

Report prepared by



Australian Plastics Flows and Fates Study 2019–20

National report

22 July 2021



Report prepared for



Australian Government
**Department of Agriculture,
Water and the Environment**



Project title:	Australian Plastics Flows and Fates Study 2019–20
Report title:	National report
Client:	The Department of Agriculture, Water and the Environment
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Reviewer:	Peter Allan
Project reference:	A21513
Document reference:	R02-02-A21513
Date:	22 July 2021
Report citation:	N/A

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GLOSSARY / ABBREVIATIONS

ABS/SAN/ASA	Acrylonitrile butadiene styrene (ABS), styrene acrylonitrile (SAN), and /or acrylonitrile styrene acrylate (ASA) (PIC 7).
Biobased	Material that is composed in whole, or in significant part, of biological products or renewable agricultural and forestry resources such as plant starch from sugarcane or corn, cellulose, or plant/animal proteins.
Biodegradable	A generic term that indicates a polymer is biologically available for microbial decomposition, with typically no detail on breakdown products, time or extent of degradation or end environments. A certified compostable plastic (product or package) is biodegradable, however, a biodegradable polymer is not necessarily certified compostable.
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'.
Biopolymer	Variable usages. Can be used with the same meaning as either bioplastic or biobased plastic.
Bio-PE	Biobased polyethylene.
Bio-PP	Biobased polypropylene.
Bio-PET	Biobased polyethylene terephthalate.
Biosolids	Solid, semi-solid or slurry material produced by the treatment of urban sewage or trade waste (liquid waste) generated by industry.
Business-to-business (B2B) packaging	Packaging used for the containment, protection or handling of product where the end-customer, prior to the packaging reaching end-of-life, is a business or institution. Typically includes the secondary and tertiary packaging that is used to move products between businesses prior to sale to end-consumers, but can also include primary packaging if the business is the end-user. Same meaning as 'Commercial packaging'. Also see 'Packaging' and 'Business-to-consumer (B2C) packaging'.
Business-to-consumer (B2C) packaging	Packaging used for the containment, protection, marketing or handling of product where the end-customer, prior to the packaging reaching end-of-life, is a consumer (i.e. a person). Includes the primary packaging that is sold to end-consumer, and possibly some secondary packaging, but excludes any B2B packaging that is part of the packaging system. Same meaning as 'Consumer packaging'. Also see 'Packaging' and 'Business-to-business (B2B) packaging'.
Capacity (reprocessing)	The industrial capacity available to reprocess waste materials per year, overall or by polymer type. 'Current capacity' is the maximum quantity possible to be reprocessed at a facility per year. 'Spare capacity' is the unused or potential quantity of reprocessing ability at a facility per year, in excess of actual reprocessed quantity. 'Planned capacity' is the quantity per year, beyond the current capacity, that the reprocessor has committed (funded) plans to install or develop.
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.
Chemical (feedstock) 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.
Circular economy	A systems-level approach to economic development designed to benefit businesses, society, and the environment. A circular economy aims to decouple economic growth from the consumption of finite resources and build economic, natural, and social capital. The CE concept is built on and applies three key principles: <ul style="list-style-type: none"> • design out waste and pollution • keep products and material in use • regenerate natural systems.
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. Closed-loop recycling of plastics is always considered to be virgin resin competing. Also see 'Open-loop recycling' and 'Downcycling'.
Commercial and Industrial (C&I)	Material used by or produced from all commercial and industry sources other than construction and demolition (C&D) related sources. This includes institutions and businesses, schools, restaurants, offices, retail and wholesale businesses, and industries including manufacturing. Also



	includes material into or from primary and secondary production, such as mining and minerals processing.
Compostable	In this report compostable is used as a specific term that describes a biodegradable bioplastic based article (usually packaging) that degrades and meets the requirements of the Australian Standards for commercial composting (AS 4736–2006) and/or home composting (AS 5810–2010), or meets similar overseas standards such as the European standard is EN 13432. To be called compostable, packaging must biologically decompose and disintegrate in a composting system (under either commercial or home composting conditions) to set levels within a defined period of time. The compost must also meet specific quality criteria relating to eco-toxicity and other characteristics.
Composting	Predominantly an aerobic biological process that turns organic material into compost, which can be a useful soil additive. This process diverts organic material from landfill and so prevents the production of methane (a powerful greenhouse gas).
Construction and Demolition (C&D)	Material from the construction, refurbishment and building demolition industries.
Consumption	Total use of product by Australian industry and consumers. Includes locally made and used product, imported product and locally utilised recycle. Does not include locally made product that is exported for sale.
Converter	Company which converts resin, either virgin resin or recycled content resin, into plastic products.
Degradable	A broad term applied to polymers or plastics that disintegrate by a number of processes, including physical disintegration, chemical degradation, and biodegradation by biological mechanisms. As a result of this definition, a polymer may be degradable but not biodegradable.
Destination	A geographical destination to export or local consumption and recovery. Also used to indicate market sector destination, which is commonly referred to as 'application area destination'. This is the intended use (consumption) for the virgin or recovered plastic after being formed into goods.
Disposal	The deposit of solid waste in a landfill or incinerator, excluding solid waste that is sent to 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'.
End-of-life (EoL)	The term for when a product or material reaches the end of its intended purpose (life cycle) and is disposed to waste streams. End-of-life arisings is the quantifiable material amount, after that point, i.e., the amount of plastic expected to enter the waste stream in any given year.
Energy recovery	Combustion of waste plastics as either a fuel substitute (e.g., in cement kilns), or in specialised waste combustion facilities to create heat, which is then generally used for steam production. The steam is then used directly in industrial processes and/or used to generate electricity. Excludes incineration where a substantial portion of energy value in the waste plastic is not recovered.
Equivalent passenger units (EPUs)	A standard tyre measure, based on the typical weight of a standard new passenger tyre (9.5 kgs) and used tyre at disposal (8.0 kg).
Export for reprocessing	Material sent for reprocessing overseas.
Feedstock recycling	Same meaning as 'Chemical recycling'
Flexible plastics	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.
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'.



Internal use	Recyclate processed and used within the one company.
Local/Locally	In Australia.
Local reprocessing	Scrap plastics reprocessed in Australia. As an example, locally reprocessed scrap plastics recovered from WA are generally reprocessed in WA but may also be reprocessed at interstate facilities. Both WA and interstate reprocessing facilities are defined as local facilities.
Local use	Recyclate used within Australia by an Australian company in the manufacture of a new product.
Material flow analysis	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).
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.
MRF	Material Recovery Facility – a facility for the sorting of recyclables (typically packaging) into various product streams.
Municipal	Household material plus material from public place recycling and other council services.
NTCRS	National Television and Computer Recycling Scheme.
Non-packaging / durable	Long-term use item; not designed to be single use or disposable within a 12-month period.
Off-the-road (OTR) tyre	Tyres for mining sites and heavy industry applications, including tyres from tractors and earthmoving vehicles.
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 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 environmentally beneficial as closed-loop recycling, particularly if the use competes with virgin resin. However, open-loop recycling can also be less environmentally beneficial than closed-loop recycling, particularly where used in applications that are not virgin resin competing. Also see 'Closed-loop recycling' and 'Downcycling'.
Out-the-gate	Material leaving a facility following reprocessing and excludes most contamination. Also see 'In-the-gate'.
Oxo-degradable or photo-degradable	Conventional fossil-based polymers (usually polyethylene or polypropylene) that have additives (sometimes called 'prodegradants') 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.
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.
PA (polyamides or nylons)	Polyamides (PIC 7). Typically referred to as 'nylon'.
PE-HD or HDPE	High density polyethylene (PIC 2). Typically referred to as HDPE.
PE-LD/LLD or LDPE/LLDPE	Both low density polyethylene and linear low density polyethylene (PIC 4). Typically referred to as LDPE/LLDPE.
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).
Plastic	A plastic material is any of a wide range of synthetic or semi-synthetic organic solids that are mouldable. Plastics are typically organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, but many are either partially natural or fully natural (i.e. biobased).
Plastics identification code (PIC)	A voluntary coding system for plastic polymers using the numbers 1–7. The PIC is used to identify the polymer composition of plastic products, potentially facilitating the post-consumer waste management of plastic goods. Also known overseas as the Resin Identification Code (RIC).
Polyolefin	A polyolefin is a type of polymer produced from an alkene monomer (general formula C_nH_{2n}). Polyethylenes (HDPE and LDPE) and polypropylene are polyolefins.
PU or PUR	Polyurethane (PIC 7).
Post-consumer domestic	Used material from household sources. Mostly packaging material from kerbside recycling collections.
Post-consumer industrial	Used material from non-household sources.
PP	Polypropylene (PIC 5).



Pre-consumer industrial	Scrap off-cuts and off-specification items in the manufacturing industry which are not used by the consumer and which are collected for reprocessing at a different site. Does not include material that is recycled directly back into manufacturing processes at the same site. Does not include material that has reached the end consumer, whether domestic or industrial.
Problematic plastic packaging	<p>The definition for Problematic and Unnecessary Single-use plastic packaging is packaging that is (APCO, 2020b, p. 5):</p> <ul style="list-style-type: none"> • Difficult to collect/recover for reuse, recycling or composting purposes; or, • A material that hinders, disrupts or obstructs opportunities to recover other materials or resources; or • A significant contributor to the plastic litter and marine debris problem; or • Manufactured with, contains or has contained hazardous chemicals or materials that pose a significant risk to human health or the environment. <p>Certain types of packaging may not be considered problematic should emerging technologies result in effective collection/recovery for reuse, recycling or composting purposes, provided it can be removed from the environment.</p>
Process engineered fuel (PEF)	PEF is a name for solid fuel of a specified size profile and energy content manufactured from high-energy content end-of-life materials, such as timber from building demolition, and scrap plastics from pre-consumer and post-consumer sources. PEF is burnt to generate heat for energy generation and is typically used in cement kilns to reduce coal and gas use.
PS	Polystyrene (PIC 6).
PS-E or EPS	Expanded polystyrene (PIC 6). Typically referred to as EPS.
PVC	Polyvinyl chloride (PIC 3).
Recover / recovery / resource recovery	The process of recovering resources from waste for reuse or reprocessing. This includes the collection, sorting and aggregation of materials, and the conversion of waste into a material suitable for manufacturing new products. The term recovery, as applied in this report, includes the reprocessing of recovered plastics in (material) recycling processes, composting of biodegradable plastics, and the combustion of recovered plastics in energy recovery.
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, and contaminants and residual wastes sent to landfill. Also see 'Diversion rate' and 'Recycling rate'.
Recyclable packaging	<p>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.</p> <p>Also see the related 'Compostable packaging' and 'Reusable packaging' definitions.</p> <p>Supporting notes:</p> <ol style="list-style-type: none"> 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 Packaging Recyclability Evaluation Portal (PREP) is an online platform used to verify if packaging is recyclable via Australian and New Zealand kerbside collections. 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	Recyclate is any recovered scrap material from both pre-consumer and post-consumer sources, either before or after reprocessing. It includes scrap plastics (before reprocessing), pellets, fines, and flakes (after reprocessing), but excludes material sent to energy recovery. Also see 'Scrap plastics'.
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	Recycling (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 'Recovery rate'.



Reprocess / reprocessing	Processing of recovered waste materials to change its physical structure and properties so it can be used as raw materials when making new products or for direct use (e.g., waste-to-fuel). May also be called 'secondary processing'.
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.
Resin	Raw polymer material.
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.
Rubber – natural	A group of biobased polyisoprenes primarily made from latex harvested from the rubber tree. Typically made into products containing other additives, for example tyres with a partial or fully natural rubber component may also contain steel wire, plastic fibres and fabrics (typically nylon or polyester based), carbon black, silica, zinc oxide, sulfur and other additives.
Rubber – synthetic	A broad group of petrochemical based elastomers such as styrene-butadiene rubbers (SBR). Typically made into products containing other additives, for example tyres with a partial or fully synthetic rubber component may also contain steel wire, plastic fibres and fabrics (typically nylon or polyester based), carbon black, silica, zinc oxide, sulfur and other additives.
Scrap plastics	Used plastic material (including used tyres), either pre-consumer or post-consumer, 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'.
Single-use plastic packaging	Single-use plastic packaging is likely to be designed to be discarded after single use and is routinely disposed of after its contents have been unpacked or exhausted.
Solid recovered fuel (SRF)	A fuel derived from solid waste produced to meet a specification. Term established by the EU via CEN/TC343 standard. In Australia, the commonly used term of 'processed engineered fuel' (PEF) has the same meaning.
Sorting / primary sorting	A process typically between collection and reprocessing in which collected end-of-life materials are sorted (or disassembled) into more usable and economically valuable material fractions. Secondary sorting can also be undertaken on some material flows. Material recovery facilities (MRFs) are (primary) sorting facilities.
Unknown polymers	Unknown polymers are plastics flows for which the polymer type cannot be identified. For example, plastic imports for which the quantity and application are identified, however, the polymer type cannot be determined either directly or through supporting investigations.
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).
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.
Waste plastics export	Export of (typically baled) scrap plastics material sent off-shore for reprocessing.
XPS	Extruded polystyrene (PIC 6).



EXECUTIVE SUMMARY

The Australian Plastics Flows and Fates (APFF) project (formerly named the Australian Plastics Recycling Survey) has been conducted annually since 2000 and provides a comprehensive time-series picture of plastics flows across all polymer types and applications.

