National Recycling and Recovery Survey (NRRS) 2015–16 for plastics packaging (IND 299/16)

Project report

Final report

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Author:	Kyle O'Farrell
Reviewer:	Peter Allan
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Envisage Works (ABN 12 584 231 841)
PO Box 7050, Reservoir EastVIC3073
admin@envisageworks.com.au

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EXECUTIVE SUMMARY

A total of 263 000 tonnes of plastics packaging was recycled across Australia during 2015–16, with total plastics packaging consumption during the same period estimated as 844 300 tonnes. This gives a 2015–16 plastics packaging recycling rate of 31.1%. which is up from the 29.3% observed in 2014–15.

Plastic packaging recovery in 2015–16 saw a relatively minor decrease of 5 500 tonnes on the 268 500 tonnes of plastics packaging recycling recorded for the 2014–15. This represents a decrease of 2% in overall recovery from 2014–15. The decrease is mostly driven by a drop in reported locally reprocessed plastic packaging, in tandem with steady exports of plastic packaging recyclate.

In part, this drop in recovery was probably driven by low oil and gas prices which resulted in cheaper virgin resins, the main competitor to recycled plastics. This competitive pressure was also compounded by a general oversupply of virgin polymer manufacturing capacity internationally.

A total of 48 100 tonnes of flexible plastics were recycled in 2015–16 compared to 49 700 tonnes in 2014–15. This represents a 3% decrease in overall recovery year on year, but is a similar result to 2013–14.

1 BACKGROUND

In 2016 the Australian Packaging Covenant Organisation Pty Ltd (APCO) has again commissioned the partnership of Envisage Works and Sustainable Resource Use (SRU) to undertake the National Recycling and Recovery Survey (NRRS) 2015–16 for plastics packaging, covering the July 2015 to June 2016 financial year.

The NRRS is undertaken as a significant component of the Australian National Plastics Recycling Survey (NPRS), which is the well-regarded and long-running annual reporting of plastics consumption and recycling in Australia, across both packaging and non-packaging applications. The study is one of the most comprehensive annual surveys of any recycled material type in Australia, and plays an important role in the Australian plastics industry's reporting in a national and global context.

Extensive efforts have been made to progressively improve the survey over time to ensure that the year-on-year rigour and detail of the study is of a high level. In line with these ongoing efforts in 2015 the project methodology that had been in place for over ten years was updated to include a much broader range of imported finished and semi-finished plastic goods, including estimates of plastic packaging on imported goods.

To ensure that the ability for year-on-year comparison of data is maintained, some of the key study findings determined using the historical consumption methodology will continue to be published for a transitional 2–3 year period. This will provide continuity of the ability to compare recycling rates over a number of years.

The study aims to give an accurate picture of the Australian plastics packaging industry, and provided in this report, are the survey results for packaging plastics consumption and recovery for the 2015–16 financial year across:

- local and imported sources of plastic packaging
- plastics packaging recycling by polymer type
- quantities of plastics packaging reprocessed locally and exported overseas for reprocessing
- recovery rates and composition of kerbside packaging plastics by material recovery facilities (MRFs) nationally
- recycling of flexible packaging plastics by polymer type
- overview of key trends in packaging plastics during 2015–16, along with a snapshot of the current state of the market for bioplastics in packaging applications.

Plastics consumption and recycling data was primarily obtained from three sources: Australian resin producers and importers, the Department of Foreign Affairs and Trade (DFAT), and Australian plastics reprocessors. Over one hundred site operators from all jurisdictions (excluding South Australia) were contacted. Of these companies 70 were identified as reprocessing plastics in 2015–16, with surveys completed for 60 companies on recycling activity during 2015–16, a response rate of 86%, and of these 49 were identified as reprocessing some form of plastics packaging.

In South Australia, Green Industries SA undertakes its own annual survey of state-wide plastics reprocessors. SA data for 2015–16 has been provided by Green Industries SA and is incorporated into this report.

Six local resin producers and major resin importers, and an industry association, were contacted to provide production and import information to the survey, including intelligence on the proportion of resin used in packaging applications.

For the MRF survey, nine major MRF operators in all jurisdictions were contacted, with seven responding, providing extensive survey coverage of operators in ACT, NSW, SA, Victoria and WA.

As in previous years, packaging materials have been defined as:

> *Plastic material used for the containment, protection, marketing and/or handling of a product. This includes primary, secondary and tertiary (freight) packaging going into retail packaging applications.*

In this survey, reprocessors were again surveyed on the quantity of flexible packaging materials reprocessed. For the purpose of this study flexible plastics were defined as:

> *Plastic packaging materials that do not maintain a three dimensional shape during sorting and transport.*

