging	Plastic – Non-packaging	Plastic non-packaging	Plastic
Aluminium – Beverage	Aluminium – Beverage	Aluminium	Metal
Aluminium – Non-beverage	Aluminium – Non-beverage	Aluminium	Metal
Aluminium – Other	Aluminium – Other	Aluminium	Metal
Steel – Tin-plate	Steel – Tin-plate	Steel	Metal
Steel – Other	Steel – Other	Steel	Metal
Other packaging	Other packaging	Other packaging	Other
Other non-packaging	Other non-packaging	Other non-packaging	Other
N/A	Commingled recyclables	Commingled recyclables	Commingled recyclables
Contamination	Contamination	Contamination	Other
Waste to landfill	Waste to landfill	Waste to landfill	Mixed wastes
Unknown	Unknown	Unknown	Unknown

APPENDIX C – PROPOSED APPROACH FOR YEAR-ON-YEAR UPDATES

[Appendix deleted from the public version of this report]

APPENDIX D – MATERIAL FLOW ANALYSIS

D.1 Auxiliary data sources used

Table D-1 – Auxiliary data sources used in the analysis

Data source	Relevant material stream	Remarks
Assessment of Australian recycling infrastructure and 2016-17 exports to China – paper and paperboard (IndustryEdge, 2018)	Paper and paperboard	Provides data on production, consumption, export of paper and cardboard. Includes description of local and exportable marketable products. Used for determining paper waste flows
Assessment of Australian recycling infrastructure and 2016-17 exports to China – Metals (REC, 2018)	Metals	Provides data on total metals exported to China. Includes description of recovery infrastructure, however is not a particularly useful data source
Assessment of Australian recycling infrastructure – Glass packaging (SRU, 2018)	Glass	Provides information on glass recycling infrastructure locally, and includes some national figures on total generation and recovery of glass packaging
Assessment of Australian recycling infrastructure and 2016-17 exports to China – Plastics (Envisage, 2018)	Plastic	Includes breakdown of plastics consumption by application (e.g., MSW packaging), and by individual polymers. Also includes breakdown of local reprocessing, reprocessed for export, and direct exports overseas
National Recycling and Recovery Surveys (NRRS) – Paper packaging, glass containers, steel cans and aluminium packaging (IndustryEdge, 2017)	Paper, glass, metals	Includes total consumption and recovered for the listed material categories for 2010/11 to 2014/15; used for calibration of other estimates
National Recycling and Recovery Survey (NRRS) 2015-16 for plastics packaging (Envisage, 2017)	Plastics	Includes data on plastic packaging recycling from 2000 to 2015/16, plastic packaging consumption, and recovery by polymer. Also includes destination of packaging recyclate by jurisdiction; Used in conjunction with other plastics data sets to determine plastic packaging flows
2016-17 Australian Plastics Recycling Survey – National Report (Envisage & SRU, 2017)	Plastics	Similar to the above data source. Used with other plastics data sets to determine plastic packaging flows
Stage 1 Final Report – Study on the South Australia Plastics Packaging Resource Recovery Sector (Rawtec, 2012)	Plastics	In depth description of the South Australian plastic packaging recovery sector. Includes data on recovery by polymer, mass balance of SA plastics recovery, and existing recovery infrastructure. Used for information on plastic recovery processes
Recycling Activity in Western Australia 2015-16 (ASK, 2017)	Paper, glass, metals and plastics	Includes data on packaging generation and recovery in general. Used to calibrate per-capita estimates
Victorian Recycling Industry Annual Report 2015-16 (Sustainability Victoria, 2017)	Paper, glass, metals and plastics	Includes data on packaging generation and recovery in general. Used to calibrate per-capita estimates

South Australia's Recycling Activity Survey 2016-17 Financial Year Report (Rawtec, 2017)	Paper, glass, metals and plastics	Includes data on packaging generation and recovery in general. Used to calibrate per-capita estimates; Contains data for container deposit flows, and packaging waste directed to energy recovery
Recycling and Waste in Queensland 2017 (Queensland Government, 2017)	Paper, glass, metals and plastics	Includes data on packaging generation and recovery in general. Used to calibrate per-capita estimates
Market Summary – Recycled Glass (Sustainability Victoria , 2014)	Glass	Estimates on glass packaging consumption, recovery, and exports in Victoria; Used to derive estimates on re-processing losses, and recovery efficiencies
NSW Glass Recycling – Issues and Options (CIE, 2017)	Glass	Study on glass recycling in NSW; Used to estimate stocks of cullet and fines.
Analysis of material recovery facilities for use in life-cycle assessment (Pressley et al., 2015)	All streams	Academic source on MRF recovery and sorting rates, based on a life cycle assessment of MRFs across the United Kingdom
National Waste Report 2018 (Blue Environment, 2018)	All streams	This National Waste Report was prepared for the Australian Department of the Environment and Energy describing the entire Australian waste management system. The report was used to compare MFA estimates

D.2 Characterising data uncertainty

Assessing data uncertainty is a key step in the MFA methodology that gives an indication of data quality, and it informs how accurately the MFA results can be stated with reasonable confidence.

If direct measurements of uncertainty for a particular flow or process activity are not available, best estimates can be made by drawing on alternative sources while acknowledging the quality and appropriateness of the source, i.e. the 'uncertainty' (Laner et al., 2014). Uncertainties can be calculated, for example by drawing on literature data, or indirect measurements, to construct probability distributions for each data point assessed, from which uncertainty bounds can be calculated. However, in the case when such data is not available, more qualitative methods can be employed, which was the approach taken in this study.

Our approach modified an established method developed by Laner et al (2015)[3]. Three indicators were used to describe the uncertainty of a data point to be assessed: **reliability** (of the data source and methodology); **completeness** (if the data includes all relevant information and flows); and **similarity** (how similar an underlying data point or source is relative to a direct measurement of a flow or process in our system).

Each data point used as an input into the MFA was evaluated according to these indicators, and scores between 1 or 2 (i.e. low or high uncertainty) were assigned.

From this score, a coefficient of variation is modelled (the ratio of the standard deviation of the data to the mean) for each quality indicator. Assuming that quantitative uncertainty increases exponentially as data quality declines, an exponential function with data quality scores as inputs is used to estimate

3 Laner et al (2015) employs figure indicators to describe the total uncertainty of a data point and a score of 1–4 is assigned. Our simplified methodology, that reduces the number of indicators and levels of appraisal, minimises possible bias in the uncertainty appraisal process.

the modelled coefficients of variation for each quality indicator. The exponential function used in this analysis is based on the function described in Laner et al (2015). The function parameters stated in Laner et al (2015) have been calibrated such that the modelled total coefficient of variation is consistent with the direct measurement of uncertainty from Envisage (2019), assuming input data is normally distributed.