This report is the national data report for the 2019–20 financial year, which is the 12-month period from 1 July 2019 to 30 June 2020. It was commissioned by the Australian Government Department of Agriculture, Water and the Environment (DAWE), and state government agencies in New South Wales, Queensland, Victoria and Western Australia.

The core dataset published annually in this report is collected through a detailed survey of Australian plastics reprocessors, Australian resin manufacturers and importers, and extensive interrogation of Australian Customs data.

Key survey findings

The key findings of the 2019–20 study are:

- 3 461 700 tonnes of plastics were consumed in Australia.
- 2 496 700 tonnes of plastics reached end-of-life (EoL) in Australia.
- 326 600 tonnes of plastics were recovered, with 310 600 tonnes being recycled and 16 000 tonnes sent to energy recovery.
- The national plastics recovery rate – being a combination of recycling and energy recovery – was 13.1%. This was a decline on the 2018–19 rate of 15.8%, which was almost entirely due to a large decrease in plastics sent to energy recovery.
- The national plastics recycling rate was 12.4%.
- Of the 326 600 tonnes of plastics reprocessed in 2019–20, 200 300 tonnes (61.3%) was reprocessed in Australia and 126 300 tonnes (38.7%) was exported for reprocessing. This was a fall of 67 200 tonnes from the 2018–19 recovery of 393 800 tonnes. This fall was mostly due to a sharp contraction in scrap plastics to energy recovery, related to the implementation of import restrictions in receiving countries, and COVID-19 related transport and manufacturing impacts.
- Reprocessing capacity in Australia was an estimated 364 800 tonnes/yr at the end of 2020. Actual reprocessing in 2019–20 was 200 300 tonnes, or 55% of potential capacity. Planned new capacity over the next five years is 182 800 tonnes, or an increase of 50% over current capacity.

Note that these reprocessing capacity estimates should be interpreted with care as they do not provide information on the availability of scrap plastics compatible with the reprocessing capacity, or on the level of reprocessing value-add that can be undertaken with any spare capacity, and so the ability to find an end-market.

Annual flows of plastics

Available data for total annual plastics consumption, End of Life (EoL) arisings and recovery, across the period 2000 to 2019–20, are presented in Table E-1.



The total EoL arisings of plastics in Australia in 2019–20 was estimated at 2 496 700 tonnes, with recovery of 326 600 tonnes, giving a recovery rate of 13.1%. Excluding the 16 000 tonnes of scrap plastics to energy recovery gives a recycling rate of 12.4%.

Table E-1 – Annual Australian plastics consumption and recovery 2000 to 2019–20

Year	Consumption (tonnes)	EoL arisings ¹ (tonnes)	Recovery (tonnes)	Recovery rate (%)	Disposal (tonnes)
2000	1 762 000	1 045 300	167 700	16.0%	877 600
2001	1 859 800	1 108 000	160 900	14.5%	947 100
2002	1 963 100	1 174 200	157 300	13.4%	1 016 900
2003	2 072 000	1 244 100	189 400	15.2%	1 054 700
2004	2 187 100	1 317 800	191 000	14.5%	1 126 800
2005	2 268 000	1 395 500	232 000	16.6%	1 163 500
2006	2 348 900	1 457 400	244 000	16.7%	1 213 400
2007	2 429 800	1 521 100	261 100	17.2%	1 260 000
2008	2 510 600	1 586 400	282 000	17.8%	1 304 400
2009–10	2 672 400	1 721 900	288 200	16.7%	1 433 700
2010–11	2 753 300	1 792 600	287 400	16.0%	1 505 200
2011–12	2 834 200	1 865 600	302 600	16.2%	1 563 000
2012–13	2 915 100	1 940 800	307 300	15.8%	1 633 500
2013–14	2 996 000	2 018 100	313 700	15.5%	1 704 400
2014–15	3 167 000	2 097 300	341 800	16.3%	1 755 500
2015–16	2 912 000	2 177 900	328 900	15.1%	1 849 000
2016–17	2 955 400	2 259 500	291 000	12.9%	1 968 500
2017–18	3 407 300	2 217 900	320 000	14.4%	1 897 900
2018–19	3 435 200	2 495 300	393 800	15.8%	2 101 500
2019–20	3 461 700	2 496 700	326 600	13.1%	2 170 100

1. EoL arisings estimated using the material flow analysis (MFA) approach outlined in Section 2.3.

Presented in Figure E-1 is the quantity of plastics recovered in Australia across the period 2000 to 2019–20. The proportion of recovered plastics exported for reprocessing in 2019–20 was 38.7%, compared with 48.4% in 2018–19. This fall was mostly due to a sharp contraction in scrap plastics to energy recovery, related to the implementation of import restrictions in receiving countries, and COVID-19 related transport and manufacturing impacts.



Figure E-1 – Annual Australian plastics recovery 2000 to 2019–20

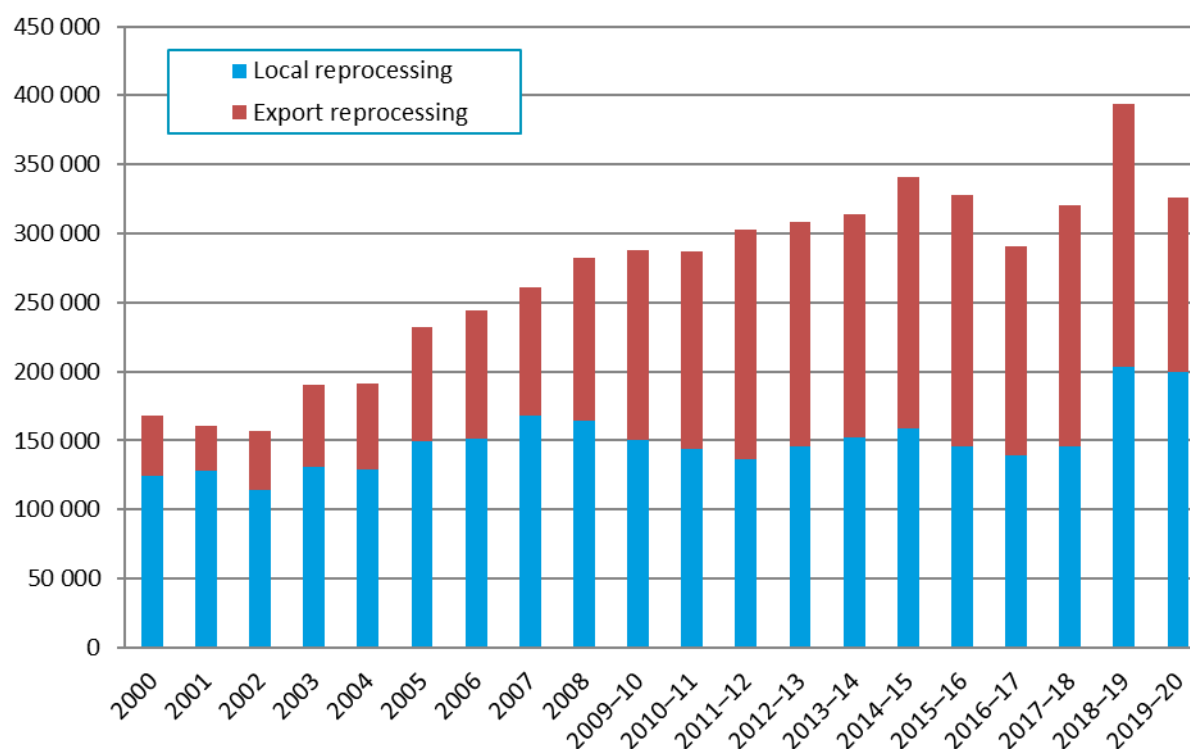


Table E-2 – Annual Australian plastics recovery 2000 to 2019–20

Year	Recovery	Local	Export	
	(tonnes)	(tonnes)	(tonnes)	(% exported)
2000	167 700	124 100	43 600	26.0%
2001	160 900	127 900	33 000	20.5%
2002	157 300	114 100	43 200	27.5%
2003	189 400	130 700	58 700	31.0%
2004	191 000	129 100	61 900	32.4%
2005	232 000	149 100	82 800	35.7%
2006	244 000	151 000	93 000	38.1%
2007	261 100	168 300	92 800	35.5%
2008	282 000	164 100	117 900	41.8%
2009–10	288 200	150 100	138 100	47.9%
2010–11	287 400	144 300	143 100	49.8%
2011–12	302 600	136 000	166 600	55.1%
2012–13	307 300	145 600	161 800	52.7%
2013–14	313 700	152 000	161 700	51.5%
2014–15	341 800	159 400	182 400	53.4%
2015–16	328 900	146 400	182 500	55.5%
2016–17	291 000	139 100	152 000	52.2%
2017–18	320 000	145 700	174 300	54.5%
2018–19	393 800	203 100	190 700	48.4%
2019–20	326 600	200 300	126 300	38.7%



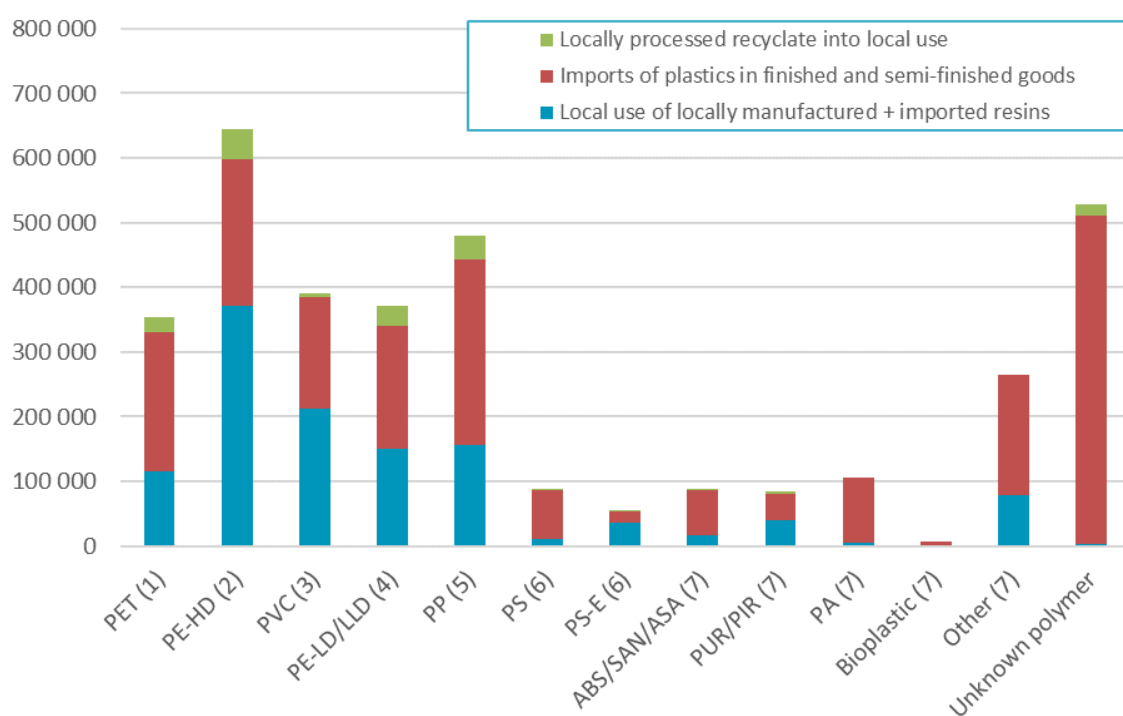
Overall plastics consumption in 2019–20

In 2019–20, 2 093 800 tonnes (60.5%) of plastics consumption was through imported finished and semi-finished goods, with 1 367 900 tonnes (39.5%) of consumption through local manufacturing using either virgin resins (34.6%) (both locally manufactured and imported) or recycle based resins (4.9%).

The last decade has seen the local manufacturers of PET, PVC, PS and EPS resins cease production, and at the current time the major resin types still produced in Australia are HDPE, LDPE and PP.

This highlights a particular challenge with respect to increasing recycling and recovery of plastic products which require good end-markets, as 60% of plastic products are now manufactured overseas. If the scrap is to be incorporated into new and similar products then, at end-of-life, it must be returned into these supply chains at an acceptable price and quality.