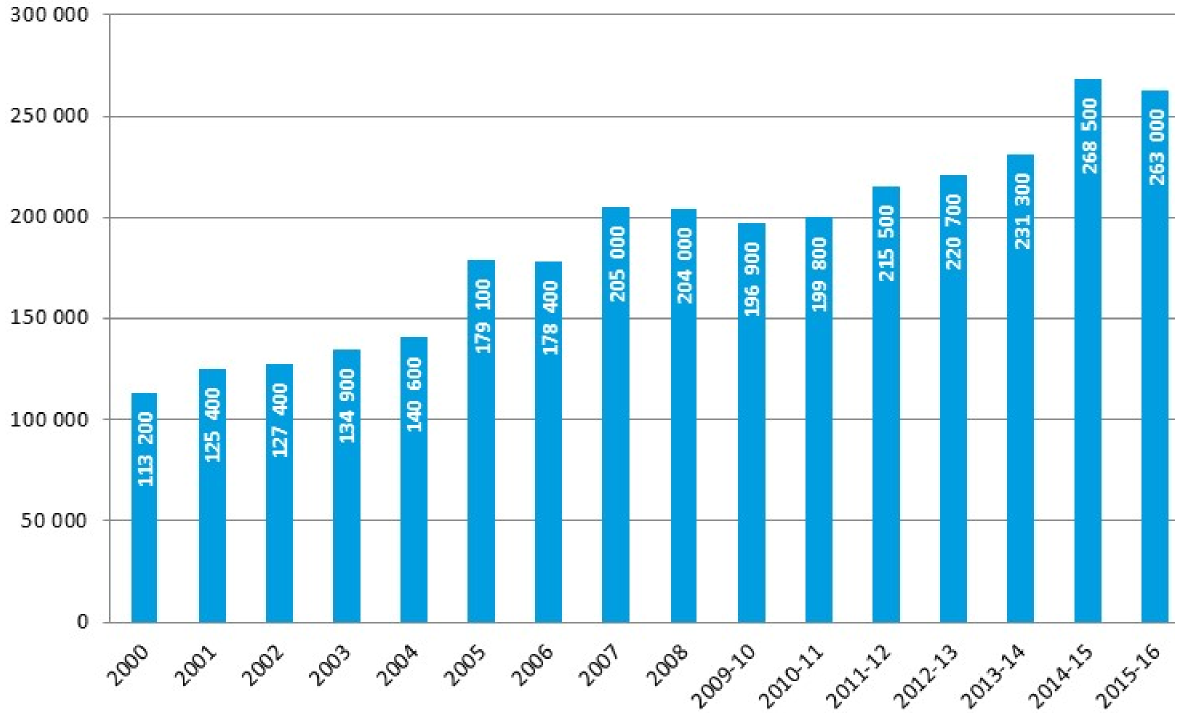
A more extensive report on the Australian Plastics Recycling Survey has also be prepared. This report provides data on durable plastics consumption and recycling, as well as plastics packaging, and details the full survey methodology and findings.

2 PLASTICS PACKAGING RECYCLING

2.1 Overall plastic packaging recovery

A total of 263 000 tonnes of plastics packaging was recycled in 2015–16, a minor decrease of 2% from 2014–15. This decrease was mostly driven by steady export of plastic packaging recyclate, in tandem with a minor decrease in local reprocessing.

Figure 1 – Total plastics packaging recycling from 2000 to 2015–16



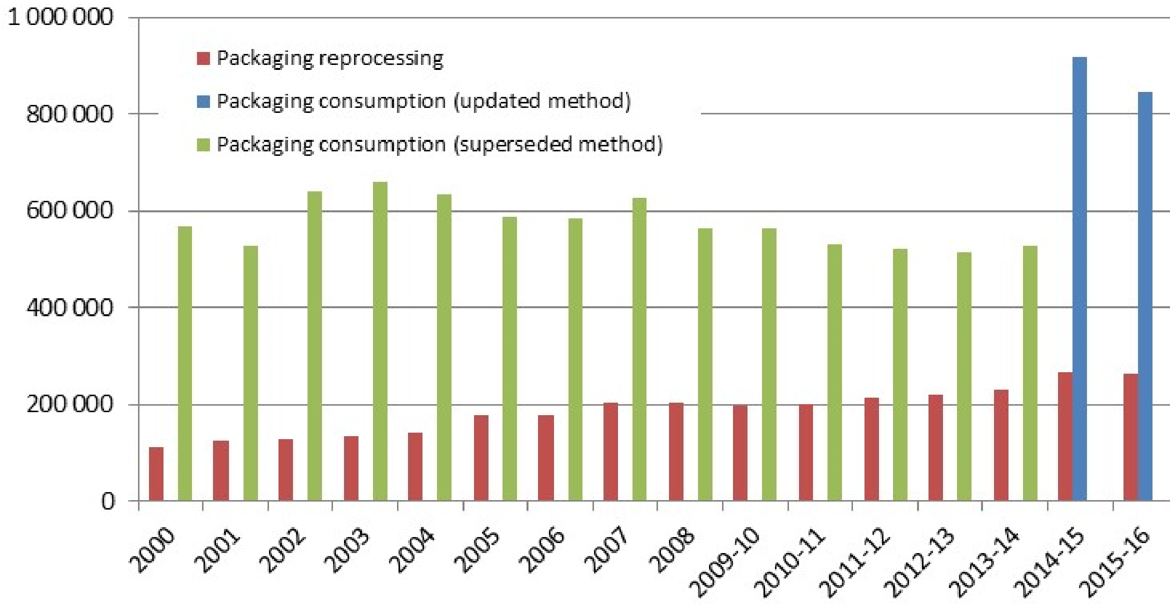
As can be seen from Figure 1 above, the general year-on-year trend in total plastics packaging recovery for recycling is upwards with a doubling of plastics recycling over the past fifteen years.