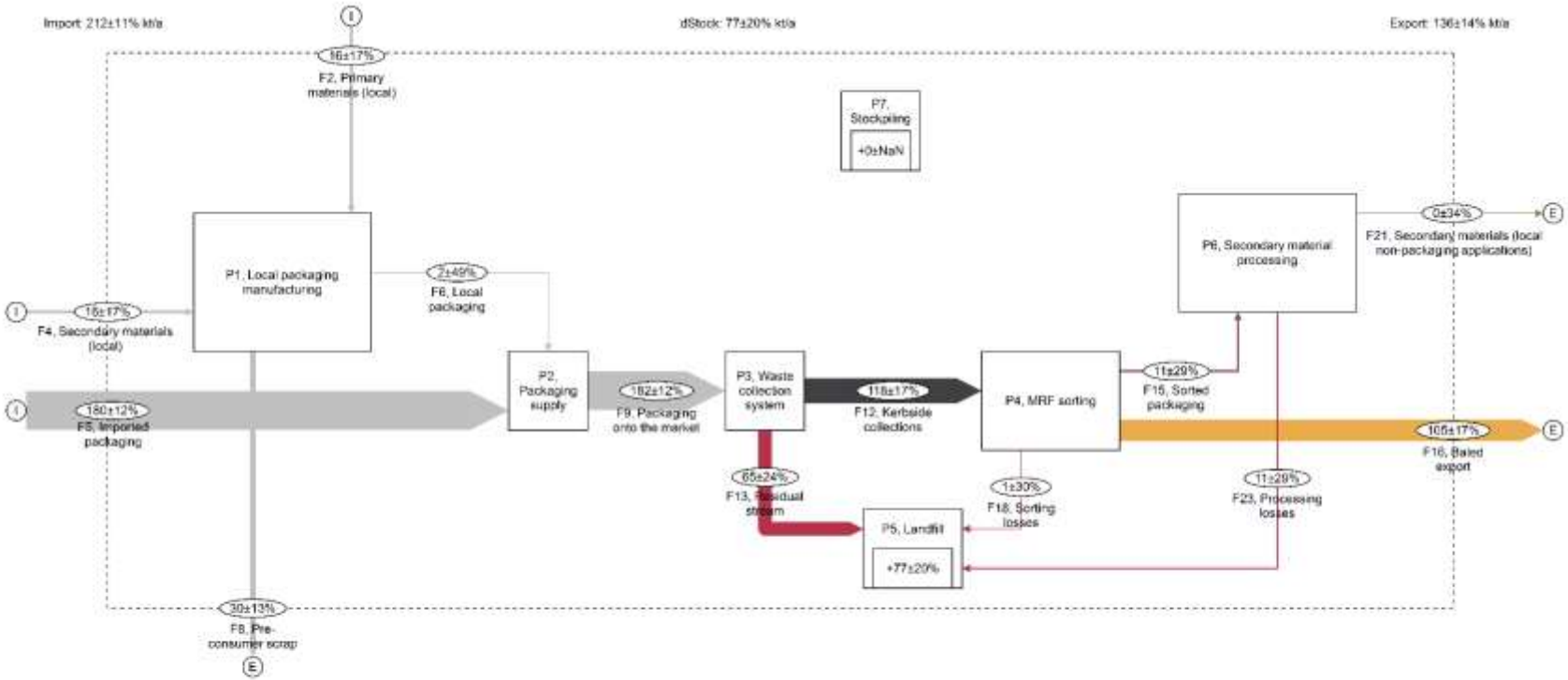
Once coefficients of variation have been determine, a 95% confidence interval can then be estimated on the input flows, and input directly along with the input data into the STAN material flow software. This software propagates the input uncertainty through the system following Gaussian error propagation, which is performed by the software. All estimated flows using STAN are presented as mean values, with plus-minus percentage error.

Table D-2 shows direct measured uncertainties used to calibrate our uncertainty approach

Table D-2 – Percentage error uncertainty for each material type used to calibrate our uncertainty approach

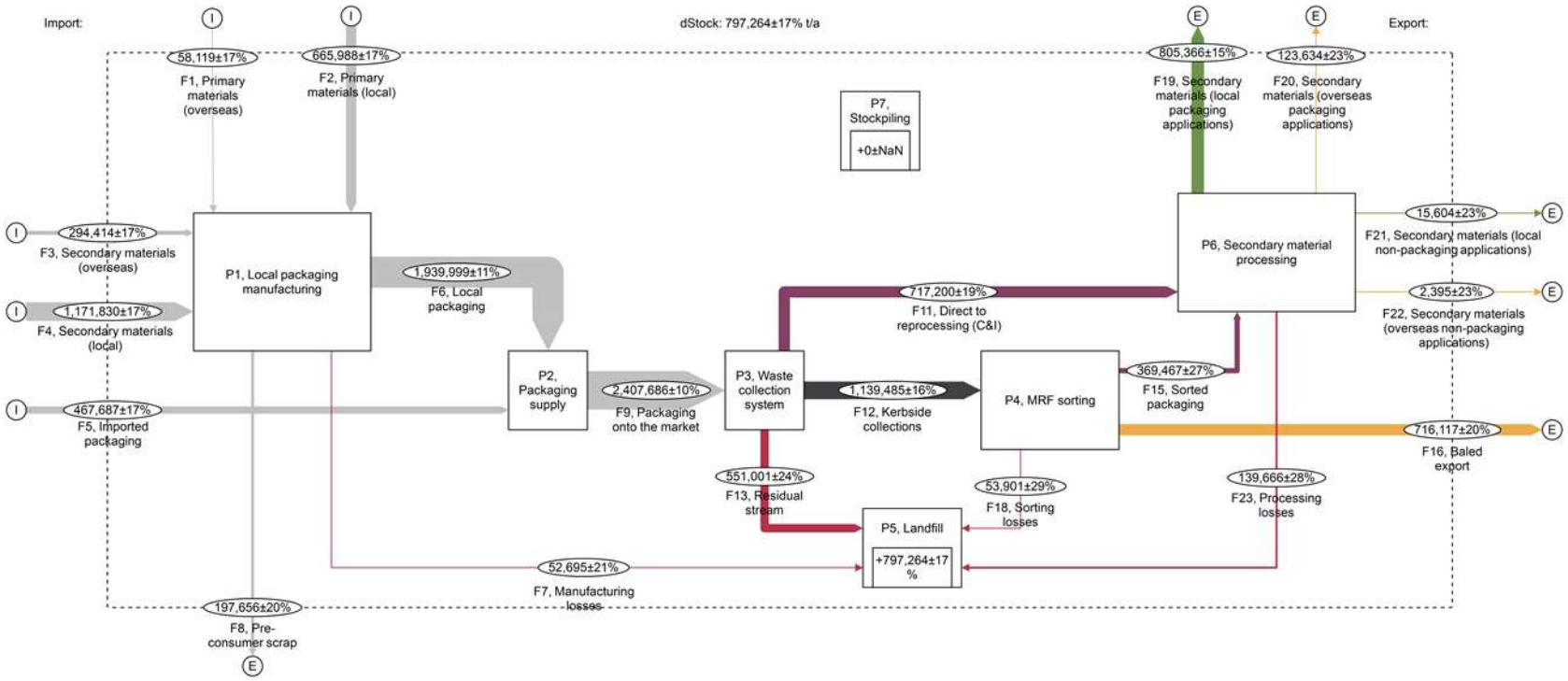
Material type	Packaging onto the market [%]	In-the-gate [%]
Boxboard/cartonboard	10%	27%
Corrugated cardboard	6%	10%
PCPB	11%	48%
Other fibre	8%	41%
Glass	17%	23%
PET	20%	15%
HDPE	20%	18%
Other polymers	22%	23%
Aluminium	12%	22%
Steel	30%	20%
Total	**13%**	**15%**