Figure E-2 – Australian plastics consumption by polymer type and source in 2019–20 (tonnes)



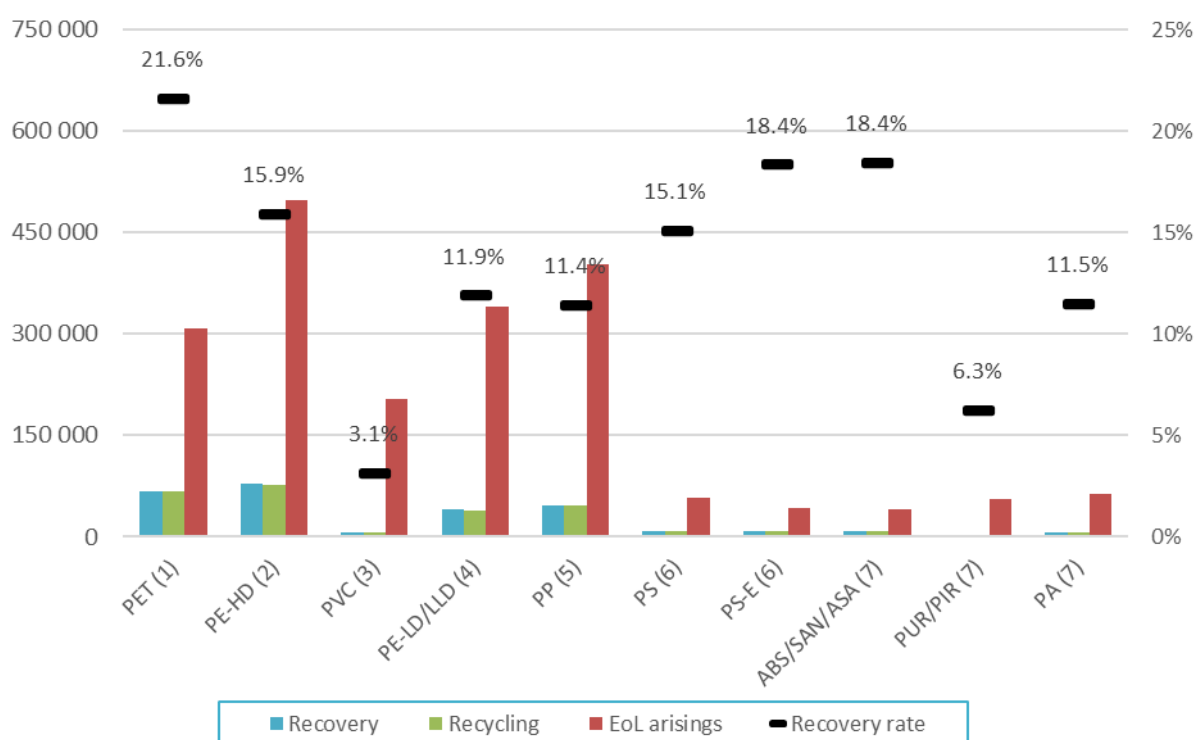


Plastics recovery and EoL arisings by polymer type in 2019–20

Presented in Figure E-3 is plastics recovery and recycling (excluding plastics to energy recovery) by polymer type during 2019–20.

The highest recovery rate observed in 2019–20 was for PET at 21.6% (primarily rigid beverage packaging with its relatively high collection rates through kerbside and container deposit scheme related collections), followed by ABS/SAN/ASA (primarily from e-waste) at 18.4%, and EPS (primarily from packaging) also at 18.4%. The recovery of these polymers is underpinned by two national product stewardship schemes, which are the Australian Packaging Covenant and the National TV and Computer Recycling Scheme (NCRS).

Figure E-3 – Plastics recovery, recycling and EoL arisings by polymer type in 2019–20 (tonnes and % recovery rate)





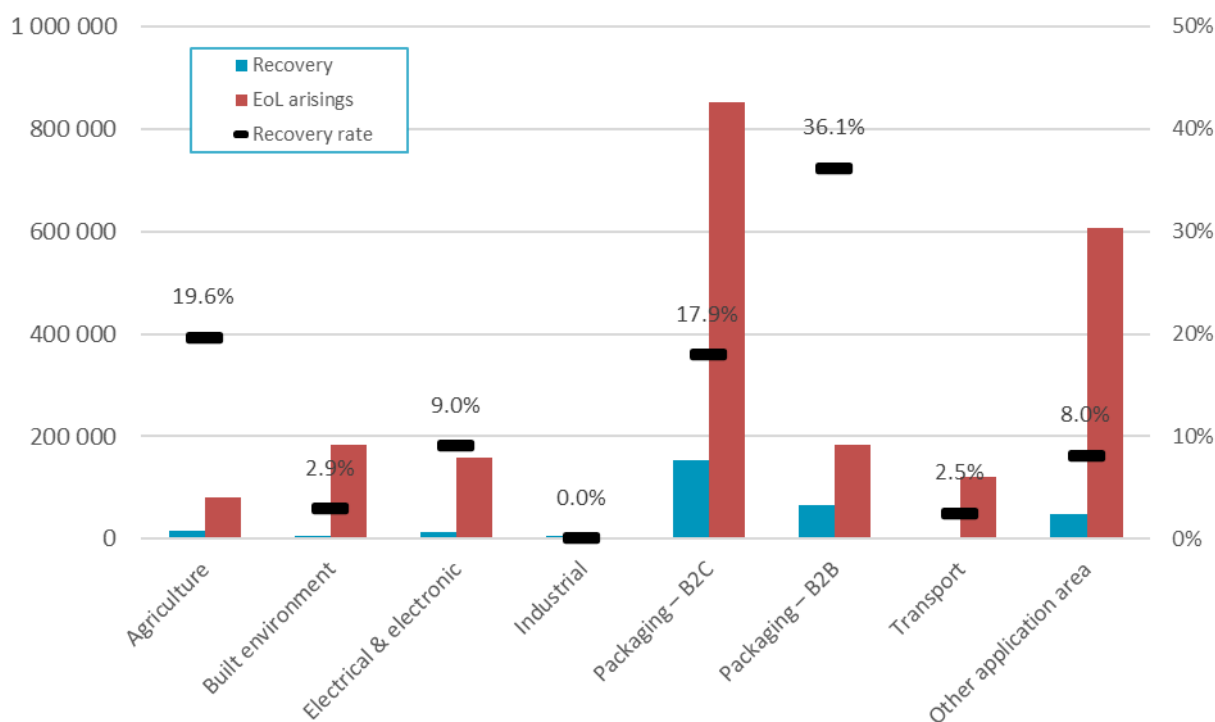
Plastics recovery and EoL arisings by application area in 2019–20

Presented in Figure E-4 is plastics recovery by application area during 2019–20. The combined business to consumer (B2C) and business-to-business (B2B) plastic packaging recovery rate of 21.1% is relatively good compared to all other application areas for plastics. It is important to note that these recovery rates include both pre-consumer packaging manufacturing scrap recovery and post-consumer packaging recovery, and are an overall recovery rate, not a post-consumer recovery rate only.

At 19.6% and 9.0%, the plastics recovery rates from agricultural and electrical and electronic (E&E) applications respectively, are the next highest after packaging. The 'Other application area' recovery rate was 8.0%, with clothing recovery contributing 62% (30 100 tonnes) of this recovery.

In absolute terms, the recovery rates across all application areas continue to be poor to very poor.

Figure E-4 – Plastics recovery and EoL arisings by application area in 2019–20 (tonnes and % recovery rate)





Recycled content of plastic products

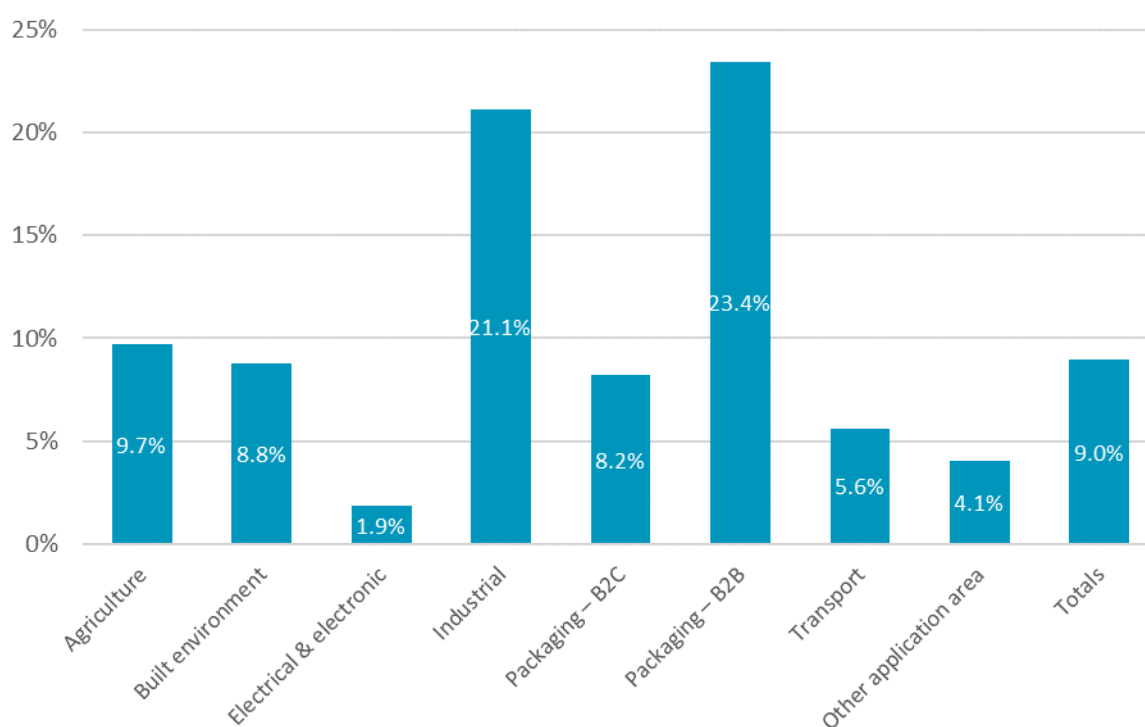
In 2019–20, 1 355 700 tonnes of plastic resins went into local plastic product manufacturing. This included locally manufactured virgin resin (22.1%), imported resin (65.6%), and locally processed or overseas sourced recyclate into local manufacturing (12.3%).

During the same period, there was 166 400 tonnes of local manufacturing using locally sourced (94%) or imported recyclate (6%), meaning the average proportion of recycled content used across all local plastic product manufacturing was 12.3%. The quantity of plastic recyclate includes material sourced from both pre-consumer and post-consumer scrap sources.

B2B packaging and industrial applications have the highest recycled content rates, at 23.4% and 21.1% respectively. The B2B packaging recycling rate is underpinned by the recyclate going into applications such as plant pots, plastic pallets, bins, pallet slips (sheets) and B2B films.

The high recycled content rate in the industrial application area may be due to an underestimation of plastics going into this application area, so is an overestimation of the true recycled content rate for the industrial application area.

Figure E-5 – Recycled content of locally manufactured products, by application area, in 2019–20 (tonnes)



Note: Energy recovery is excluded as the recycled content of WtE fuel is not relevant to the scope of this study. Unidentified applications are excluded as the recyclate input estimate and total consumption estimate are not related quantities.



1 INTRODUCTION

1.1 Background

The Australian Plastics Flows and Fates (APFF) project (formerly named the Australian Plastics Recycling Survey (APRS)) has been conducted annually since 2000, providing a comprehensive time-series picture of plastics consumption and recycling across all polymer types and jurisdictions.

The 2019-20 study has been commissioned by the Australian Government Department of Agriculture, Water and the Environment (DAWE), and state government agencies in New South Wales, Queensland, Victoria and Western Australia.

1.2 Purpose

This report is the national data report for the 2019–20 financial year, which is the 12-month period from 1 July 2019 to 30 June 2020. The report provides a comprehensive picture of the consumption, end-of-life (EoL) arisings and recovery of plastics in Australia. It also presents information on the state of reprocessing markets and the status of product stewardship commitments that affect plastics. The study is a valuable tool that can assist industry with its forward planning. Further, it supports governments in developing targeted policies to improve plastics resource efficiency and provides data that helps in monitoring the success of existing policies.

This year's report has a particular focus on supporting the monitoring of outcomes and other plastics data requirements under the National Waste Policy Action Plan, including for the phase out of problematic single-use plastics and to track the impact of the waste export ban on plastic material flows.

In more detail, this time-series plastics flow data provides reliable and consistent year-on-year information:

- on the current state of demand, use, recovery, and recycling across a broad range of sectors, locations, and polymer types
- to support reporting under relevant International Agreements
- on plastic recovery rates by application area for interested stakeholders
- on the import and export flows of plastics
- on the use and destination of recovered plastics materials
- to support the development and tracking of policies and programs to assist further improvement of plastics resource efficiency over whole of life.

There have also been a number of substantial enhancements and expansions incorporated into the scope of the 2019-20 study. These are outlined in Sections 1.3.3 and 2.6.



1.3 Project scope

1.3.1 Definition of ‘plastic’

The definition of a ‘plastic’ used for this study is:

A plastic material is any of a wide range of synthetic or semi-synthetic organic solids that are mouldable. Plastics are typically organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, but many are either partially natural or fully natural (i.e. biobased).

The polymer types covered in the study are summarised in the following table.

Table 1 – Polymer types and plastic identification code (PIC)

PIC	Polymer type	Main applications
1	Polyethylene terephthalate (PET)	Rigid packaging and clothing.
2	High density polyethylene (PE-HD)	Rigid and flexible packaging applications, and many other significant applications.
3	Poly-vinyl chloride (PVC)	Rigid and flexible building products.
4	Low / linear low density polyethylene (PE-LD/LLD)	Many film applications, both packaging and non-packaging.
5	Polypropylene (PP)	Packaging, vehicles and many other significant applications.
6	Polystyrene (PS) and expanded polystyrene (PS-E)	Packaging, built environment, electrical & electronic devices.
7	Acrylonitrile butadiene styrene / styrene acrylonitrile / acrylonitrile styrene acrylate (ABS/SAN/ASA)	Vehicles and electrical & electronic devices.
7	Polyurethanes (PUR) and polyisocyanurates (PIR)	Vehicles, built environment and many other applications.
7	Polyamides (PA) (nylons)	Clothing, vehicles, built environment and many other applications.
7	Synthetic and natural rubbers	Vehicles (tyres), the built environment, industrial (e.g., conveyor belts), and many other applications.
7	Bioplastics	Rigid and flexible packaging applications. Other film applications.
7	Other aggregated polymer types	Very diverse applications. Clear and coloured films and sheet, engineered plastics.