Using the historical method of calculating the recycling rate (which excludes significant imports of plastic packaging on finished goods), the packaging recycling rate increased from 46.9% in 2014–15 to 54.7% in 2015–16. This significant jump in the historical recycling rate is primarily due to closures of two major local resin manufacturers across 2014–15 and 2015–16, producing an apparent drop in plastic packaging production and consumption, if the resultant increased imports are not considered.

As discussed, the updated method of calculating total plastics packaging consumption has also been undertaken. Under the historical method, total plastics packaging consumption during 2015–16 was estimated at 474 200 tonnes. Using the updated method which includes imported finished and semi-finished plastic goods, total plastics packaging consumption during 2015–16 was estimated at 844 300 tonnes, which allows the calculation of the updated plastics recycling rate of 31.1%.

This is outlined in Figure 2 to show year on year trends.

Figure 2 – Plastics packaging consumption and recycling 2000 to 2015–16



2.2 Recovery by polymer type

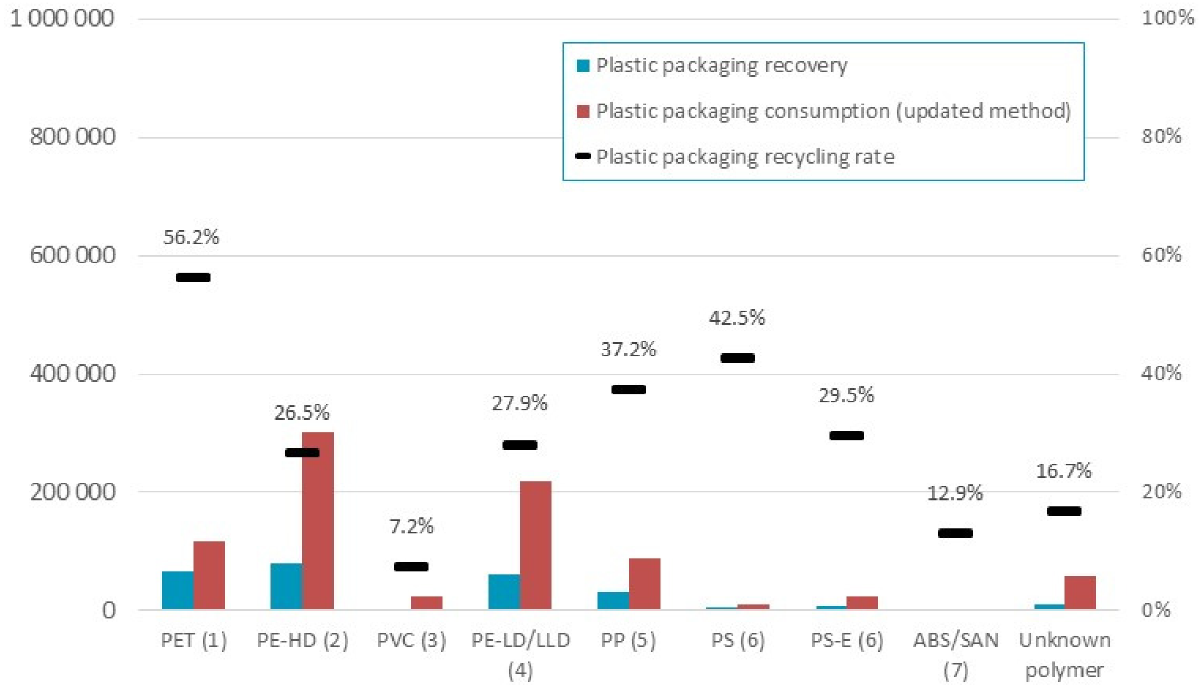
Table 1 below presents total packaging consumption, reprocessing and recycling rates for 2015–16 using the updated method.

Table 1 – Packaging consumption and recycling by polymer type in 2015–16

Polymer	Packaging consumption (updated method)	Domestic reprocessing of packaging	Export of packaging for reprocessing	Total reprocessing of packaging	Packaging recycling rate
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(%)
PET (1)	116 800	26 200	39 400	65 600	56.2%
PE-HD (2)	301 400	27 400	52 500	79 900	26.5%
PVC (3)	23 600	100	1 600	1 700	7.2%
PE-LD/LLD (4)	218 100	31 900	29 000	60 900	27.9%
PP (5)	88 500	15 500	17 400	32 900	37.2%
PS (6)	11 700	900	4 100	5 000	42.7%
PS-E (6)	23 500	1 800	5 100	6 900	29.4%
ABS/SAN (7)	2 900	400	0	400	13.8%
Unknown polymer	57 900	9 700	0	9 700	16.8%
Totals	**844 400**	**113 900**	**149 100**	**263 000**	**31.1%**