D.3 Material flow diagram: Paper – boxboard/cartonboard



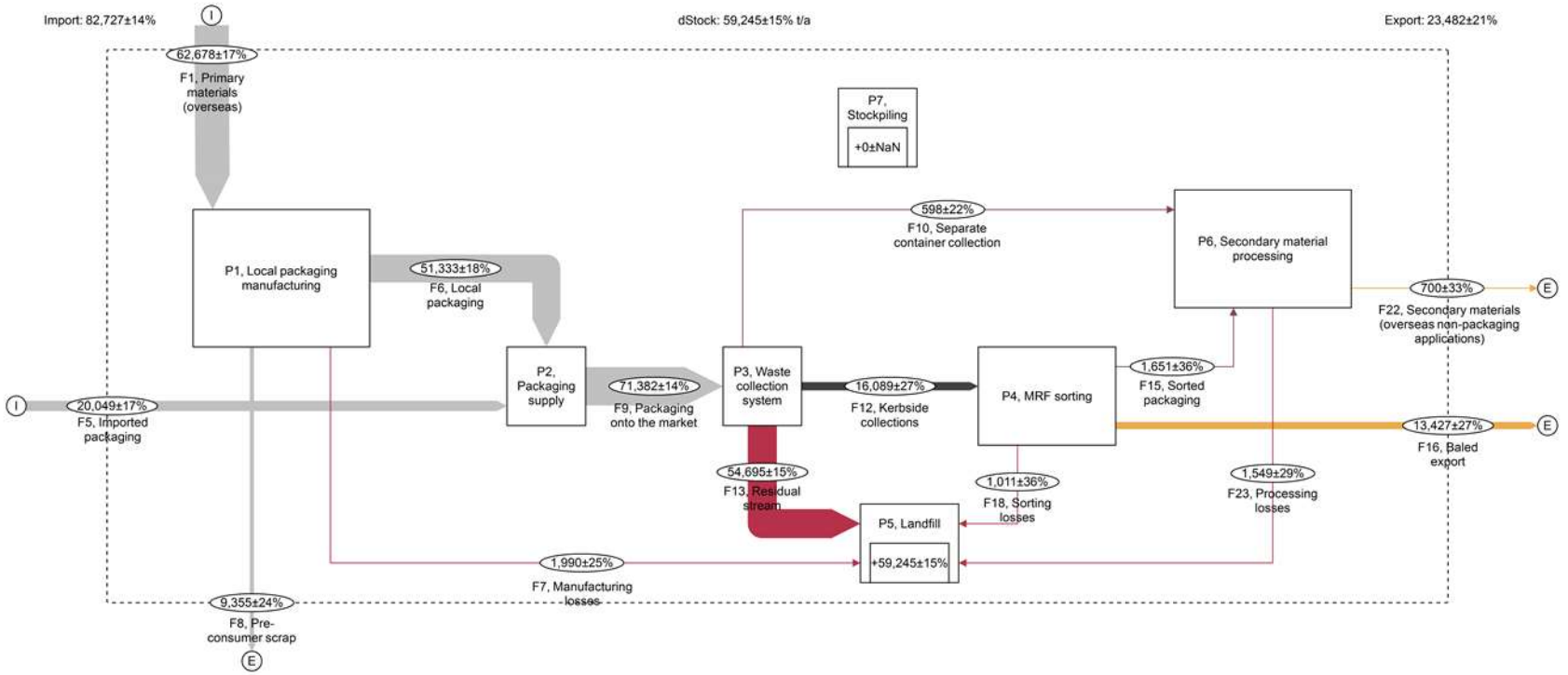
Australian packaging flows, 2017-18
[Paper - boxboard/cartonboard packaging, kilotonnes/year]

D.4 Material flow diagram: Paper – corrugated cardboard

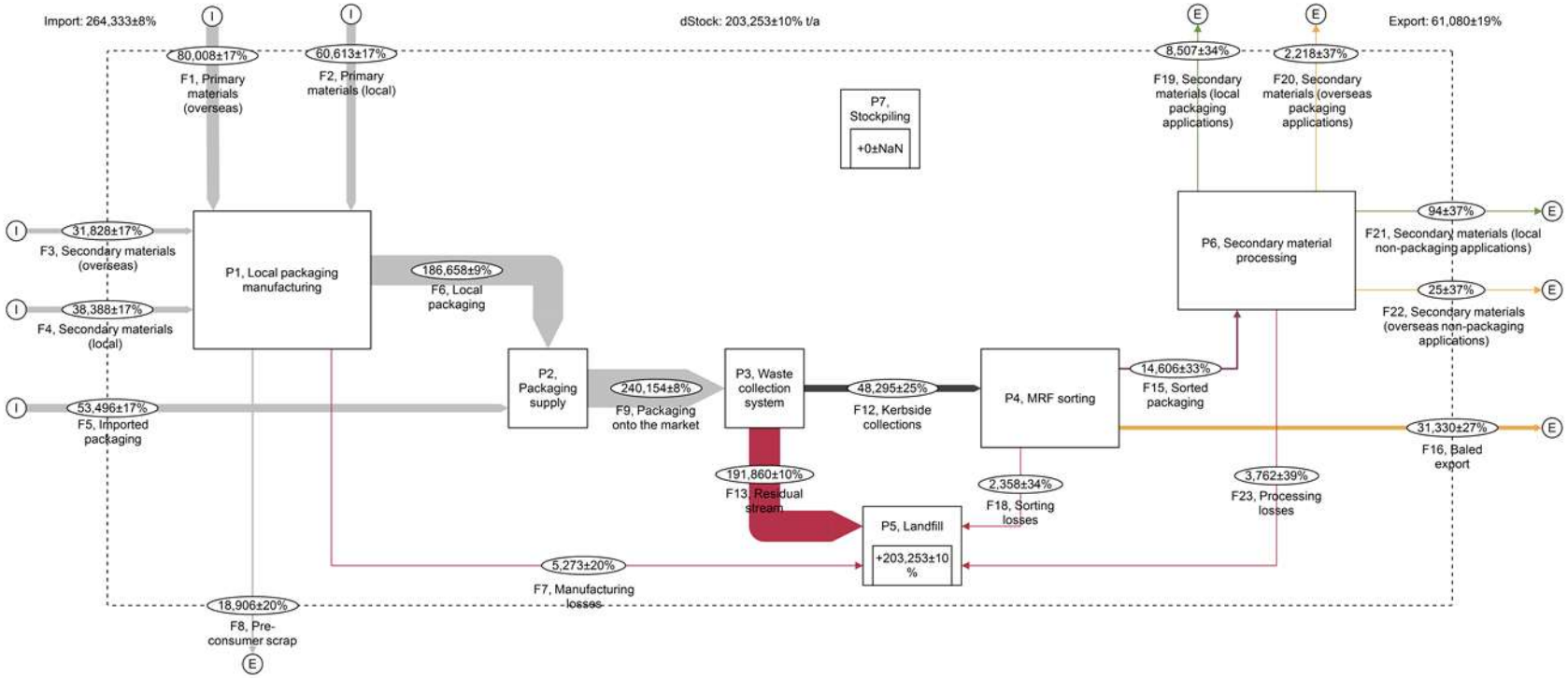


Australian packaging flows, 2017-18
[Paper - OCC packaging, kilotonnes/year]