The plastic resin types which make up most of the ‘other aggregated’ category are various acrylics, acetals, polyethylene oxide, polyisobutylene and other polymers of propylene (other than PP), and polymers of styrene (other than PS, P-ES and ABS/SAN).

1.3.2 Definition of ‘reprocessing’

To avoid double-counting of material flowing through the system to local reprocessors, the focus of data gathering was placed on the reprocessing stage of the plastics life cycle.



The applied definition of Australian-based reprocessing for the survey is the off-site sourcing of waste plastics (including returned product, e.g., EPS waffle pod off-cuts from building sites) which are then processed locally into a value-added finished or semi-finished product (e.g. plastics components requiring further manufacturing steps), or into a chipped format or similar.

EPS (foam) compaction and extrusion is reported as reprocessing. This process is the compaction of EPS using a bale press (or similar), and then either baling the compressed EPS, or the heating and extrusion of the semi-liquid EPS.

In-house recovery/regrind, or the baling and compaction of plastics where further reprocessing is required (e.g., size reduction) before the recyclate can be used to manufacture a new product is not reported as reprocessing, to avoid double-counting plastics reprocessing at different points in the supply chain.

Plastic scrap that is collected and exported for reprocessing and use overseas is defined as reprocessed. Sorting, reprocessing and manufacturing losses that occur overseas are not estimated. That is, the reprocessing losses that occur when exported unprocessed scrap plastics (e.g., exported bales of PET bottles as sorted by material recovery facilities) are reprocessed overseas, have not been estimated.

All local reprocessor reported data has been standardised to an 'out-the-gate' basis. This means that reprocessing losses (to landfill) associated with locally reprocessed scrap plastics are excluded from recovery estimates.

1.3.3 Changes in scope inclusions 2019–20

New scope inclusions of plastics flows coverage this year are:

- Quantifications of plastics end-of-life (EoL) arisings, in addition to the long running determinations of plastics consumption and recovery.

It is important to note that in previous APFF reports, the 'recovery rate' was an approximation calculated by dividing plastics recovery by consumption. This year estimates of EoL arisings by polymer type and application area have been determined using the material flow analysis (MFA) approach outlined in Section 2.3, so the recovery rate is now calculated as recovery divided by EoL arisings. This provides a 'true' recovery rate as the rate is based on plastics recovery divided by the quantity of plastics that are available to be recovered. For this reason, the recovery rates reported in earlier reports are not comparable to the recovery rates reported in this report.
- Tyres are a significant plastics application, and this year tyres consumption and recovery are included in the project scope. The data draws on detailed 2019–20 financial year data provided by Tyre Stewardship Australia (TSA, 2020). For reference, tyres were included in the scope of the 2016–17 report, but not in subsequent reports.

The inclusion of tyres in the project scope would result in an apparent jump in plastics consumption of around 15%, which would cause a number of issues for national waste reporting. For this reason, the tyres data is reported separately (Section 3.5 onwards) from the core historical plastics consumption and recovery data (Sections 3.1–3.4).
- Polymers used in paints, adhesives and other coatings are included in the scope of the project for the first time this year. This has increased overall plastics consumption relative to previous years to a minor extent.



- A significant expansion of the reporting coverage of single-use plastic products (SUPPs) consumption.

This year there have also been numerous new reporting sections added to the report to quantify specific plastic products or aspects of plastics flows. These are summarised in Section 2.6.

1.4 Data limitations and assumptions

This report provides data on plastics reprocessing from Australian sources for the 2019–20 financial year. Data for 87 reprocessing facilities nationally, out of 93 facilities known to be active during 2019–20, has been obtained either through surveys or estimated (9 facilities) and incorporated into the survey dataset.

This is a coverage rate of 94% by number which is estimated to account for >95% of local reprocessing by weight. Considering individual reprocessor stated response accuracies, nationwide it is estimated that local reprocessing quantities provided in this report are within $\pm 7\%$ of actual reprocessing.

Plastics consumption at the state and territory level is estimated based on per capita allocations, as there is no other good quality data available to break down consumption by jurisdiction. As such, estimates for consumption are approximations only, and do not account for any variations in intensity of industry across different jurisdictions, nor does it allow for any variable patterns of domestic consumption.

National Television and Computer Recycling Scheme (NTCRS) data incorporated into the study is for the 2018–19 financial year, as 2019–20 data was not available at the time of reporting.

In the tables presented in this report, minor discrepancies may occur between the stated summed totals and the apparent sums of the contributing values, as summed totals and percentage values are calculated using contributing 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 100 tonnes (i.e. more than three significant figures). Percentage values are rounded to either two or three significant figures, depending on the accuracy of the contributing values.

1.5 Confidentiality

Assurances were provided to stakeholders surveyed as part of this project on the confidentiality and security of their responses. This report does not include any company specific data from survey responses. All survey data published in this report has generally been aggregated to the level of polymer type and application area, except where otherwise identified.



2 PROJECT METHOD

2.1 Data sources

2.1.1 Primary data sources

The following stakeholder groups were surveyed to obtain primary data on plastics consumption and recycling:

1. **Australian resin manufacturers** – Polymer types and quantities manufactured, local production quantities, export of locally produced resin, destination market sectors and market commentary.
2. **Resin importers** – Polymer types and quantities imported, destination market sectors, market commentary.
3. **Plastics reprocessors** – Polymer type and quantities reprocessed, source industries and application, source jurisdictions, destination market sectors, approved and current maximum capacity, market commentary.
4. **Plastics exporters** – Interpretation and verification of scrap plastics export data, market commentary.
5. **Single-use plastic product (SUPPs) manufacturers, importers and brand-owners** – Product types and quantities placed onto market.

Stakeholders were identified through previous survey contacts, the project team's industry knowledge, state agency consultation, and industry sources.

2.1.2 Secondary data sources

Significant secondary (pre-existing) data sources included:

- An Australian Customs import/export *Harmonized Tariff Item Statistical Code* (HTISC) data extract. Import and export flows of plastics were primarily determined through the quantitative review and analysis of 3 700 Customs import codes and 2 400 export codes contained in the Customs data extract.
- South Australian plastics reprocessing data provided by Green Industries SA (GISA, 2020).
- Tyres consumption and recovery data provided by Tyre Stewardship Australia (TSA, 2020).
- Paint packaging recovery data provided by Paintback Ltd (PBL, 2021).
- Certified compostable plastics consumption data from the Australasian Bioplastics Association.
- Population data was sourced from the Australian Bureau of Statistics for all states and territories and was used to estimate plastics consumption for each jurisdiction on a per capita basis.



Table 2 – Estimated state/territory populations on 1 June 2020 (ABS, 2021a; ABS, 2018)

Jurisdiction	Population	% of national population
ACT	426 300	1.7%
NSW	8 087 400	31.9%
NT	246 100	1.0%
QLD	5 093 900	20.1%
SA	1 752 700	6.9%
TAS	534 600	2.1%
VIC	6 596 900	26.0%
WA	2 623 300	10.3%
Total	25 361 200	100.0%

2.2 Determination of plastics consumption

Consumption data is estimated from a variety of sources including:

- Australian based resin manufacturers.
- Australian based resin importers.
- Customs import and export data.
- Plastics reprocessors (returning end-of-life plastics back into use).

Plastics consumption is determined using the approach outlined in Table 3.

Table 3 – Determination of plastics consumption and related information sources

±	Consumption flow	Primary information sources
+	Local resin production	Local resin manufacturers
+	Imported resin	Customs import data
+	Imported plastics in finished and semi-finished goods	Customs import data
+	Plastic recycle back into local use	Local reprocessors
+	Scrap import	Customs import data
-	Export of locally produced resin	Customs export data / Local resin manufacturers
-	Exported plastics in finished and semi-finished goods	Customs export data
=	Domestic consumption	



In 2015, the methodology for determining plastics consumption was updated and expanded to include estimates of consumption of plastics through imported finished and semi-finished plastic goods, including packaging on imported goods. Prior to the 2014–15 year, the methodology only included imported virgin plastics, and no other plastic product imports. For this reason, plastics consumption estimates prior to 2014–15 are drawn from the material flow analysis (MFA) undertaken for the project. See Section 2.3 for details on the MFA.

2.3 Determination of plastics end-of-life arisings

The lifespan of plastic products varies from short-term and single-use items to long-term durable products which may remain in use for many years before reaching end-of-life. This creates a challenge for estimating the recovery rates of plastic products with a lifespan of more than a couple of years, as consumption is not equivalent to the quantity of plastics reaching end-of-life and thus available for recovery.

This issue has been addressed through the application of a material flow analysis (MFA). A material flow analysis is an analytical method of quantifying flows and stocks of materials or substances in a well-defined system, in this case for plastics.

The MFA system developed for this project is a model of flows of all plastic products, built up from estimated flows of historical, current and future sales and estimated lifespans, differentiated by application area and polymer type. The MFA model back-casts to the 1979–80 financial year data, with time series estimates of the model outputs to 2049–50.

The plastics material flow modelling outputs across the period of 2009–10 to 2049–50 are reported in Section 3, providing estimates of consumption and end-of-life (EoL) arisings across the modelled time-period. Projections of recovery are not modelled, as future actions to increase or decrease recovery are not sufficiently predictable.

Some of the key attributes of the underlying modelling are:

- Plastics consumption and recovery data across the period of 2014–15 to 2019–20 is based on the survey data collected for this report, and the survey data for previous years.
- Plastic product lifespans (i.e. the period of use before reaching EoL) by application area are based on Geyer (2017b, p. 10), with normal distributions adopted for lifespan distribution estimates. More appropriate functions do exist for this type of lifespan or reliability modelling (e.g., Weibull distributions). However, insufficient empirical data is currently available with which to fit long-lived plastic product lifespans (e.g., greater than 10 years) to a potentially more ideal function. It is also worth noting that only 32% of plastics consumption in 2019–20 had an adopted average lifespan of greater than 10 years, so a relatively small proportion of plastics flows are potentially sensitive to the application of non-ideal lifespan distributions.
- Plastic sales from 1980 to 2004 for all application areas are generally calculated using a 24-year compound annual growth rate (CAGR) estimate based on Geyer, et al. (2017b) data.
- Plastic sales from 2004 to 2015–16 by polymer type and application area are based on a straight-line interpolation between the 2004 sales estimates (including imports of finished and semi-finished goods) and the available 2016–17 to 2018–19 data averages.



- Plastic sales from 2016–17 to 2019–20 by polymer type and application area are based on actual data drawn from previous iterations of this study.
- Plastic sales from 2019–20 to 2049–50 by polymer type and application area are based on either 5-year CAGR (non-packaging flows) or industry reports of anticipated market growth over the next 5 years (packaging flows).
- The future market shares of each polymer type in each of the application areas are assumed to be steady. For example, purchases of plastics in electrical & electronic goods remain proportional to plastics purchases in transport.

2.4 Determination of plastics recovery

Plastics recovery is determined using the approach outlined in Table 4.

Table 4 – Determination of plastics recovery and related information sources

±	Recycling flow	Primary information sources
+	Recyclate to local reprocessors (to local use)	Local reprocessors ¹
+	Recyclate to local reprocessors (to export)	Local reprocessors
+	Recyclate (unprocessed scrap) to overseas reprocessors	Customs export data
+	Tyres recovery	TSA
+	Plastics in e-waste recovery	NTCRS reporting / MobileMuster
=	Total recovery	

1. Included contact with 4–5 major composters nationally to seek information on the receipt of compostable plastics.

Domestic reprocessing figures are obtained from surveying individual Australian plastics reprocessing businesses. Export of recyclate (scrap plastic) is estimated from data provided by reprocessors and exporters, and review and analysis of the relevant Australian Customs export codes.

While there are a range of current technologies available for recovery, in Australia mechanical recycling is the main process used to recover plastic materials.

However, the recovered plastics data published throughout this report does include scrap plastics and tyres going to energy recovery, which is mostly burnt in cement kilns (both locally and overseas).

Note that tyres data is only included in reporting from Section 3.5 onwards and is not reported in the core plastics consumption and recovery data (Sections 3.1–3.4)

2.5 Reporting categories

2.5.1 Polymer types

The polymer types covered by this study, and the identifying Plastics Identification Code (PIC) have been previously outlined on page 9 of this report.



2.5.2 Application areas

The application area destinations (to consumption) and application area sources (to reprocessing) used in this report are outlined in Table 5. There have been several updates to the list this year, as described in the table below.

Table 5 – Application areas

Application area	Coverage	Comments
Agriculture	Agriculture, forestry and fishing related applications.	-
Built environment	Construction and demolition related applications. Includes plastics into building products, roads, railway sleepers, and landscaping applications.	-
Electrical & electronic	Electrical and electronic products related applications.	-
Industrial	Industrial and manufacturing equipment/machinery, consumables and other inputs.	This is a newly defined application area for 2019–20.
Packaging – B2C	Business to consumer (B2C) or 'Consumer' packaging related applications.	This application area called 'Packaging – consumer' prior to 2019–20.
Packaging – B2B	Business to business (B2B) or 'Commercial and industrial' packaging related applications.	This application area called 'Packaging – C&I' prior to 2019–20.
Transport	Self-propelled vehicles, including those used in primary production and manufacturing. Mainly automotive and other transport related applications.	This application area called 'Automotive' prior to 2019–20.
Other application area	All other applications.	-
Energy recovery	Energy production related applications.	'Energy recovery' is an application for end-of-life plastics, it is not an application for new products.
Unidentified applications	Unknown applications.	-

The major applications within each application area are summarised in Table 6.