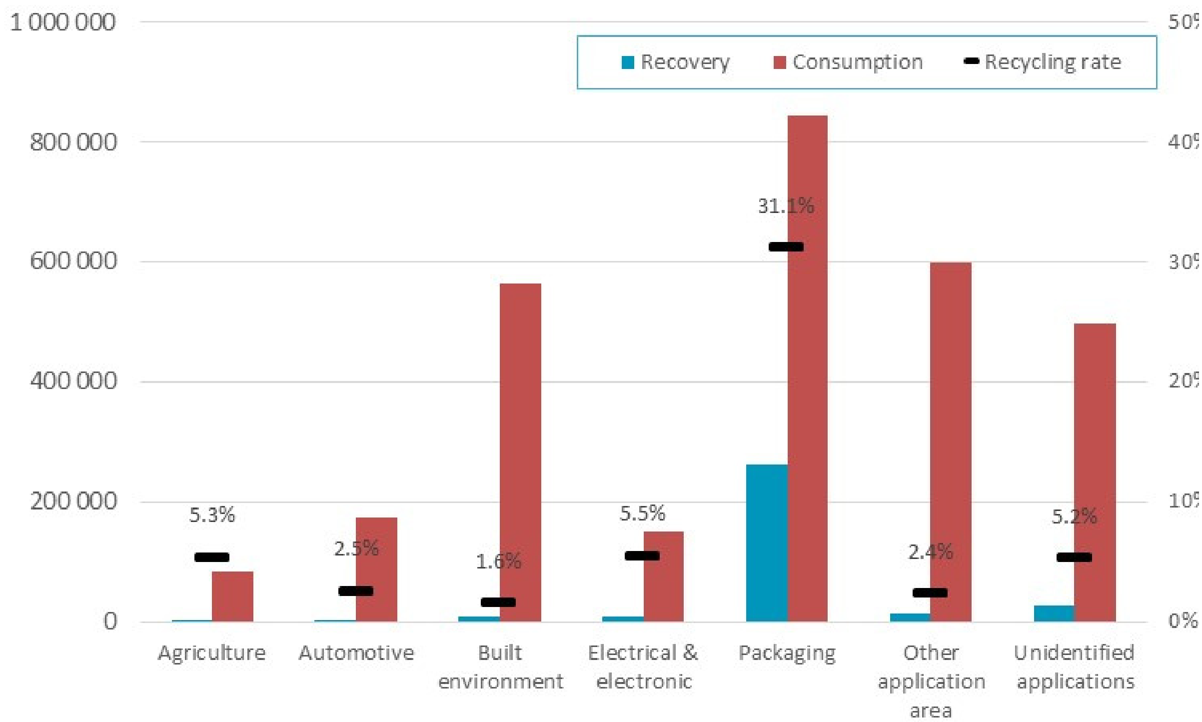
Notes: *1. In the table above minor discrepancies may occur between the stated totals and the sums of the component items. Totals are calculated using component item values prior to rounding, and therefore a minor discrepancy may occur from those that could be calculated from the rounded figures given above.*

Figure 3 – Packaging consumption and recycling by polymer type in 2015–16 (tonnes and % recycling rate)



Presented in Figure 4 is a summary of plastics consumption and recycling across all application areas of plastics, including packaging. This illustrates that the quantity of plastic packaging recovery and the recycling rate of 31.1% are relatively good compared to all other application areas for plastics.

Figure 4 – Australian plastics consumption and recovery by application area in 2015–16 (tonnes and % recycling rate)



At 5.5% the recycling rate for electrical and electronic equipment is the next highest after the packaging recycling rate of 31.1%, which is driven almost entirely by plastics recovery through the National Television and Computer Recycling Scheme (NTCRS).

2.3 Destination of plastic packaging recycling

Figure 5 and Table 2 present the destination of plastic packaging by source state.

Figure 5 – Destination of plastic packaging recyclate for reprocessing by jurisdiction in 2015–16 (tonnes)