D.5 Material flow diagram: Paper – PCPB

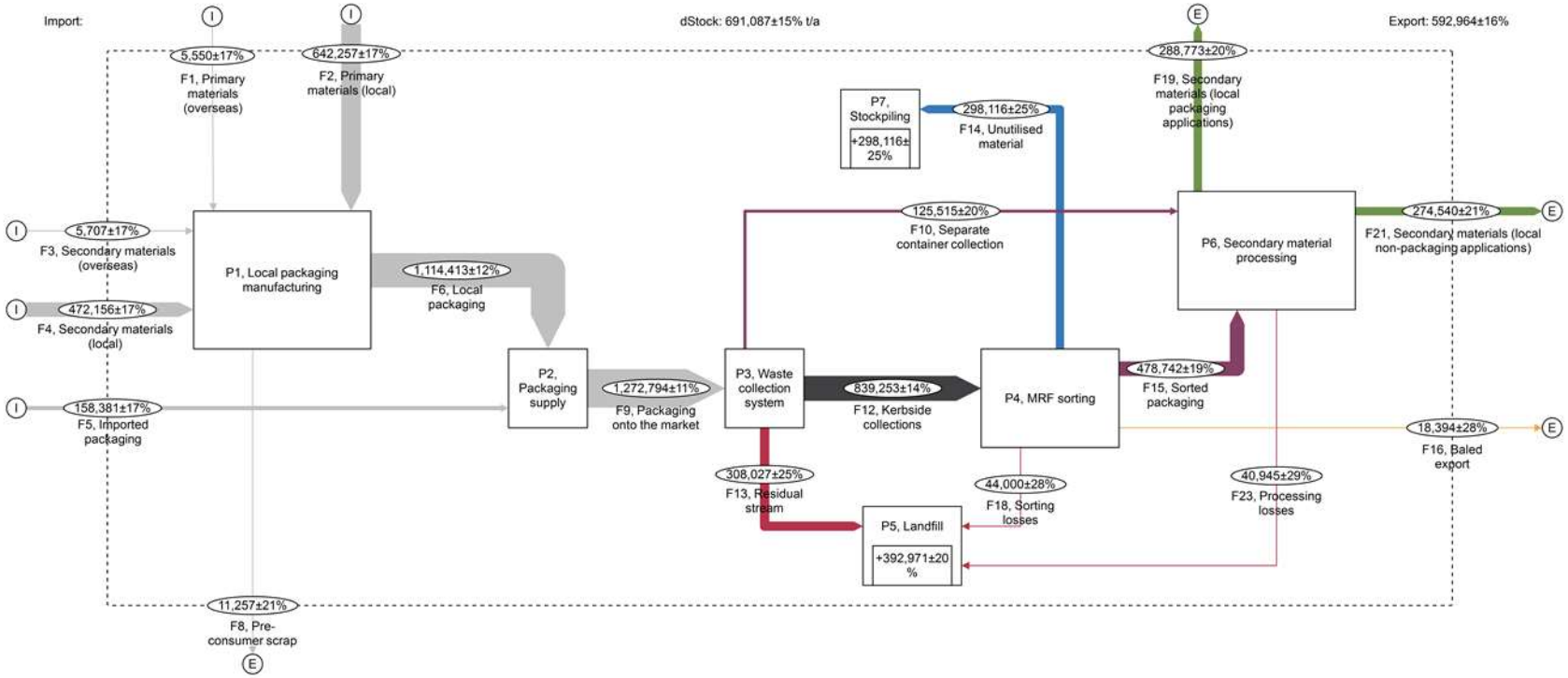


D.6 Material flow diagram: Paper – other fibre packaging



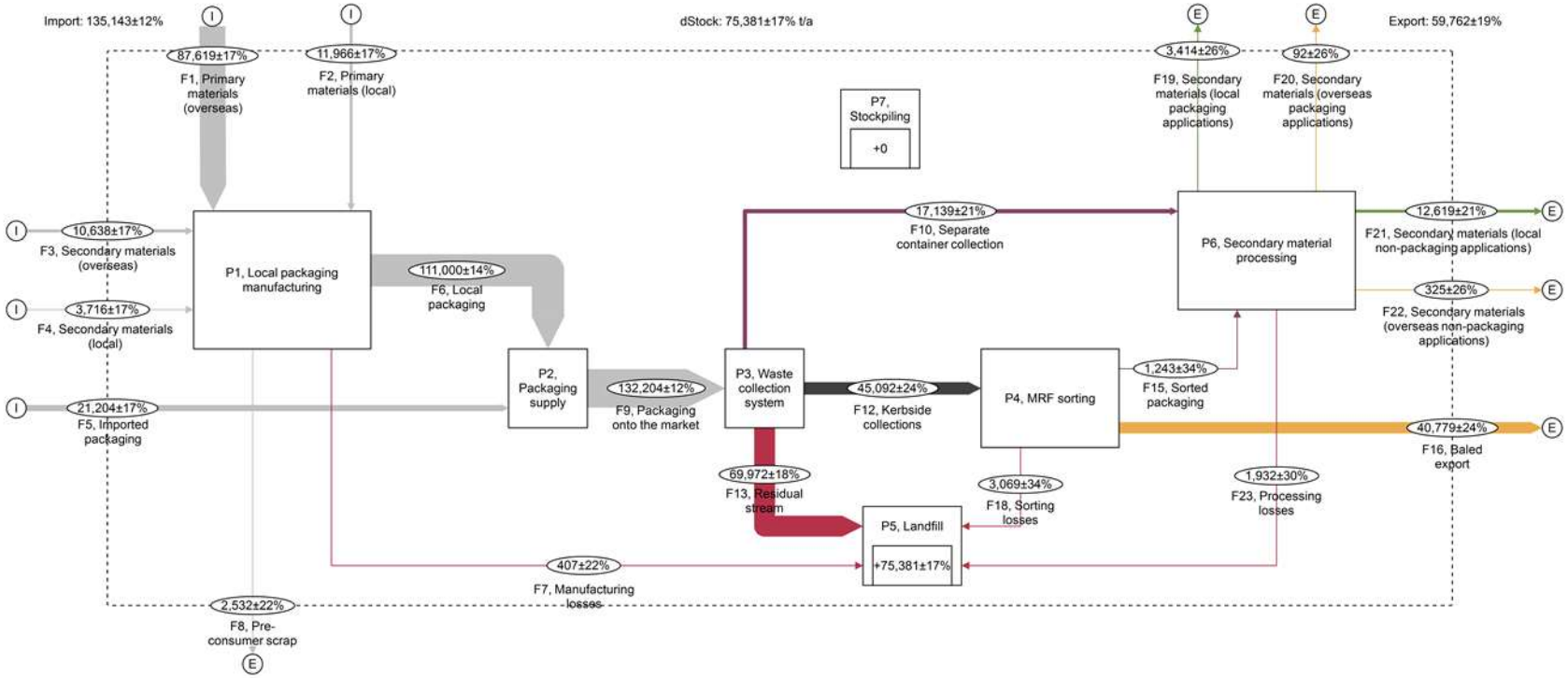
Australian packaging flows, 2017-18
[Paper - other fibre packaging, kilotonnes/year]