Table 6 – Major product types in each application area

Application area	Product types
Agriculture	Flexible film
	Irrigation pipe
	Rope, cable, twine and filament
	Fishing nets, fishing floats
	Other agricultural applications
Built environment	Carpet and other floor coverings
	Fit-out products – includes interior materials such as panelling, partitions, benches, cupboards, sinks, other fixtures made from plastics.
	Insulation
	Pipes and cables
	Structural and envelope, i.e. any structural components or external materials such as cladding.
	Windows and doors
	Other built environment
Electrical & electronic	TVs, computers, monitors, and printers
	Power tools
	Lighting fixtures and lamps
	Toys
	White goods (e.g. fridges), air conditioning units and small appliances.
	Other electrical and electronic
Industrial	Capital goods – includes manufacturing equipment and other fixed industrial and commercial equipment.
	Other industrial
Packaging – B2C	Flexible packaging
	Rigid packaging
	Other packaging
Packaging – B2B	Flexible packaging
	Rigid packaging
	Other packaging
Transport	Vehicle body
	Tyres
	Other transport



Application area	Product types
Other application area	Absorbent hygiene products
	Clothing and footwear
	Food and beverage
	Furniture
	Household (misc.), leisure and sporting goods
	Medical products
	Printing and writing
	Rope, cable, twine and filament
	All other applications
Energy recovery	Energy production
Unidentified applications	Unidentified applications

2.5.3 Waste streams

In this report, the following waste stream sources of recyclate are applied:

- Municipal.
- Commercial and Industrial (C&I).
- Construction & Demolition (C&D).

2.5.4 Waste account industry classifications

Plastics end-of-life (EoL) arisings can also be quantified in terms of the source industry, as this provides useful information on where EoL plastic products arise in the economy.

There are (at least) two potential schemas that could be applied, which are:

- ABS waste account industry classifications – See ABS publication 4602.0.55.005 (ABS, 2020). This schema is based on the experimental environmental-economic accounts produced by the Australian Bureau of Statistics (ABS), which are in turn based on the United Nations System of Environmental-Economic Accounting (SEEA).
- Australian and New Zealand Standard Industrial Classification (ANZSIC) system – See ABS publication 1292.0 (ABS, 2013).

The first of these schemas (see Table 7 below) has been adopted in the data analysis and reporting of recovery data to provide a source industry perspective on plastics recovery, as it was assessed as being more practically and usefully applicable to EoL plastics flows.



Table 7 – Waste account industry classifications

Classifications		Comments
Agriculture – Agriculture		-
Agriculture – Forestry		-
Agriculture – Fishing		-
Mining		-
Manufacturing		-
Electricity, gas & water services		ANZSIC Division D, but excluding subdivision 29-Waste collection, treatment & disposal services.
Construction		-
Public administration & safety		-
Waste collection, treatment & disposal services		ANZSIC subdivision 29 - Waste collection, treatment & disposal services.
All other industries		-
Households		-
Unidentified industries		-
Not applicable		-

2.6 Summary of new sections in 2019–20

Beyond the core year-on-year plastics flows dataset (extended this year to include a material flow analysis modelling approach for the quantification of estimated end-of-life arisings), the report this year also contains a number of new sections quantifying specific plastic products or aspects of plastics flows, which are:

- **Recovery by waste account industry classification.**
- **Tyre sales and recovery.**
- **Paint and other surface coatings.**
- **Single-use plastic products consumption** – This section has been significantly extended from a quantification of plastic bags only in 2018–19.
- **Plastics from e-waste.**
- **New reprocessor capacity.**
- **Plastics in the environment** – A review and synthesis of publicly available information on the impact of plastic waste on the environment

Outlines of the scope and method for these new supporting sections are provided in the respective sections of this report as needed.



3 PLASTICS FLOWS

3.1 Annual plastics flows data

Presented in Table 8 is the available surveyed data for total annual plastics consumption and recovery, and the estimated data for plastics end-of-life (EoL) arisings for the period of 2000 to 2019–20.

The total EoL arisings of plastics in Australia in 2019–20 was estimated at 2 496 700 tonnes. With recovery of 326 600 tonnes, this gives a recovery rate in 2019–20 of 13.1%.

The recovery rate has decreased from the 2018–19 rate of 15.8%. This fall was mostly due to a sharp contraction in scrap plastics to energy recovery, related to the implementation of import restrictions in receiving countries, and COVID-19 related transport and manufacturing impacts.

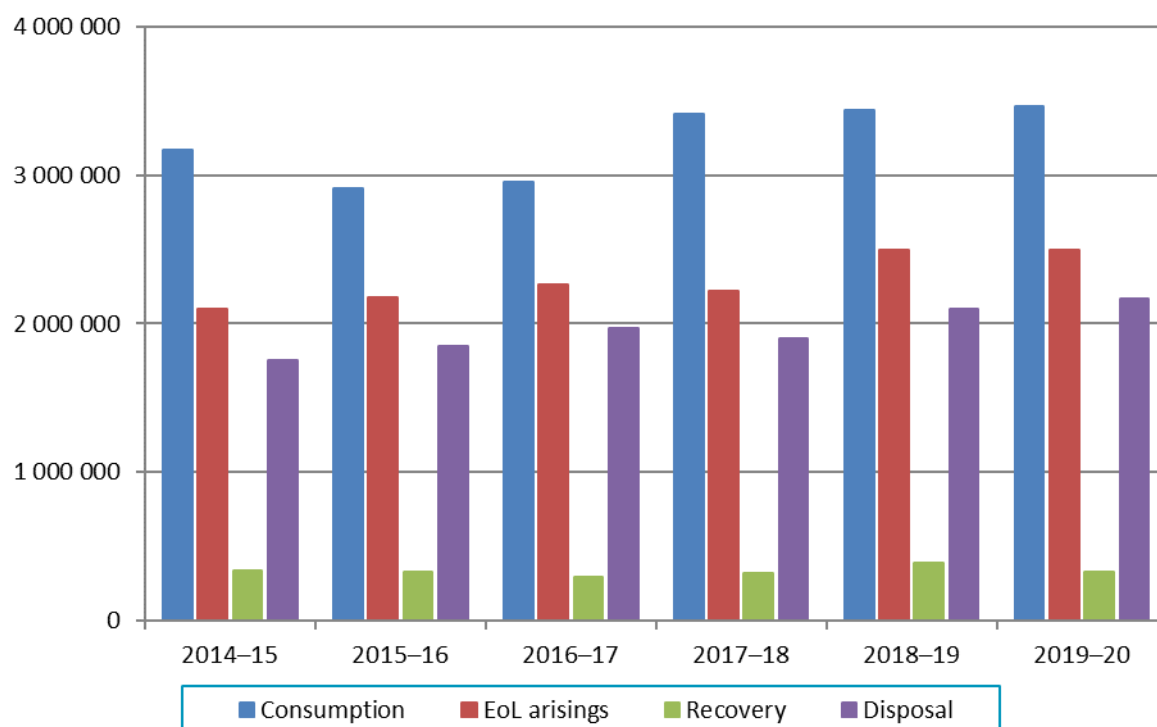
Table 8 – Annual Australian plastics consumption and recovery 2000 to 2019–20

Year	Consumption (tonnes)	EoL arisings ¹ (tonnes)	Recovery (tonnes)	Recovery rate (%)	Disposal (tonnes)
2000	1 762 000	1 045 300	167 700	16.0%	877 600
2001	1 859 800	1 108 000	160 900	14.5%	947 100
2002	1 963 100	1 174 200	157 300	13.4%	1 016 900
2003	2 072 000	1 244 100	189 400	15.2%	1 054 700
2004	2 187 100	1 317 800	191 000	14.5%	1 126 800
2005	2 268 000	1 395 500	232 000	16.6%	1 163 500
2006	2 348 900	1 457 400	244 000	16.7%	1 213 400
2007	2 429 800	1 521 100	261 100	17.2%	1 260 000
2008	2 510 600	1 586 400	282 000	17.8%	1 304 400
2009–10	2 672 400	1 721 900	288 200	16.7%	1 433 700
2010–11	2 753 300	1 792 600	287 400	16.0%	1 505 200
2011–12	2 834 200	1 865 600	302 600	16.2%	1 563 000
2012–13	2 915 100	1 940 800	307 300	15.8%	1 633 500
2013–14	2 996 000	2 018 100	313 700	15.5%	1 704 400
2014–15	3 167 000	2 097 300	341 800	16.3%	1 755 500
2015–16	2 912 000	2 177 900	328 900	15.1%	1 849 000
2016–17	2 955 400	2 259 500	291 000	12.9%	1 968 500
2017–18	3 407 300	2 217 900	320 000	14.4%	1 897 900
2018–19	3 435 200	2 495 300	393 800	15.8%	2 101 500
2019–20	3 461 700	2 496 700	326 600	13.1%	2 170 100

1. EoL arisings estimated using the material flow analysis (MFA) approach outlined in Section 2.3.

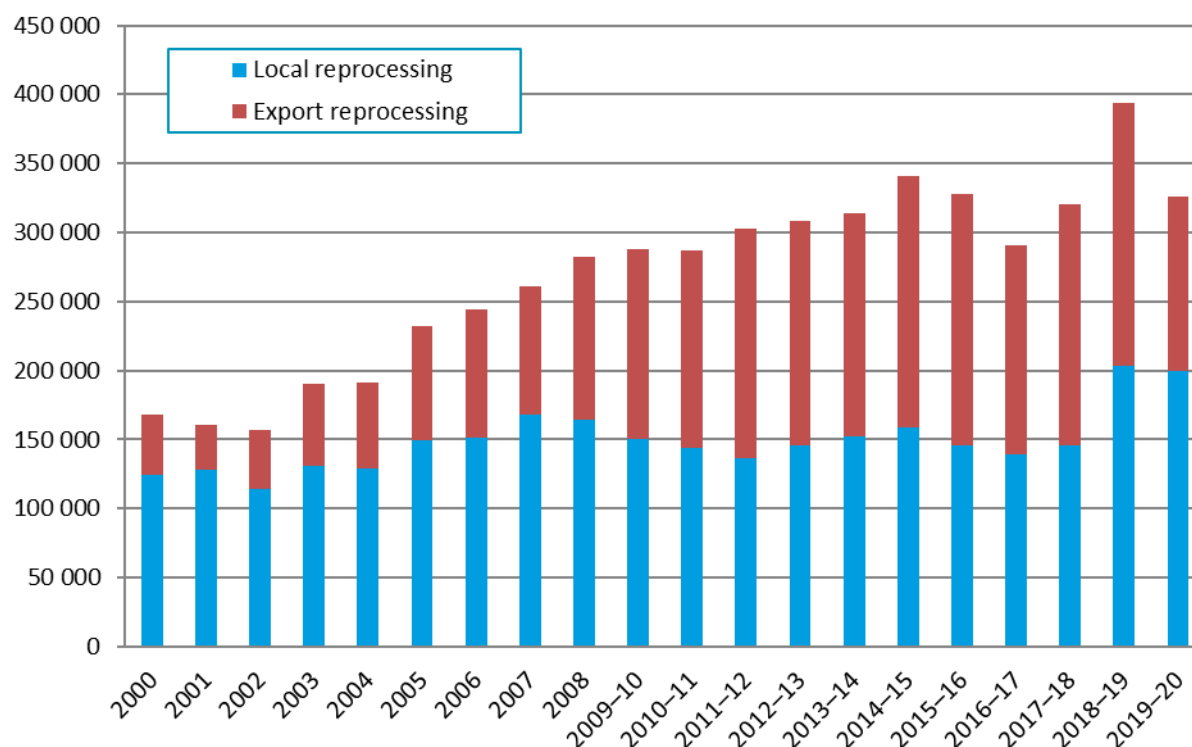


Figure 1 – Annual Australian plastics consumption and recovery 2014–15 to 2019–20 (tonnes)



Presented in Figure 2 is the quantity of plastics recovered in Australia across the period from 2000 to 2019–20, broken down by local and export reprocessing.

Figure 2 – Annual Australian plastics recovery 2000 to 2019–20

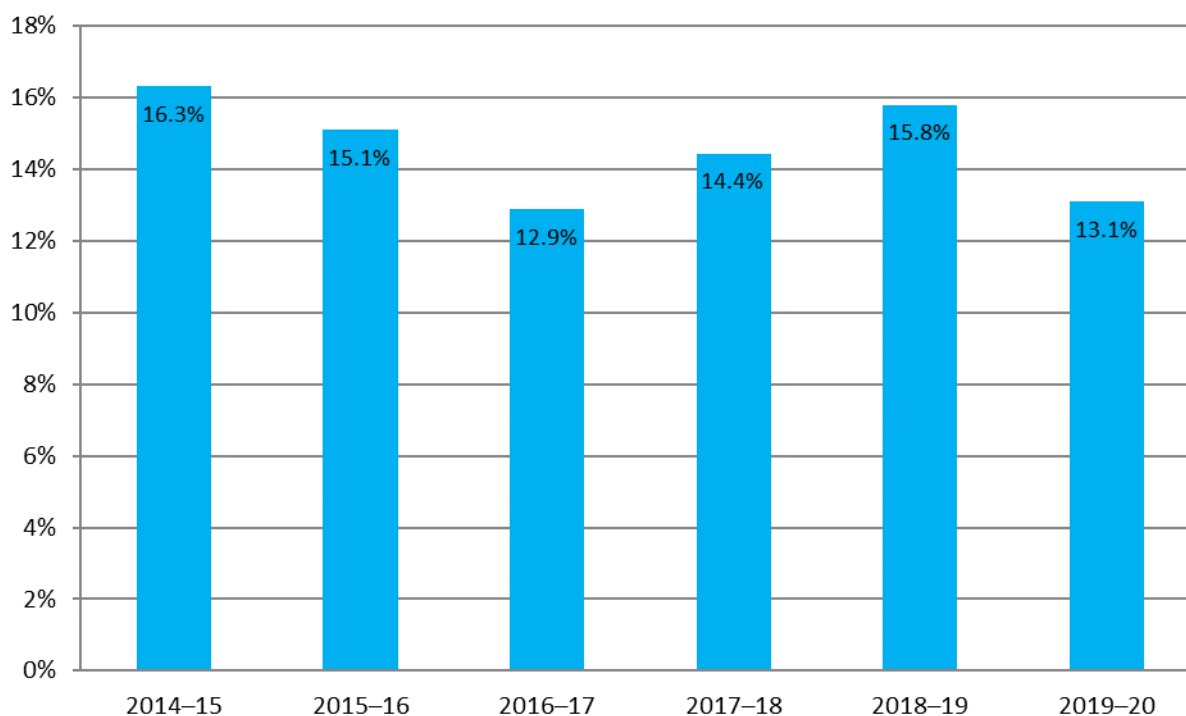




The level of export for reprocessing for 2019–20 was 38.7% and is down markedly from the highest level of 55.3% which occurred in 2015–16. This fall in exports is due to a significant fall in exports of scrap plastics going into energy recovery applications overseas, related to the implementation of import restrictions in receiving countries.