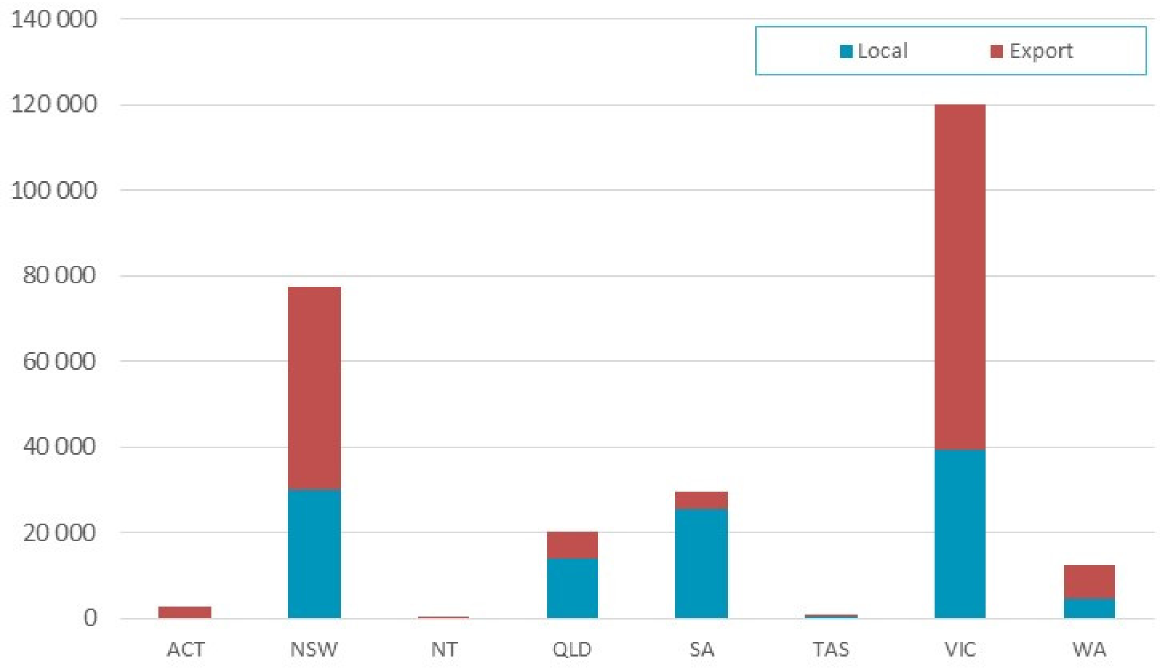


Table 2 – Destination of plastic packaging recyclate for reprocessing by jurisdiction in 2015–16

State	Local reprocessing	Export for reprocessing	Total packaging	Percentage of national total
	(tonnes)	(tonnes)	(tonnes)	(%)
ACT	100	2 500	2 600	(%)
NSW	30 100	47 400	77 500	1.0%
NT	100	0	100	29.5%
QLD	14 000	6 300	20 300	0.0%
SA	25 500	4 000	29 500	7.7%
TAS	400	200	600	11.2%
VIC	39 400	80 700	120 100	0.2%
WA	4 400	7 800	12 200	45.7%
Totals	**114 000**	**148 900**	**262 900**	**100.0%**

Note: 1. In the table above minor discrepancies may occur between the stated totals and the sums of the component items. Totals are calculated using component item values prior to rounding, and therefore a minor discrepancy may occur from those that could be calculated from the rounded figures given above.

Victoria and NSW's high level of packaging recycling is due to the larger number of established plastics manufacturers located in those states, with their corresponding high level recovery of pre-consumer recyclate and also due to larger number of export channels. Recovery of packaging has increased across every state in 2015–16, except for Tasmania, which is probably due not to any actual drop, but recyclate recorded as exported from Victoria actually originating from Tasmania.

The majority of exported Australian used packaging plastics are packaging materials from post-consumer domestic and post-consumer industrial sources. It is estimated that a total of 148 900 tonnes of plastic packaging recyclate was exported in 2015–16, mainly post-consumer domestic packaging scrap. This is down by around 5 000 tonnes from 2014–15.

3 MATERIAL RECOVERY FACILITY PLASTIC PACKAGING RECOVERY

Across October–November 2016 a survey was distributed to and completed by a number of MRF operators nationally. The responding MRFs serviced an estimated 1.44 million households across ACT, NSW, SA, Victoria and Western Australia during the 2015–16 year. The objective of the survey is to determine estimates of household plastics packaging recovery, and polymer compositions, as recovered by MRFs nationally.

Provided here is a summary of the key findings of the MRF survey. To protect any commercially sensitive data that may have been provided by survey respondents all survey data has been aggregated to the national level and no company specific data is published this report.

Table 3 below presents the aggregated quantity of rigid plastic packaging recovered by the surveyed MRFs. The primary product streams are bales of PET, HDPE and mixed polymers. Estimates of the polymer composition of the mixed polymer bales have also been determined (see Table 4), to allow the estimation of recovery by polymer type.

Table 3 – Household rigid plastic packaging recovery by the surveyed MRFs

Polymer	Recovery by product stream[1]		Recovery by polymer[2]	
	Total (tonnes)	Recovery per household (kg/hh.yr)	Total (tonnes)	Recovery per household (kg/hh.yr)
PET (1)	6,500	4.5	10,600	7.4
PE-HD (2)	8,200	5.7	12,400	8.6
PVC (3)	>100	0.0	200	0.1
PE-LD/LLD (4)	800	0.6	800	0.6
PP (5)	900	0.6	2,800	1.9
PS (6)	0	0.0	200	0.2
PS-E (6)	0	0.0	300	0.2
Mixed polymers	11,000	7.7	0	0.0
ABS/SAN (7)	0	0.0	0	0.0
Other (7)	0	0.0	0	0.0
Total	**27,400**	**19.0**	**27,300**	**19.0**

1. *Product streams are baled products leaving MRFs.*
2. *Recovery by polymer is calculated by estimating the polymer composition of 'Mixed polymers' and allocating this to the respective polymer type.*
3. *In the table above minor discrepancies may occur between the stated totals and the sums of the component items. Totals are calculated using component item values prior to rounding, and therefore a minor discrepancy may occur from those that could be calculated from the rounded figures given above.*

Across the surveyed MRFS the quantity of plastic packaging collected ranged from 10–26 kg/hh.yr. The reason for this high level of variability in kerbside recovery was not explored further with the MRF operators.

In Table 4 are estimations of the average polymer split of mixed polymer bales of rigid packaging. The compositions only apply to bales where PET and HDPE have previously been positively sorted from the rigid plastic packaging stream. The data is based on the MRF survey responses and also a number of export broker interviews.