D.7 Material flow diagram: Glass

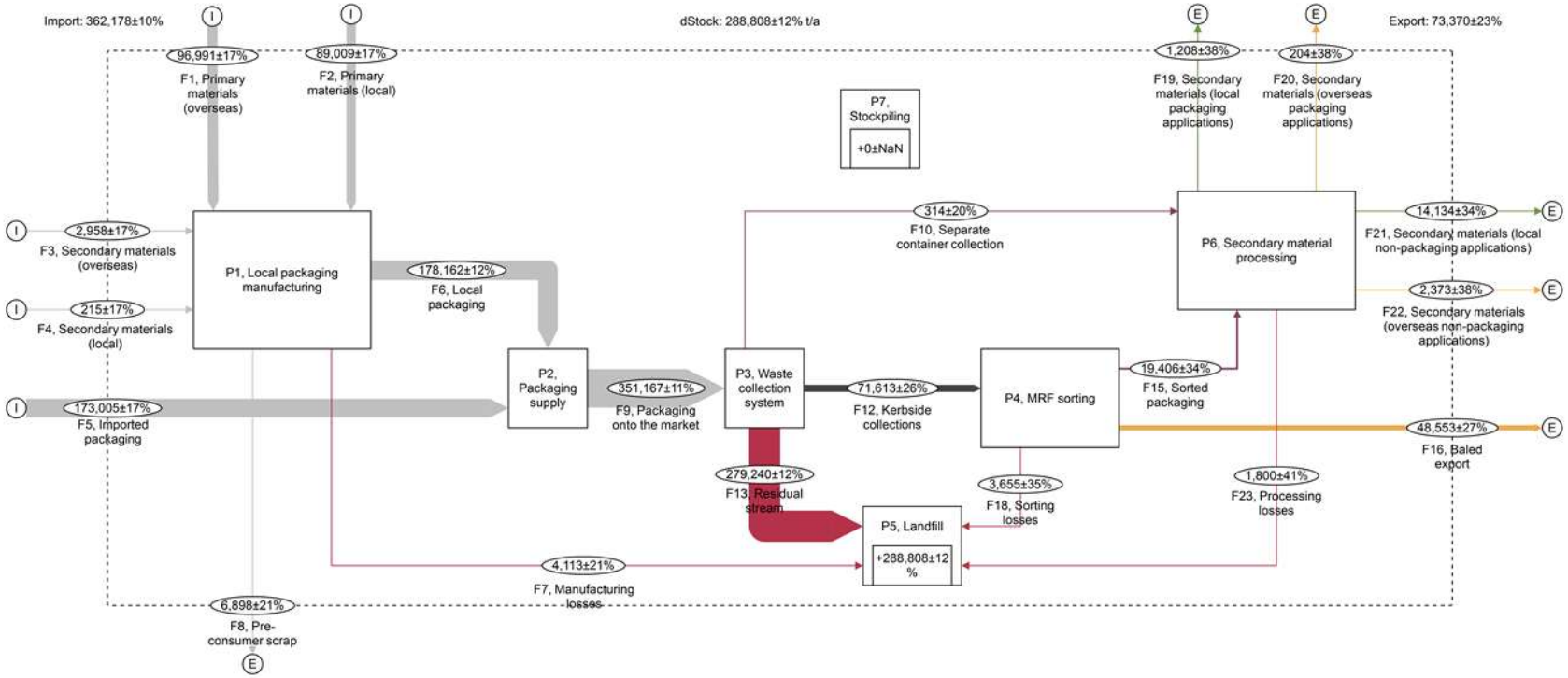


Australian packaging flows, 2017-18
[Glass packaging, kilotonnes/year]

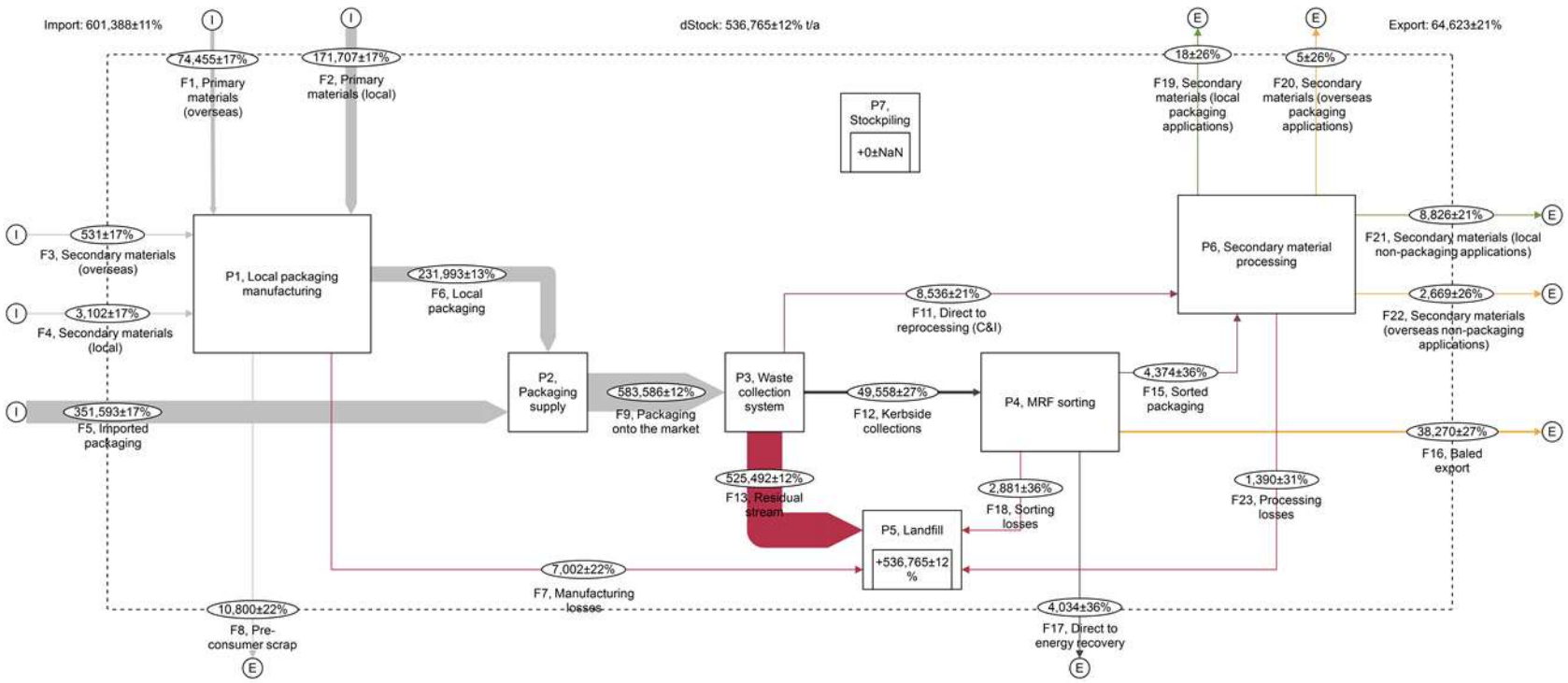
D.8 Material flow diagram: Plastic – PET