Presented in Figure 3 are the annual plastics recovery rates across 2014–15 to 2019–20.

Figure 3 – Annual Australian plastics recovery rates 2014–15 to 2019–20



3.2 Plastics consumption

This section of the report provides the detailed surveyed consumption data for 2019–20 and surveyed or projected national consumption data across the period of 2009–10 to 2049–50.

3.2.1 Plastics consumption in 2019–20

In 2019–20, nearly 3.5 million tonnes of plastic products were consumed in Australia. Consumption data by polymer type and source location for 2019–20 is summarised in Figure 4 and Table 9.

In 2019–20, around 60% of plastics consumption was through imported finished and semi-finished goods, with only 40% of consumption through local manufacturing using either virgin resins (both locally manufactured and imported) or recycle-based resins. The last decade has seen the local manufacturers of PET, PVC, PS and EPS resins cease production, and at the current time the major resin types still produced in Australia are HDPE, LDPE and PP.



This highlights a particular challenge with respect to increasing recovery of scrap plastics. As 60% of plastic products are now manufactured overseas, and assuming the recovered plastics are to be incorporated into new and similar products, then a significant proportion of this material must be returned into these overseas supply chains at an acceptance price and quality.

Figure 4 – Australian plastics consumption by polymer type and source in 2019–20 (tonnes)

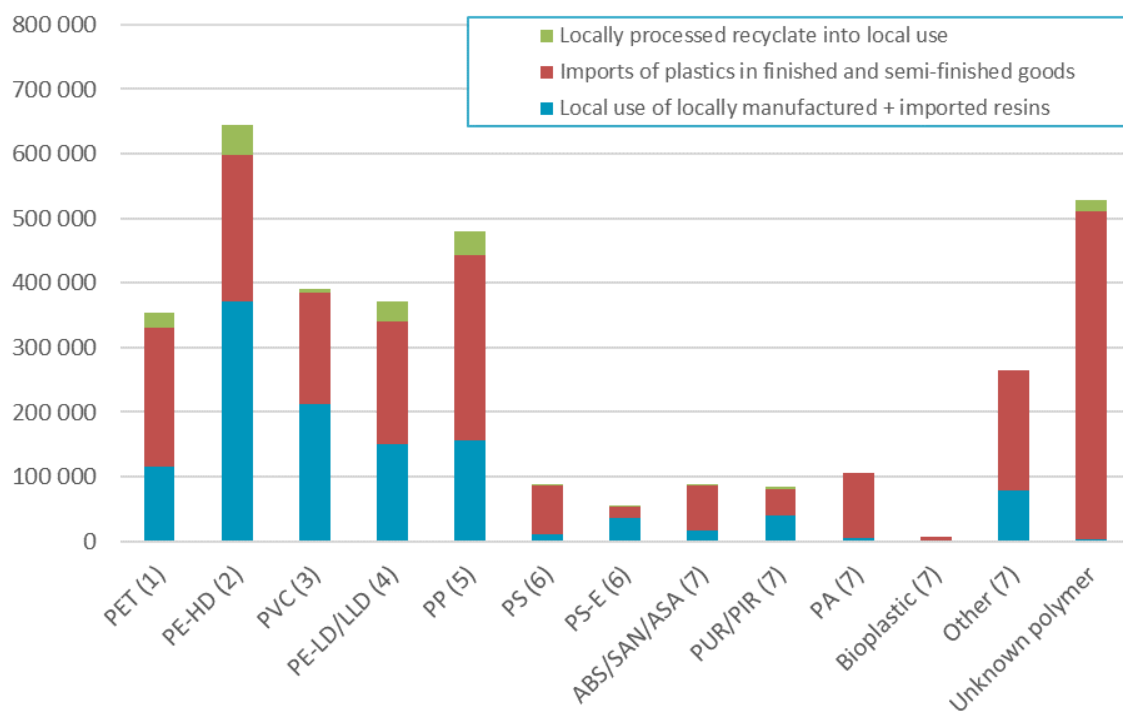




Table 9 – Australian plastics consumption by polymer type and source in 2019–20 (tonnes)

Polymer type	Local use of locally manufactured + imported virgin resins	Imports of plastics in finished and semi-finished goods	Locally processed recycle into local use	Australian consumption
PET (1)	114 600	214 900	25 000	354 500
PE-HD (2)	370 700	228 100	45 000	643 800
PVC (3)	212 800	172 100	5 200	390 100
PE-LD/LLD (4)	150 200	190 800	29 800	370 800
PP (5)	156 900	287 500	36 200	480 600
PS (6)	10 600	75 000	3 100	88 700
PS-E (6)	35 600	17 400	2 900	55 900
ABS/SAN/ASA (7)	16 800	68 700	700	86 200
PUR/PIR (7)	40 400	41 400	3 400	85 200
PA (7)	6 400	99 100	200	105 700
Bioplastic (7)	1 900	6 500	100	8 500
Other (7)	79 500	184 800	400	264 700
Unknown polymer	2 900	507 500	16 600	527 000
Total	1 199 300	2 093 800	168 600	3 461 700

Figure 5, Table 10 and Table 11 present the national consumption of plastics by application areas and polymer types for the 2019–20 period.

Figure 5 shows that in 2019-20:

- The consumption of PET is predominately split between packaging and other applications (mainly clothing and textiles).
- HDPE and LDPE are predominately consumed in packaging applications, however, a reasonable proportion of HPDE goes into the built environment (e.g., pipe and rotational moulding products).
- PVC consumption is dominated by built environment applications, such as pipe and conduit.
- PP consumption is dominated by packaging, transport (e.g. car components) and other application areas.
- A large proportion of PS goes into electrical and electronic applications.
- EPS is largely going into the built environment, followed by electrical and electronic applications, and packaging.



Figure 5 – Plastics consumption by polymer type and application area in 2019–20 (tonnes)

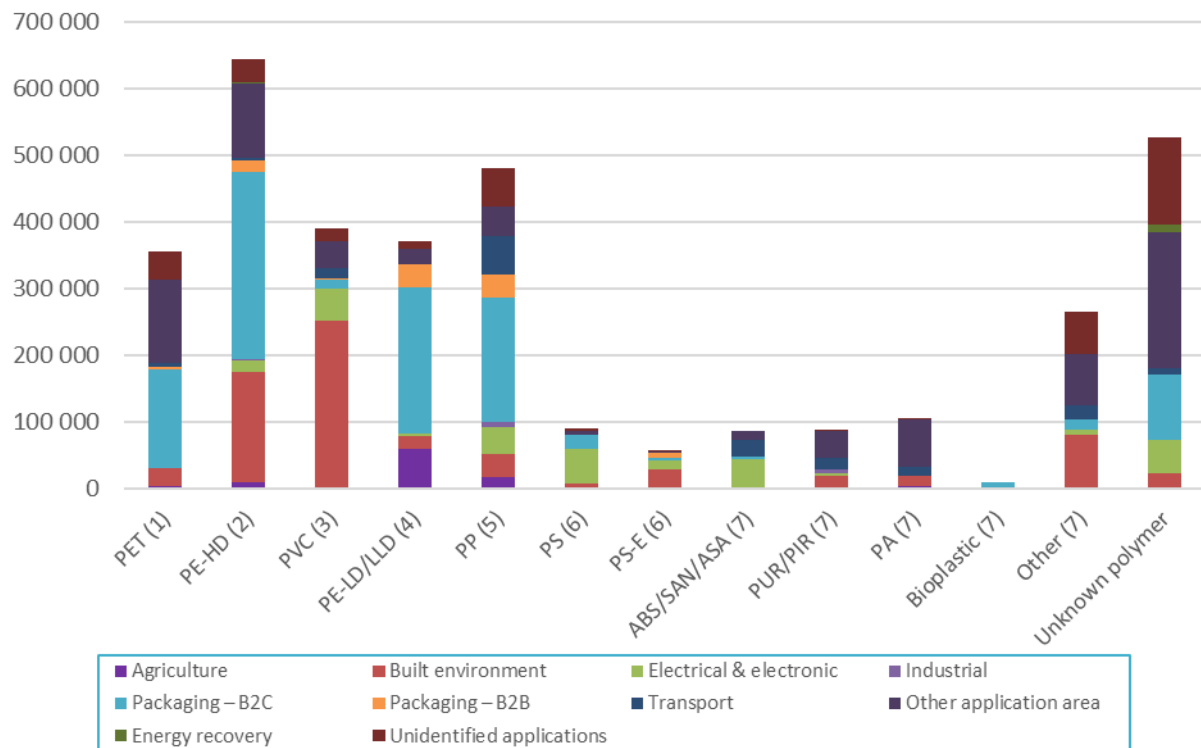




Table 10 – Plastics consumption by polymer type and application area in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Energy recovery	Unidentified applications	Total
PET (1)	3 300	26 200	0	500	147 300	5 000	4 700	125 900	100	41 400	354 400
PE-HD (2)	9 400	165 000	17 600	2 000	280 700	17 500	3 100	112 400	400	35 700	643 800
PVC (3)	400	251 300	47 400	400	14 000	2 100	14 100	41 100	0	19 100	389 900
PE-LD/LLD (4)	59 200	19 000	4 500	100	217 600	35 300	0	23 600	300	11 200	370 800
PP (5)	16 500	34 800	41 000	7 100	186 100	34 500	58 900	44 500	0	57 100	480 500
PS (6)	300	6 900	52 500	0	20 200	300	0	6 300	0	2 300	88 800
PS-E (6)	0	29 000	12 300	0	5 000	6 700	0	2 800	0	200	56 000
ABS/SAN/ASA (7)	0	2 100	42 200	0	2 400	100	25 800	13 500	0	0	86 100
PUR/PIR (7)	200	17 700	3 700	6 300	0	0	18 200	39 000	0	200	85 300
PA (7)	2 300	16 000	0	0	100	0	13 300	72 400	0	1 600	105 700
Bioplastic (7)	400	0	0	0	8 100	0	0	0	0	0	8 500
Other (7)	600	80 300	7 400	200	14 200	100	21 400	77 400	0	63 200	264 800
Unknown polymer	600	21 700	50 700	0	97 800	0	9 300	203 500	11 500	131 900	527 000
Total	93 200	670 000	279 300	16 600	993 500	101 600	168 800	762 400	12 300	363 900	3 461 600



Table 11 – Application area destinations of all plastics by polymer type in 2019–20 (%)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Energy recovery	Unidentified applications	Total
PET (1)	0.9%	7.4%	0.0%	0.1%	41.6%	1.4%	1.3%	35.5%	0.0%	11.7%	100%
PE-HD (2)	1.5%	25.6%	2.7%	0.3%	43.6%	2.7%	0.5%	17.5%	0.1%	5.5%	100%
PVC (3)	0.1%	64.4%	12.2%	0.1%	3.6%	0.5%	3.6%	10.5%	0.0%	4.9%	100%
PE-LD/LLD (4)	16.0%	5.1%	1.2%	0.0%	58.7%	9.5%	0.0%	6.4%	0.1%	3.0%	100%
PP (5)	3.4%	7.2%	8.5%	1.5%	38.7%	7.2%	12.3%	9.3%	0.0%	11.9%	100%
PS (6)	0.3%	7.8%	59.2%	0.0%	22.7%	0.3%	0.0%	7.1%	0.0%	2.6%	100%
PS-E (6)	0.0%	51.9%	21.9%	0.0%	8.9%	12.0%	0.0%	5.0%	0.0%	0.3%	100%
ABS/SAN/ASA (7)	0.0%	2.4%	49.1%	0.0%	2.8%	0.1%	30.0%	15.7%	0.0%	0.0%	100%
PUR/PIR (7)	0.2%	20.8%	4.3%	7.4%	0.0%	0.0%	21.4%	45.8%	0.0%	0.2%	100%
PA (7)	2.2%	15.1%	0.0%	0.0%	0.1%	0.0%	12.6%	68.5%	0.0%	1.5%	100%
Bioplastic (7)	4.3%	0.0%	0.0%	0.0%	95.7%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
Other (7)	0.2%	30.3%	2.8%	0.1%	5.3%	0.0%	8.1%	29.2%	0.0%	23.9%	100%
Unknown polymer	0.1%	4.1%	9.6%	0.0%	18.6%	0.0%	1.8%	38.6%	2.2%	25.0%	100%
Weighted average	2.7%	19.4%	8.1%	0.5%	28.7%	2.9%	4.9%	22.0%	0.4%	10.5%	100%

Note: See Section 1.4. Minor discrepancies in tables may occur between the stated summed totals and the apparent sums of the contributing values, as summed totals and percentage values are calculated using contributing values prior to rounding.