Table 4 – Mixed bales average composition

Polymer	% composition by weight
PET (1)	38.0%
PE-HD (2)	38.6%
PVC (3)	1.4%
PE-LD/LLD (4)	0.0%
PP (5)	17.0%
PS (6)	2.0%
PS-E (6)	3.0%
Mixed polymers	0.0%
ABS/SAN (7)	0.0%
Other (7)	0.0%
Total	**100.0%**

A summary of the reported destinations of the main polymer product streams is provided in Table 5, with around 80% of all packaging sold to export markets.

Table 5 – Polymer destinations

Product stream	Local or internal use	Sale to export	Total
	(tonnes)	(tonnes)	(tonnes)
PET (1)	400	1,600	2,000
PE-HD (2)	600	1,600	2,200
PVC (3)	0	0	0
PE-LD/LLD (4)	200	0	200
PP (5)	100	0	100
PS (6)	0	0	0
PS-E (6)	0	0	0
Mixed polymers	600	4,200	4,800
ABS/SAN (7)	0	0	0
Other (7)	0	0	0
Total	**1,900**	**7,400**	**9,300**

Note: 1. In the table above minor discrepancies may occur between the stated totals and the sums of the component items. Totals are calculated using component item values prior to rounding, and therefore a minor discrepancy may occur from those that could be calculated from the rounded figures given above.

4 RECYCLING OF FLEXIBLE PACKAGING PLASTICS

For the purposes of this study, flexible packaging plastics are defined as plastic packaging formats that do not maintain a three-dimensional shape during sorting and transport. Flexible plastic packaging recovery is dominated by the recovery of low and linear low density polyethylene (PE-L/LLD) film from commercial and industrial sources, however growing quantities of flexible packaging are being recovered from households. It is expected that strong growth in flexible plastic packaging will be seen nationally over the next 5 years, driven by increasing recovery through kerbside collections from households.

A total of 48 100 tonnes of flexible plastics were recycled in 2015–16 compared to 49 700 tonnes in 2014–15. This represents a modest decrease of 3% year on year, but is similar to the 2013–14 result.

Table 6 – Flexible plastic packaging recycling by polymer type in 2015–16

Polymer	Flexible packaging to local reprocessors	Flexible packaging to overseas reprocessors	Flexible packaging recovery (tonnes)
PET (1)	400	0	400
PE-HD (2)	400	0	400
PVC (3)	0	0	0
PE-LD/LLD (4)	17 000	29 000	46 000
PP (5)	1 200	0	1 200
PS (6)	0	0	0
PS-E (6)	0	0	0
Other (7) & unknown	0	0	0
Totals	**19 100**	**29 000**	**48 100**

Note: 1. In the table above minor discrepancies may occur between the stated totals and the sums of the component items. Totals are calculated using component item values prior to rounding, and therefore a minor discrepancy may occur from those that could be calculated from the rounded figures given above.

5 KEY TRENDS IN PACKAGING PLASTICS

There are a number of ongoing developments and trends in international markets, plastic packaging technology, materials, design, and processing infrastructure that impact upon recycling trends. These developments/trends apply to some packaging types more than others, and are summarised below.

5.1 International markets

- Very slim margins available on recycled plastics due to low oil and gas prices making virgin plastics cheaper, along with a general oversupply of virgin polymer manufacturing capacity internationally.
- A number of bankruptcies and shutdowns of large-scale and capital intensive packaging recyclers has been seen internationally over the last 12–24 months, with Europe particularly hard hit. A key driver of these outcomes has been the low oil and gas prices, driving virgin resin prices down.

5.2 Technical development

- Light weighting – new production techniques are enabling plastics to be produced with the same performance properties but thinner material, meaning lighter packaging weight and less packaging material per unit weight of product. These gains have plateaued somewhat over the last few years, but are still ongoing.
- Multi-layer plastics (co-extruded) – laminated plastics, primarily films, are being increasingly produced where different types of plastics with different properties (UV protection, O_2/H_2O/CO_2 barrier) are extruded together to perform more complex functions. These are being used to meet the demand for improved food preservation and product protection. Co-extruded films are less able to be mechanically recycled, and are less likely to be labelled as recyclable, and may therefore be exerting some downward pressure on recycling rates.
- Similarly to multi-layer plastics, the increasing use of biodegradable plastic polymer based packaging in rigid applications may be exerting a small amount of downward pressure on recycling rates. Total usage of these polymer types remains a very small proportion of plastics packaging consumption in Australia. A snapshot of current market situation with respect to bioplastics use in packaging is provided in Section 5.5.

5.3 Packaging design developments

- Rigids to flexibles – products such as laundry detergents, and shelf stable foods such as soups and sauces, had seen a shift some years back from packaging in cardboard, glass or tin-plated steel, to rigid plastics. These product packages are now further evolving to use flexible pouches and satchels. This shift in format can yield a weight reduction of well over 50% for some packaging types, however, generally these types of flexible packaging are not currently recoverable through kerbside recycling systems.
- Single serve – products are increasingly sold in single serve containers. This is increasing the quantity and complexity of plastic items, reducing their average size, and potentially negatively impacting levels of recycling.

5.4 Collection and infrastructure

- Export quality continues to be identified as a key challenge in 2015–16 for recovered packaging plastics, particularly for mixed plastics.
- Closed-loop recycling facilities are now coming on-line here in Australia, driving increased local recovery of some packaging formats such as clear PET and HDPE bottles.
- Changes in processing –International innovations in processing equipment (e.g. polymer sorters) mean there is greater capacity to sort and separate different plastic packaging types by polymer type and colour. This type of equipment is now well-established at significant scale of use in Australia.