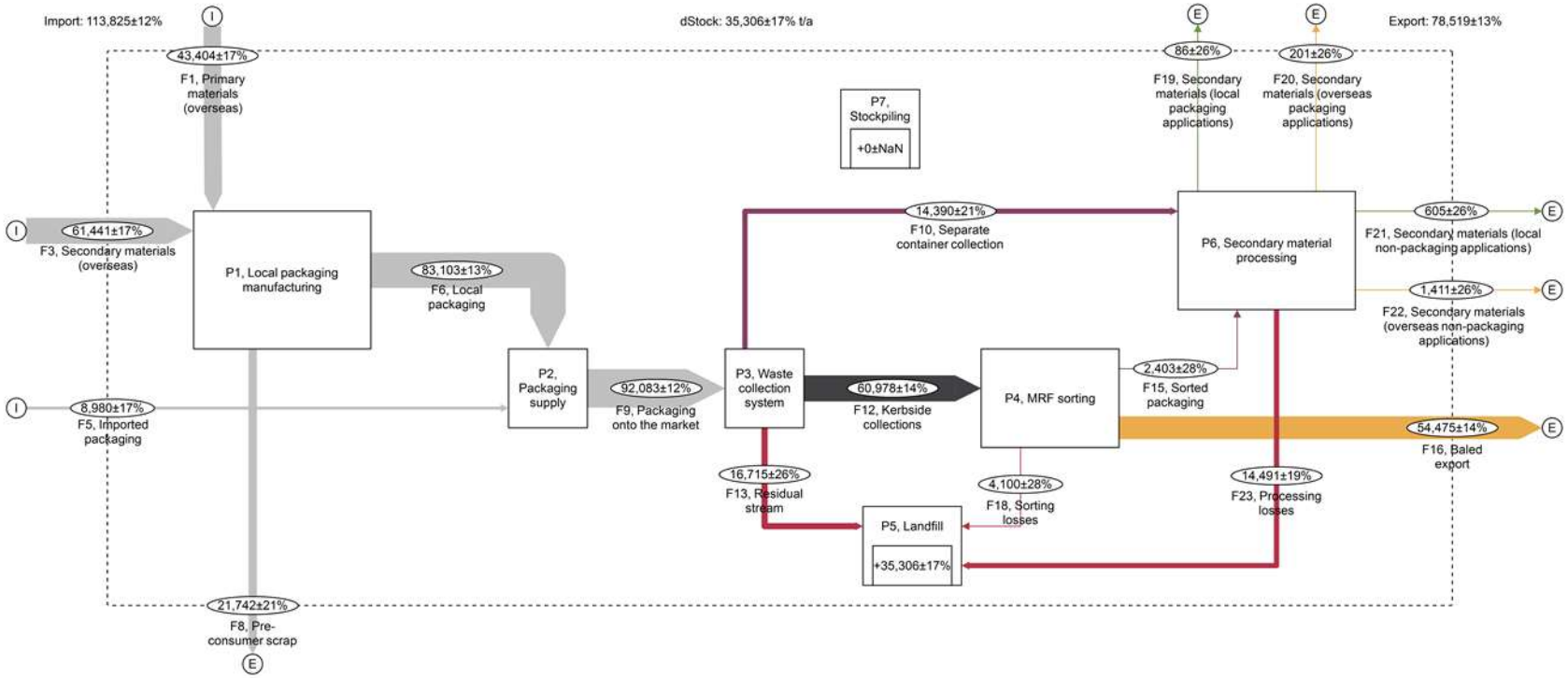
D.9 Material flow diagram: Plastic – HDPE



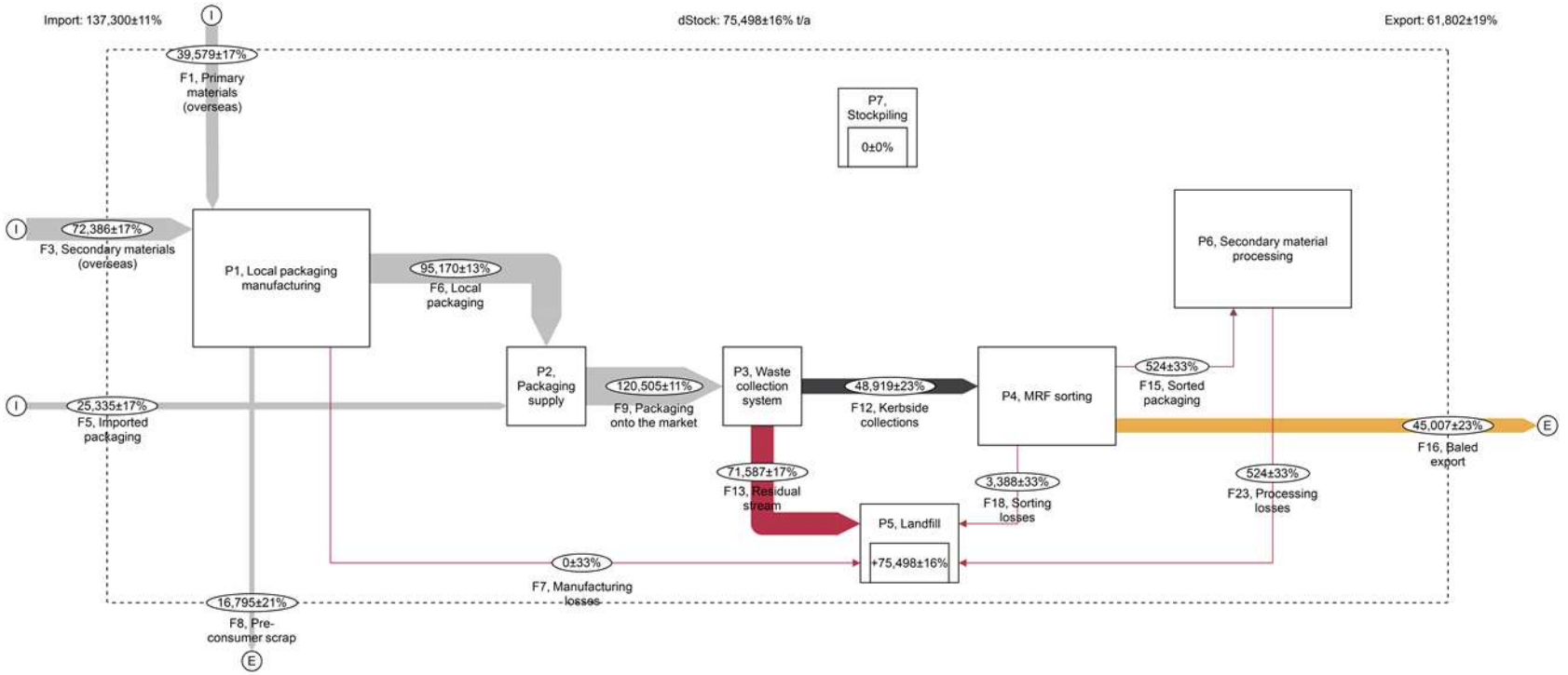
D.10 Material flow diagram: Plastic – other polymers



D.11 Material flow diagram: Metal – aluminium



D.12 Material flow diagram: Metal – steel



D.13 Discrepancies in packaging onto the market values

There are minor differences between POM flows determined in Section 2 of the report and those calculated by the MFA model in this appendix and Section 4.

Table D-3 compares POM flows from both sources. These differences can be attributed to the MFA data reconciliation process performed in the MFA software STAN, which attempts to reconcile inconsistencies in flow estimates and data inputs when uncertainties are considered.