3.2.2 Projected plastics consumption 2009–10 to 2049–50

Consumption by application area

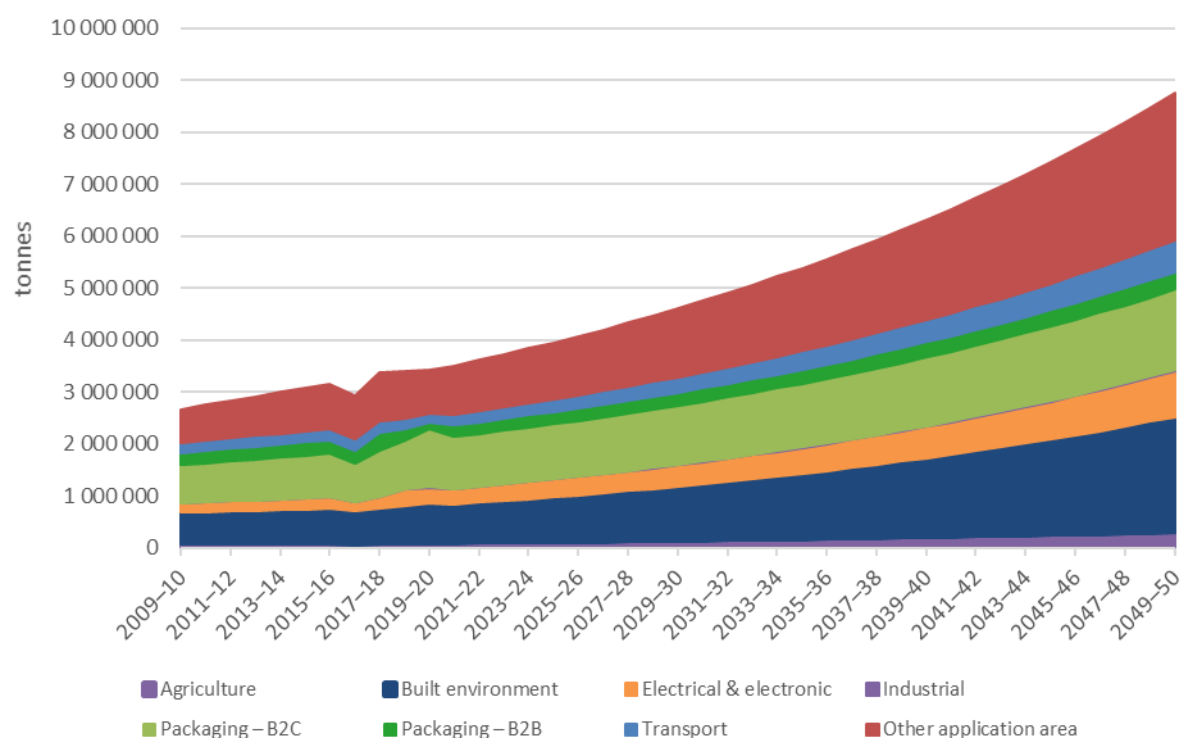
In 2019–20, over 3.4 million tonnes of plastic products were consumed in Australia. Of this, around 36% went into packaging, 25% into the 'Other application area', which includes significant applications such as clothing and footwear, and household goods in general, and 22% into the built environment.

Between 2009–10 and 2019–20, plastics consumption grew by nearly 30%, from less than 2.7 million tonnes to 3.4 million tonnes. Per capita growth has been significantly lower, growing by 10% over the same period, from 121 kg per person to 134 kg per person.

In general, this growth has been across all application areas. Compared to ten years ago, there is now a greater consumption of goods, and/or a higher proportion of plastics in goods, going into agricultural production, vehicles, buildings, electrical and electronic goods, packaging, and many other products.

Based on current trends, by 2049–50, annual plastics consumption in Australia is projected to increase by 155% from 2019–20 to 8.8 million tonnes. This would equate to an annual per capita consumption of around 236 kg per person.

Figure 6 – Australian plastics consumption 2009–10 to 2049–50, by application area





By 2049–50, consumption of plastics into the 'Other application area' (which includes household products, clothing and other textiles, and many other non-packaging applications) and the built environment are projected to both grow by 200% or more, so would be 32% and 25% of all plastics consumption, respectively. See Table 6 for the available detail on what is included in these application areas.

Plastics consumption into packaging and electrical and electronic applications are projected to be 22% and 10% of all consumption, respectively.

Table 12 – Australian plastics consumption 2009–10 to 2049–50, by application area

Year	Agriculture (tonnes)	Built environ. (tonnes)	E&E (tonnes)	Industrial (tonnes)	Packaging – B2C (tonnes)	Packaging – B2B (tonnes)	Transport (tonnes)	Other applic. (tonnes)	Total (tonnes)
2009–10	88 000	592 500	185 700	0	724 700	242 400	187 100	652 100	2 672 400
2014–15	91 100	647 800	215 300	0	826 600	257 600	212 000	826 400	3 076 900
2019–20	104 300	749 600	312 500	18 600	1 111 300	113 600	168 800	852 800	3 431 300
2024–25	121 600	858 800	341 200	7 600	1 052 800	237 700	240 900	1 096 300	3 956 900
2029–30	147 000	1 038 200	412 400	9 100	1 130 800	255 600	291 200	1 325 200	4 609 700
2034–35	177 600	1 254 600	498 400	11 100	1 219 100	274 800	351 900	1 601 500	5 389 000
2039–40	214 600	1 515 700	602 100	13 400	1 317 400	295 400	425 100	1 934 700	6 318 500
2044–45	259 200	1 830 600	727 200	16 100	1 427 100	317 500	513 500	2 336 700	7 427 900
2049–50	313 000	2 210 300	878 100	19 500	1 550 700	341 200	619 900	2 821 400	8 754 100

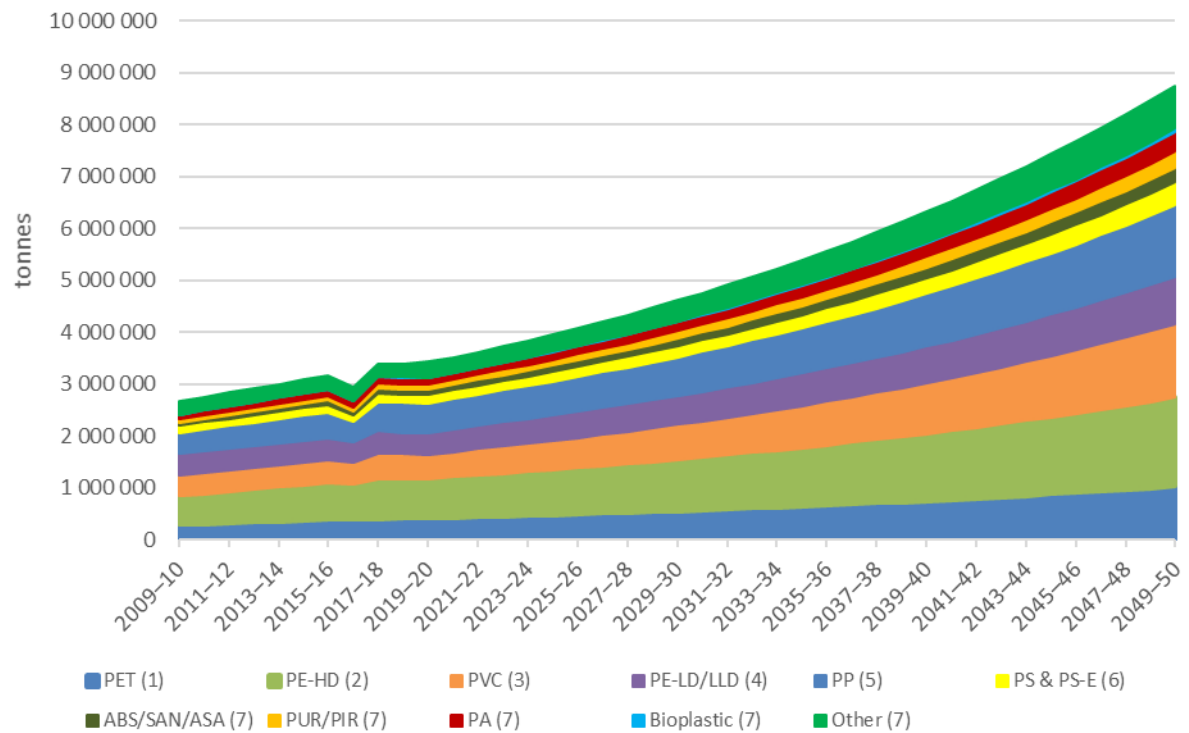
Note: In Table 12 and Figure 6, 'Unidentified applications' are allocated to the other applications on a pro-rated basis.

Consumption by polymer type

Figure 7 and Table 13 present projected Australian plastics consumption, by polymer type, to 2049–50. Of the 3.4 million tonnes of plastic products that were consumed in Australia in 2019–20, around 35% were PE (HDPE and LDPE), 17% was PP, 13% was PVC and 12% was PET.



Figure 7 – Australian plastics consumption 2009–10 to 2049–50, by polymer type



Note: See Table 1 on page 9, or glossary, for polymer type abbreviation full names.



Table 13 – Australian plastics consumption 2009–10 to 2049–50, by polymer type

Year	PET (1)	PE-HD (2)	PVC (3)	PE-LD/LLD (4)	PP (5)	PS & PS-E (6)	ABS/SAN/ASA (7)	PUR/PIR (7)	PA (7)	Bioplastic (7)	Other (7)	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)
2009–10	288 400	548 000	397 600	413 700	413 300	135 700	55 300	79 900	71 100	1 200	268 200	2 672 400
2014–15	373 500	672 300	443 100	419 400	479 100	150 100	74 000	91 000	110 900	2 400	261 200	3 076 900
2019–20	411 500	757 000	459 000	436 100	565 500	170 200	101 400	100 300	108 800	10 000	311 400	3 431 300
2024–25	479 400	860 100	566 400	489 900	652 200	185 900	114 900	119 600	146 400	9 200	332 700	3 956 900
2029–30	556 100	979 300	679 600	552 000	752 500	216 900	138 400	144 400	176 700	13 600	400 200	4 609 700
2034–35	646 600	1 119 000	815 900	623 200	871 200	257 300	166 500	174 300	213 300	20 200	481 300	5 389 000
2039–40	753 600	1 283 500	980 200	705 400	1 012 000	306 800	200 500	210 300	257 300	29 900	579 000	6 318 500
2044–45	880 100	1 477 500	1 178 100	800 200	1 179 200	366 600	241 300	253 700	310 400	44 400	696 400	7 427 900
2049–50	1 030 100	1 706 700	1 416 500	910 100	1 378 000	438 400	290 400	306 000	374 300	65 800	837 700	8 754 100

Note: In Table 13 and Figure 7 'Unknown polymer' are allocated to the polymer types on a pro-rated basis.

Based on current trends, by 2049–50 the consumption of polyethylenes (HDPE and LDPE) are projected to be 2.6 million tonnes, which is 30% of the projected total for plastics consumption. This will be followed by PVC at 1.4 million tonnes (16%), PP at a little under 1.4 million tonnes (16%), and PET at 1.0 million tonnes (12%).

Polymer types with a larger exposure to non-packaging applications (e.g., PVC, ABS/SAN/ASA, PUR/PIR and PA) are anticipated to see more significant growth rates out to 2049–50. This is based on growth rates over the last 5 years, and industry reports of anticipated market growth by application area and polymer type.



3.3 Plastics End-of-Life (EoL) arisings

This section of the report presents the detailed material flow analysis (MFA) modelled end-of-life (EoL) arisings data for 2019–20, and projected national EoL arisings estimates across the period of 2009–10 to 2049–50.

3.3.1 Plastics End-of-Life (EoL) arisings in 2019–20

Figure 8 and Table 14 present the national estimated EoL arisings of plastics in 2019–20, by application area and polymer type. These are modelled estimates based on the method described in Section 2.3.

It is estimated that during the 2019–20 year there were 2 496 700 tonnes of plastic products reaching end-of-life in Australia. Of this, an estimated 1 035 000 tonnes (41%) were from packaging related applications, 607 700 tonnes (24%) were from 'Other' application areas, and 183 000 tonnes (7%) were from built environment applications.