These trends represent ongoing challenges and opportunities to maintaining and increasing plastics packaging recycling rates.

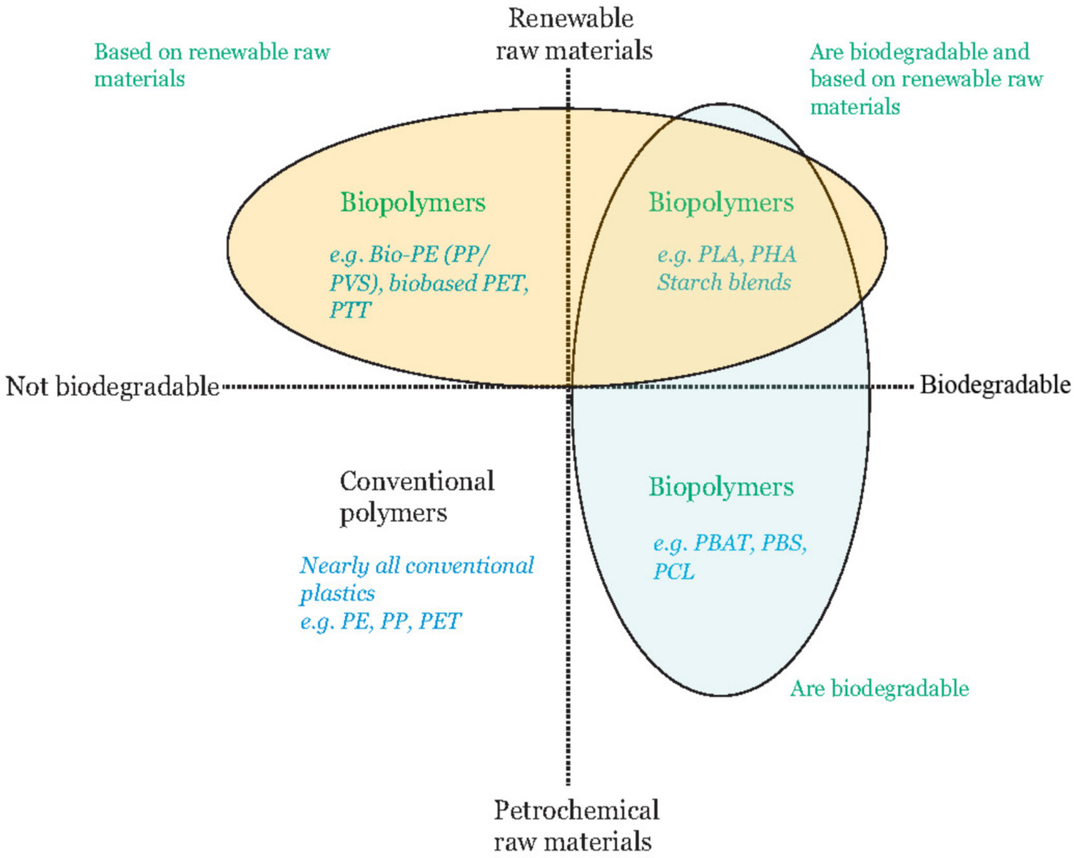
5.5 Bioplastics snapshot

European Bioplastics (EuBP, 2012a) defines bioplastics as being biobased, biodegradable or both. Bioplastics fall into three broad groupings, which are:

- biobased (but not biodegradable)
- biodegradable (but not biobased)
- biobased and biodegradable.

A consensus definition for a 'biobased' plastic does not yet exist, however it is generally held to be plastics in which 100% of the carbon is derived from renewable agricultural and forestry resources such as plant starch from sugarcane or corn, cellulose or plant/animal proteins. Most biobased plastics on the market today are blends of biobased and petroleum-based materials. Provided in Figure 6 is a graphical representation of the bioplastics groupings.

Figure 6 – Bioplastics groupings (Bioplastics science from a policy vantage point, 2012)



Types of bioplastics and packaging applications

Provided in the Table 7 below is a brief outline of the major types of bioplastics used in packaging applications, with examples of packaging applications for selected bioplastics in Table 8.

Table 7 – Types of bioplastics

Type of polymer	Chemical name	Examples of trade names and manufacturers		Is the raw material also a food crop[1]	Biobased	Biodegradable	Certified compostable[2]
		Trade name	Manufacturer (country)				
PLA polyester	Poly-lactic acid (PLA)	Ingeo®	NatureWorks (USA)	Yes	Yes	Yes	Yes
		Revode	Hisun Biomaterials (China)	Yes	Yes	Yes	Yes
Starch-based polymers	Amorphous amylose + amylopectin (+ polymeric complexing agents)	Plantic range	Plantic (Australia)	Yes	Yes	Yes	Yes
	Wheat starch	Envirofill®	Pro-Pac Packaging (Australia)	Yes	Yes	Yes	Yes
	Corn and potato starch	Mater-Bi® starch grade	Novamont (Italy)	Yes	Yes	Yes	Yes
Cellulose-based polymers	Cellulose from wood pulp	NatureFlex™	Innovia Films (UK)	No	Yes	Yes	Yes
Naturally produced polyesters	Polyhydroxylalkanoates (PHA) family, including PHB, PHV and PHH	Mirel®	Metabolix (USA)	Yes	Yes	Yes	Yes
	Polyhydroxybutyrate (PHBH)	Biocycle®	PHB Industrial (South Africa)	Yes	Yes	Yes	Yes
Synthetic polyesters	Polybutylene succinate (PBS)	Bionelle®	Showa Denko	No	No	Yes	Yes
	Aliphatic-aromatic copolyesters (AAC)	Ecoflex®	BASF (Germany)	No	No	Yes	Yes
	Aliphatic-aromatic copolyester (AAC) compounded with PLA	Ecovio®	BASF (Germany)	Partly	Partly	Yes	Yes
Starch-polyester blends	Starch polyester blend	Cardia Compostable B-F™	Cardia Bioplastics (China)	Partly	Partly	Yes	Yes