Table D-3 – Discrepancies in POM values between values in Section 2 of this report and the MFA (Section 4)

Material group	POM (Section 2) [kt]	MFA estimates [kt]	Uncertainty	Within MFA uncertainty bounds
Paper packaging	2,901	2,902	±8%	Yes
Glass packaging	1,273	1,272	±8%	Yes
Plastic packaging	1,067	1,058	±9%	Yes
Metal packaging	213	213	±8%	Yes
Total	**5,453**	**5,450**	**±8%**	**Yes**

APPENDIX E – SURVEY FORMS

APCO packaging consumption and recycling study – Manufacturer interview form

(target time period is the 2017–18 financial year)

Interview guidance:

1. The preferred time period for this survey is the 2017–18 financial year.
2. Yellow cells are for responses. Drop-down lists are provided in many of the yellow cells, however these can all be over-written as required. Green cells are headings or labels.
3. Please fill out the information request as completely as possible. All responses will be treated as confidential. Published data will be aggregated to a national/jurisdictional level.
4. Please make a copy of this form if your organisation is involved in the manufacturing of more than six types of packaging.
5. If possible, please complete a separate form for each major facility that your company is operating, particularly those in separate states/territories, as this will support the determination of packaging consumption at the jurisdiction level.

This survey will make a major contribution to the determination of packaging flows in Australia. The survey is detailed in parts, so please do not hesitate to contact us for assistance with completion. Please contact Kyle O'Farrell at kyle.ofarrell@envisageworks.com.au or on (03) 9016 5490.

SECTION 1 – ORGANISATION DETAILS

Organisation name:		**Address line 1:**	
Organisation type:		**Address line 2:**	
Facility name(s):		**Town or suburb:**	
Contact name:		**Postcode:**	
Contact position:		**State/Territory**	
Phone number:		**Response date:**	
Email address:		**Reference year for data reporting:**	2017–18

SECTION 2 – PACKAGING MATERIAL TYPES

Material type designation→	**Material A**	**Material B**	**Material C**	**Material D**	**Material E**	**Material F**
Packaging material types used in manufacturing (see drop-down list in cell)						
Packaging material placed onto the Australian market (tonnes/reference year)						
Level of accuracy of the onto market estimate above (±%)?						
Packaging material placed onto the Australian market that is locally sourced (tonnes/reference year)						
Packaging material placed onto the Australian market that is sourced from overseas (tonnes/reference year)						
Total packaging material (tonnes)	0	0	0	0	0	0
What % of the material received 'in-the-gate' (into local manufacturing) goes to recycling as scrap?						
What % of the material received 'in-the-gate' (into local manufacturing) ends up going to landfill?						

SECTION 3 – PACKAGING FORMATS (please complete for the top four formats for each of the material types reported in Section 2)

Material type (select in Section 2 above)		N/A	N/A	N/A	N/A	N/A	N/A
Format 1	Packaging format						
	If 'Other' selected above please provide a short description						
	Format % of material type onto market						
	If applicable to the material/ format, please provide a degradability rating						
Format 2	Packaging format						
	If 'Other' selected above please provide a short description						
	Format % of material type onto market						
	If applicable to the material/ format, please provide a degradability rating						
Format 3	Packaging format						
	If 'Other' selected above please provide a short description						
	Format % of material type onto market						
	If applicable to the material/ format, please provide a degradability rating						
Format 4	Packaging format						
	If 'Other' selected above please provide a short description						
	Format % of material type onto market						
	If applicable to the material/ format, please provide a degradability rating						
Total packaging formats (100%)		100%	100%	100%	100%	100%	100%

SECTION 4 – PACKAGING MATERIAL RECYCLED CONTENT

Material type (select in Section 2 above)	N/A	N/A	N/A	N/A	N/A	N/A
Packaging material input sourced from post-consumer sources , e.g. used packaging collections (%)						
Packaging material input sourced from pre-consumer sources, e.g. packaging manufacturing scrap (%)						
Material input sourced from virgin sources (%)						
Total material input (100%)	100%	100%	100%	100%	100%	100%

What is your estimate of the easily achievable post-consumer recycled content (without major redesign or manufacturing equipment upgrades) for the most significant material type/format application?						
What is your estimate of the maximum achievable post-consumer recycled content (with major redesign and equipment upgrades) for the most significant material type/format application?						
Can you please provide a short description of the major redesign and equipment upgrades that would be required?						
What sort of external assistance or market changes would assist your organisation to increase the amount of recycled content?						
What are the top 3 or so problematic contaminants received in your facility?						

SECTION 5 – DESTINATIONS OF PACKAGING (estimates of jurisdiction and sector of packaging use)

Material type (select in Section 2 above)	N/A	N/A	N/A	N/A	N/A	N/A
ACT use (%)						
NSW use (%)						
NT use (%)						
QLD use (%)						
SA use (%)						
TAS use (%)						
VIC use (%)						
WA use (%)						
Overseas use (%)						
Total packaging onto market (100%)	100%	100%	100%	100%	100%	100%
Packaging into *consumer (at home or away-from-home) sector* related applications (%)						
Packaging into *commercial (business-to-business) sector* related applications (%)						
Packaging into *other or unknown* sectors (%)						
Total packaging consumption sectors (100%)	100%	100%	100%	100%	100%	100%

SECTION 6 – MARKET GROWTH AND CAPACITY CHANGES

Material type (select in Section 2 above)	N/A	N/A	N/A	N/A	N/A	N/A
Can you provide an estimate of the anticipated growth in consumption for Format 1 in Section 3, over the next few years (%/yr)?						
Can you provide an estimate of the anticipated growth in consumption for Format 2 in Section 3, over the next few years (%/yr)?						
Can you provide an estimate of the anticipated growth in consumption for Format 3 in Section 3, over the next few years (%/yr)?						
Can you provide an estimate of the anticipated growth in consumption for Format 4 in Section 3, over the next few years (%/yr)?						
Do you have any funded and approved plans to increase your use of post-consumer recycled content in packaging over the next few years (yes/no)?						
If yes to the previous question, by how much do you anticipate post-consumer recycled content in packaging increasing (tonnes/yr)?						
Can you please provide a short description on the nature and timing of these planned changes?						

SECTION 7 – FINAL QUESTIONS		
Do you have any other comments you would like to make in relation to the purpose of this survey?		
Would you like to receive a copy of the APCO reports that are published as an outcome of this study?		

Many thanks for completing this survey. It is greatly appreciated and will be of significant assistance in supporting the assessment of packaging consumption, recycling and infrastructure capacity in Australia.

APCO packaging consumption and recycling study – Reprocessor interview form

(target time period is the 2017–18 financial year)

Interview guidance:

1. The preferred time period for this survey is the 2017–18 financial year.
2. Yellow cells are for responses. Drop-down lists are provided in many of the yellow cells, however these can all be over-written as required. Green cells are headings or labels.
3. Please fill out the information request as completely as possible. All responses will be treated as confidential. Published data will be aggregated to a national/jurisdictional level.
4. Please make a copy of this form if your organisation is involved in the reprocessing of more than six material types.
5. If possible, please complete a separate form for each major facility that your company is operating, particularly those that are in separate states/territories, as this will support the determination of packaging recycling rates at this level.

This survey will make a major contribution to the determination of packaging flows in Australia. The survey is detailed in parts, so please do not hesitate to contact us for assistance with completion. Please contact Kyle O'Farrell at kyle.ofarrell@envisageworks.com.au or on (03) 9016 5490.

SECTION 1 – ORGANISATION DETAILS

Organisation name:		**Address line 1:**	
Organisation type:		**Address line 2:**	
Facility name(s):		**Town or suburb:**	
Contact name:		**Postcode:**	
Contact position:		**State/Territory**	
Phone number:		**Response date:**	
Email address:		**Reference year for data reporting:**	2017–18

SECTION 2 – MATERIAL TYPES REPROCESSED

Material designation→	**Material A**	**Material B**	**Material C**	**Material D**	**Material E**	**Material F**
Material types received (see drop-down list in cell)						
Total reprocessed (tonnes/reference year)						
Level of accuracy of 'total reprocessed' estimate (±%)?						
Is quantity reported as reprocessed 'in the gate' (unprocessed) or 'out the gate' (processed product)?						
What is the level of reprocessing undertaken by your facility? (use drop-down list in cell or overwrite as required)						
What % of the 'in the gate' quantity received ends up going to landfill?						
What % of the landfill stream is made up of materials that your organisation recovers?						
Material sourced from *packaging* applications (%)						
Material sourced from *non-packaging* applications (%)						
Total material received (100%)	100%	100%	100%	100%	100%	100%

Packaging material sourced from *post-consumer sources*, e.g. used packaging collections (%)						
Packaging material sourced from *pre-consumer sources*, e.g. packaging manufacturing scrap (%)						
Total material received (100%)	100%	100%	100%	100%	100%	100%

Material sourced from *municipal* collections (%)						
Material sourced from *commercial & industrial* (C&I) collections (%)						
Material sourced from *construction & demolition* (C&D) collections (%)						
Material sourced from *container deposit scheme (CDS) related collections (%)*						
Material sourced from *other collections (%)*						
Total material received (100%)	100%	100%	100%	100%	100%	100%
Please provide a short description of the 'other collections' type (if used).						

Of the material type is plastic packaging, the percentage that is a *rigid format* (%)						
Of the material type is plastic packaging, the percentage that is a *flexible (soft) format* (%)						
Total plastic packaging received (100%)	100%	100%	100%	100%	100%	100%

ACT sourced material (%)						
NSW sourced material (%)						
NT sourced material (%)						
QLD sourced material (%)						
SA sourced material (%)						
TAS sourced material (%)						
VIC sourced material (%)						
WA sourced material (%)						
Total material received (100%)	100%	100%	100%	100%	100%	100%

SECTION 3 – DESTINATIONS OF PRODUCT (recovered materials)

Material type (select in Section 2 above)	N/A	N/A	N/A	N/A	N/A	N/A
Product into *packaging* applications (%)						
Product into *non-packaging* applications (%)						
Total products (100%)	100%	100%	100%	100%	100%	100%
Can you please provide a short description of the key end-markets for the products from each reprocessed material?						
Product into *local (Australian made) products* (%)						
Product sold to export (%)						
Total products (100%)	100%	100%	100%	100%	100%	100%

SECTION 4 – REPROCESSING CAPACITY

Material type (select in Section 2 above)	N/A	N/A	N/A	N/A	N/A	N/A
Are there any constraints on how much additional packaging material you could process (yes/no)?						
If 'yes' to the previous question, what are the main constraints on your capacity to process more packaging (e.g. equipment, space, approvals)?						
How much additional packaging material could you process (tonnes/yr)?						
What is the proportion of your site's installed capacity that is currently utilised (%)?						
Do you have any funded and approved plans to change your reprocessing capacity over the next six years (yes/no)?						
If yes to the previous question, by how much will capacity increase (tonnes/yr)?						
Can you please provide a short description on the nature of these planned changes?						
Do you provide for material drop-off at your facility? If so, what types and how much is received through drop-off?						
What are the top 3 or so problematic contaminants received in your facility?						

SECTION 5 – STOCKPILES

Material type (select in Section 2 above)	N/A	N/A	N/A	N/A	N/A	N/A
What was the approximate stockpile of this material type in July 2017 (tonnes)?						
What is the approximate stockpile of this material type in June 2018 (tonnes)?						
What is the approximate stockpile of this material type currently (tonnes)?						
Please provide a short description of the factors that influence the size of each material stockpile held at your site? (e.g. seasonality, supplier requirements, major events, etc.)						

SECTION 6 – BUSINESS OUTLOOK

How has 2018–19 shaped up compared with 2017–18?	
What are your priorities for capital investment?	
What sort of help would your organisation need to be able to generate more and/or higher value product?	

SECTION 7 – FINAL QUESTIONS

Do you have any other comments you would like to make in relation to the purpose of this survey?		
Would you like to receive a copy of the APCO reports that are published as an outcome of this study?		

Many thanks for completing this survey. It is greatly appreciated and will be of significant assistance in supporting the assessment of packaging consumption, recycling and infrastructure capacity in Australia.

APPENDIX F – JURISDICTIONAL DATA

Table F-1 – ACT packaging consumption and recycling data in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	49 000	31 000	63%
Glass	21 000	10 000	45%
Plastic	16 000	2 000	15%
Metal	4 000	2 000	48%
Total	**90 000**	**45 000**	**50%**

Table F-2 – NSW packaging consumption and recycling data in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	927 000	582 000	63%
Glass	407 000	178 000	44%
Plastic	349 000	48 000	14%
Metal	68 000	33 000	49%
Total	**1 751 000**	**841 000**	**48%**

Table F-3 – NT packaging consumption and recycling data in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	29 000	13 000	44%
Glass	13 000	7 000	52%
Plastic	9 000	1 000	9%
Metal	2 000	1 000	54%
Total	**53 000**	**21 000**	**40%**

Table F-4 – QLD packaging consumption and recycling data in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	582 000	346 000	59%
Glass	255 000	81 000	32%
Plastic	198 000	14 000	7%
Metal	43 000	20 000	47%
Total	**1 078 000**	**461 000**	**43%**

Table F-5 – SA packaging consumption and recycling data in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	202 000	147 000	73%
Glass	88 000	55 000	63%
Plastic	66 000	27 000	41%
Metal	15 000	9 000	58%
Total	**371 000**	**238 000**	**64%**

Table F-6 – TAS packaging consumption and recycling data in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	61 000	42 000	68%
Glass	27 000	0	1%
Plastic	21 000	1 000	3%
Metal	4 000	2 000	52%
Total	**113 000**	**45 000**	**39%**

Table F-7 – VIC packaging consumption and recycling data in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	750 000	521 000	69%
Glass	329 000	198 000	60%
Plastic	302 000	73 000	24%
Metal	55 000	27 000	49%
Total	**1 436 000**	**818 000**	**57%**

Table F-8 – WA packaging consumption and recycling data in 2017–18, by material group

Material group	POM	Recovery	Recovery rate
	(tonnes)	(tonnes)	(%)
Paper and paperboard	301 000	137 000	45%
Glass	132 000	53 000	40%
Plastic	105 000	8 000	7%
Metal	22 000	8 000	35%
Total	**561 000**	**205 000**	**37%**

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