Type of polymer	Chemical name	Examples of trade names and manufacturers		Is the raw material also a food crop[1]	Biobased	Biodegradable	Certified compostable[2]
		Trade name	Manufacturer (country)				
	Starch polyester blend	Mater-Bi® starch-polyester grade	Novamont (Italy)	Partly	Partly	Yes	Yes
Biobased non-biodegradable polyethylene	Polyethylene (PE)	Green Polyethylene	Braskem (Brazil)	Yes	Yes	No	N/A
Biobased non-biodegradable polypropylene	Polypropylene (PP)	Green Polypropylene	Braskem (Brazil)	Yes	Yes	No	N/A
Cartonboard coated with biodegradable polyesters	Cellulose / polyester laminate	Amcor development	Amcor (Australia)	Partly	Partly	Yes	Yes

Table 8 – Typical packaging applications of selected bioplastics

Type of polymer	Trade name examples	Rigid applications	Flexible applications	Current packaging applications in the Australian market
PLA polyester	Ingeo®	Rigid packaging, bottles, blister pack. Similar physical properties to PET.	Flexible as paper coating. Various blends with similar properties to LLDPE / LDPE.	Bottles, clamshells, food service ware, coated paper products.
	Revode	N/A	Coated paper products	None identified.
Starch-based polymers	Plantic range	Rigid thermoformable packaging with similar physical properties to PET and rigid PVC.	N/A	Thermoformed clam shell trays.
	Envirofill®	Use for loose fill. Similar energy absorbing characteristics to expanded polystyrene.	N/A	Loose fill.
	Mater-Bi® starch grade	Loose fill and expanded packaging. Similar properties to expanded polystyrene.	N/A	None identified.
Cellulose-based polymers	NatureFlex™	N/A	Wide range of flexible packaging applications, such as shelf stable stand-up pouches to flexible fresh food and confectionary packs.	Chocolate products, coffee.
Naturally produced polyesters	Mirel®	N/A	Film and bags.	None identified.
	Biocycle®	Blow moulded bottles and injection mouldings.	Suitable for plastic film applications.	None identified.

Type of polymer	Trade name examples	Rigid applications	Flexible applications	Current packaging applications in the Australian market
Synthetic polyesters	Bionelle	Injection moulded products as closures/caps.	Similar properties to PET, especially for blown film extrusion. Able to meet functional requirements of cling film. PBS is used for packaging film, bags and flushable products. Generally blended with other compounds, such as starch (TPS), to improve cost efficiency.	None identified.
	Ecoflex®	Similar properties to LDPE. Individual properties vary between grades.	Similar properties to LDPE. Individual properties vary between grades.	Food packaging and nappy packaging.
	Ecovio®	Similar properties to LDPE. Individual properties vary between grades.	Similar properties to LDPE. Individual properties vary between grades.	Foam packaging (Ecovio®).
Starch-polyester blends	Cardia Compostable B-F™	Starch/polyester blends have similar properties to LDPE/LLDPE. Rigid applications include; food-contact foam trays, loose fill.	Starch/polyester blends have similar properties to LDPE/LLDPE. Flexible applications include; bags, general packaging, in laminates for confectionary, coffee, bakery products.	Breville juicer pulp bags.
	Mater-Bi® starch-polyester grade	Similar properties to expanded polystyrene	Similar properties to LDPE / LLDPE. Flexible applications include bags, general packaging and in laminates.	Coffee and confectionery packs.
Biobased non-biodegradable polyethylene	Green Polyethylene	All applications for which polyethylene is suited.	All applications for which polyethylene is suited.	Bottle closures.
Biobased non-biodegradable polypropylene	Green Polypropylene	All applications for which polypropylene is suited.	All applications for which polypropylene is suited.	None identified.

To compete with conventional polymers in packaging applications, bioplastics substitutes need to be able to offer comparable or better processing and packaging performance, at a reasonably competitive price.

Bioplastics have largely been developed to a point where they offer equivalent packaging performance characteristics to traditional polymer solutions. For this reason there is less contentiousness around the packaging performance of bioplastics packaging than around the issues of recycling, composting and consumer behaviour.

Bioplastics are being developed as both drop-in substitutes for conventional plastics and for biodegradability. Their performance will continue to improve. As to price, for the foreseeable future bio-based plastics will be sold at a premium due to higher feedstock costs.