Figure 8 – Application area sources of all EoL plastics by polymer type in 2019–20 (tonnes)

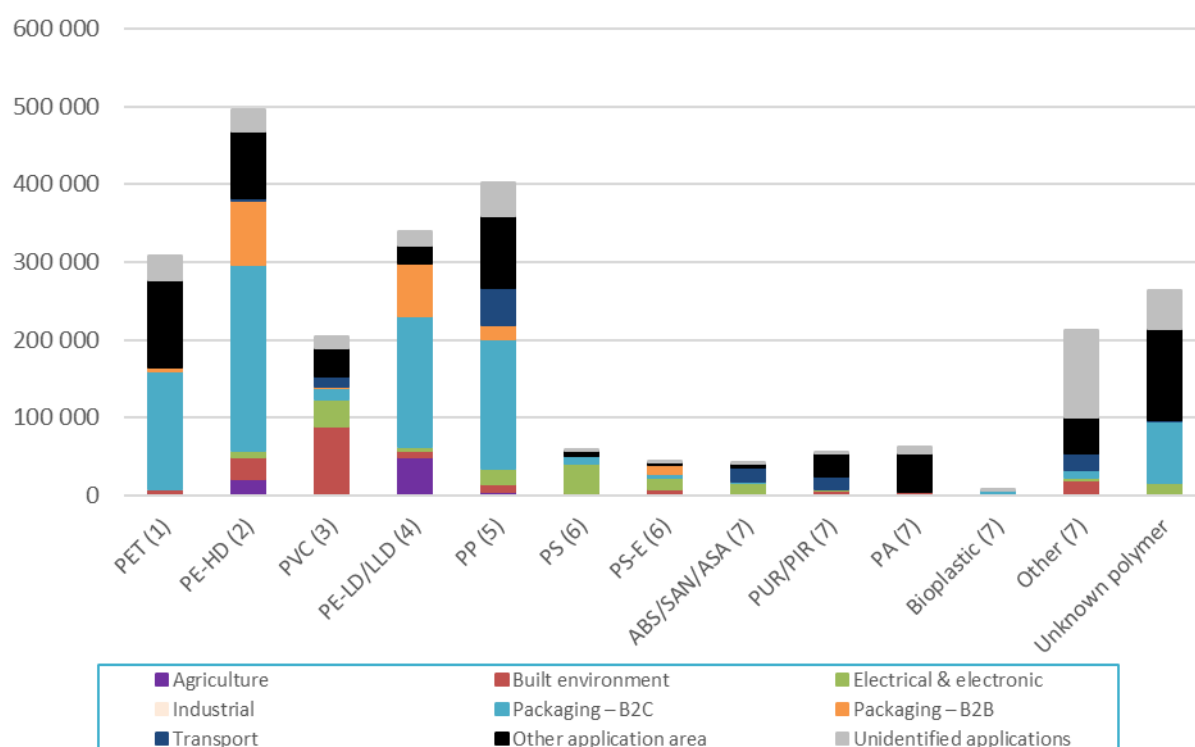




Table 14 – Application area sources of all EoL plastics by polymer type in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial ¹	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Energy recovery	Unidentified applications	Total
PET (1)	2 400	5 700	<100	N/R	152 200	4 600	0	111 300	N/A	32 400	308 600
PE-HD (2)	20 900	28 900	8 700	N/R	239 000	81 800	3 800	85 700	N/A	28 100	496 900
PVC (3)	<100	89 000	34 700	N/R	15 300	200	13 700	36 400	N/A	15 000	204 500
PE-LD/LLD (4)	48 600	9 400	5 300	N/R	168 200	66 900	<100	23 900	N/A	17 800	339 900
PP (5)	5 500	8 500	20 200	N/R	166 000	18 200	47 800	92 700	N/A	43 600	402 600
PS (6)	<100	2 700	38 900	N/R	9 100	200	800	6 500	N/A	200	58 300
PS-E (6)	0	9 000	13 900	N/R	5 100	11 600	0	2 300	N/A	500	42 500
ABS/SAN/ASA (7)	0	200	15 900	N/R	2 500	<100	17 000	4 700	N/A	200	40 700
PUR/PIR (7)	<100	7 200	1 400	N/R	0	0	15 900	29 700	N/A	1 900	56 000
PA (7)	2 200	2 000	<100	N/R	<100	0	0	50 100	N/A	8 300	62 800
Bioplastic (7)	<100	0	0	N/R	6 400	0	0	0	N/A	<100	6 400
Other (7)	300	20 000	3 500	N/R	9 000	200	21 100	46 800	N/A	112 300	213 200
Unknown polymer	500	500	16 000	N/R	78 400	0	2 100	117 500	N/A	49 100	264 100
Total	80 600	183 000	158 800	N/R	851 200	183 800	122 200	607 700	N/A	309 400	2 496 700

1. N/R indicates data was not reported. Insufficient historical consumption data available to estimate industrial application area plastics EoL arisings.

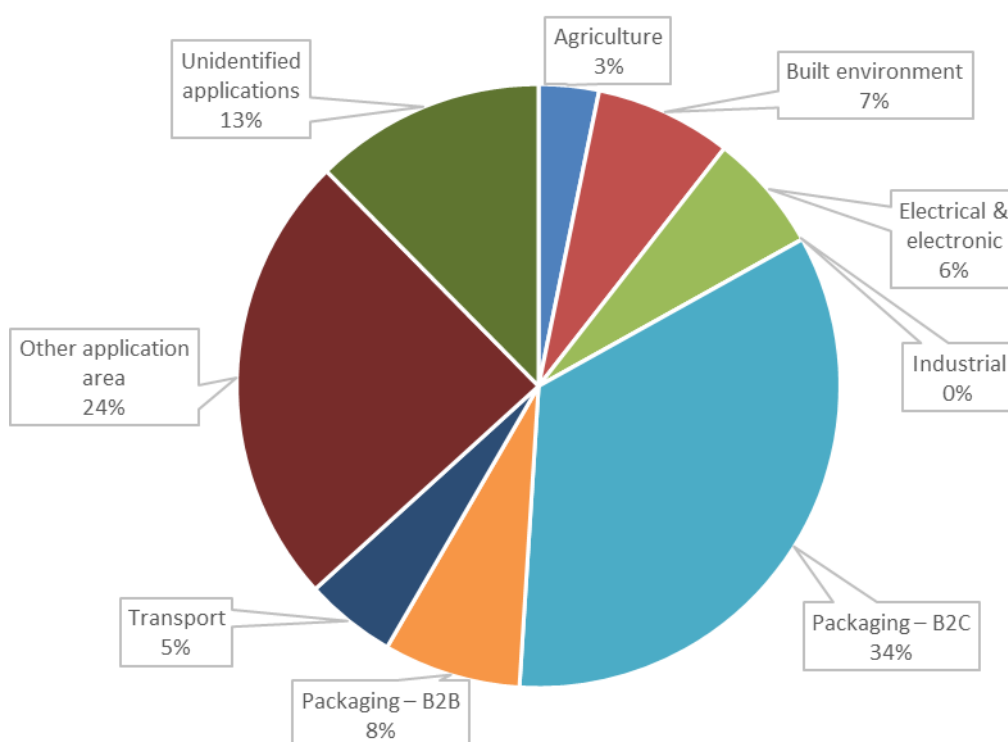


Table 15 – Application area sources of all EoL plastics by polymer type in 2019–20 (%)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Energy recovery	Unidentified applications	Total
PET (1)	0.8%	1.8%	0.0%	0.0%	49.3%	1.5%	0.0%	36.1%	0.0%	10.5%	100%
PE-HD (2)	4.2%	5.8%	1.8%	0.0%	48.1%	16.5%	0.8%	17.3%	0.0%	5.7%	100%
PVC (3)	0.0%	43.5%	17.0%	0.0%	7.5%	0.1%	6.7%	17.8%	0.0%	7.4%	100%
PE-LD/LLD (4)	14.3%	2.8%	1.6%	0.0%	49.5%	19.7%	0.0%	7.0%	0.0%	5.2%	100%
PP (5)	1.4%	2.1%	5.0%	0.0%	41.2%	4.5%	11.9%	23.0%	0.0%	10.8%	100%
PS (6)	0.0%	4.6%	66.7%	0.0%	15.5%	0.3%	1.3%	11.2%	0.0%	0.3%	100%
PS-E (6)	0.0%	21.2%	32.8%	0.0%	12.1%	27.3%	0.0%	5.5%	0.0%	1.1%	100%
ABS/SAN/ASA (7)	0.0%	0.6%	39.2%	0.0%	6.2%	0.2%	41.9%	11.4%	0.0%	0.6%	100%
PUR/PIR (7)	0.0%	12.9%	2.5%	0.0%	0.0%	0.0%	28.4%	53.0%	0.0%	3.3%	100%
PA (7)	3.6%	3.2%	0.0%	0.0%	0.1%	0.0%	0.0%	79.8%	0.0%	13.3%	100%
Bioplastic (7)	0.8%	0.0%	0.0%	0.0%	99.2%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
Other (7)	0.1%	9.4%	1.7%	0.0%	4.2%	0.1%	9.9%	22.0%	0.0%	52.7%	100%
Unknown polymer	0.2%	0.2%	6.1%	0.0%	29.7%	0.0%	0.8%	44.5%	0.0%	18.6%	100%
Weighted average	3.2%	7.3%	6.4%	0.0%	34.1%	7.4%	4.9%	24.3%	0.0%	12.4%	100%



Figure 9 – Application area sources of all EoL plastics by polymer type in 2019–20 (%)



3.3.2 Projected plastics End-of-Life (EoL) arisings 2009–10 to 2049–50

EoL arisings by application area

Based on current trends, annual plastics EoL arisings are projected to increase by 135% across the period 2019–20 to 2049–50 to 5.9 million tonnes. By 2049–50, annual per capita EoL arisings will be around 159 kg per person, which is more than the estimated 2019–20 consumption of 134 kg per person.

It is worth noting that the MFA model underlying this report estimates that there were 2.5 million tonnes of plastics EoL arisings in 2018–19. This is consistent with the *National Waste Report 2018–19* estimate, which is based on a direct analysis of waste to landfill quantities and waste audit data, also estimated as 2.5 million tonnes (Blue Environment, 2020, p. 38).

By 2049–50, EoL arisings of plastics from the built environment are projected to grow by 250% to 600 000 tonnes, and the 'Other application area' (which includes household products, clothing and other textiles, and many other non-packaging applications) by nearly 200% to 2.1 million tonnes.

By 2049–50, EoL arisings of plastics from the 'Other application area' are projected to be 35% of plastics EoL arisings, which would make this application area the largest contributor to EoL arisings. This is followed by plastics EoL arisings from the packaging application area of 1.9 million tonnes (32% of EoL arisings), and the built environment application area of 700 000 tonnes (13% of EoL arisings).



Figure 10 – Australian plastics EoL arising 2009–10 to 2049–50, by application area

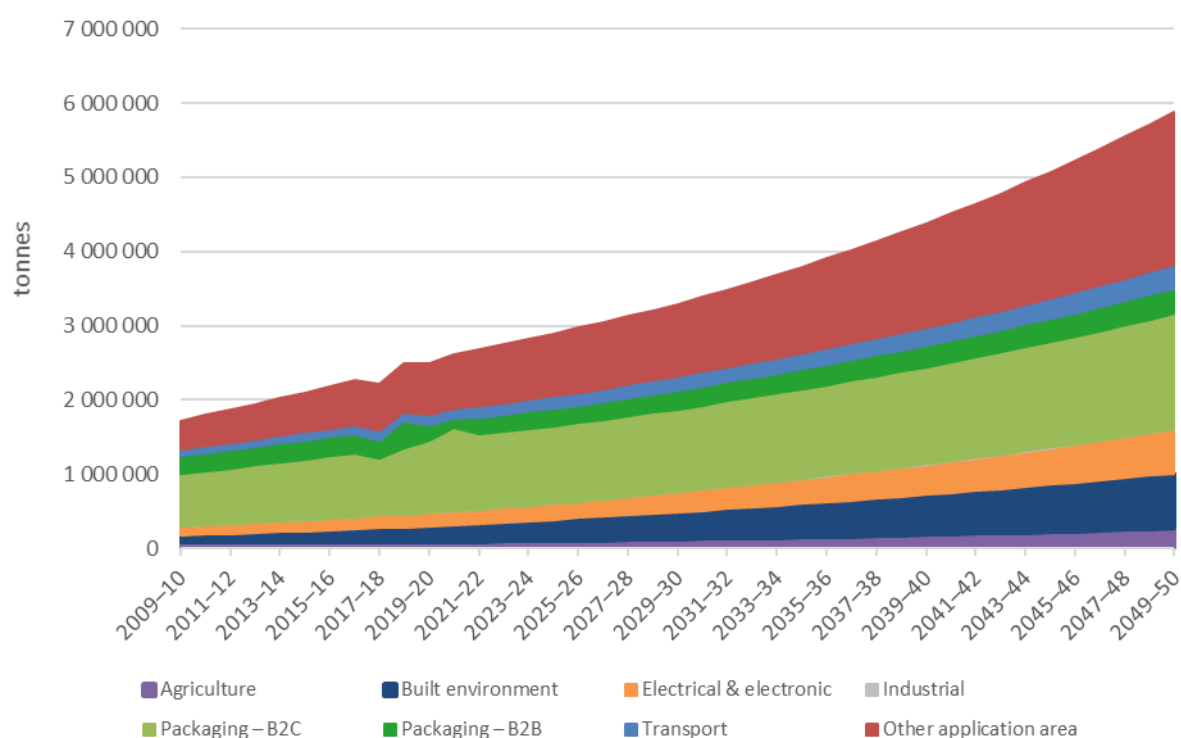


Table 16 – Australian plastics EoL arising 2009–10 to 2049–50, by application area

Year	Agriculture (tonnes)	Built environ. (tonnes)	E&E (tonnes)	Industrial (tonnes)	Packaging – B2C (tonnes)	Packaging – B2B (tonnes)	Transport (tonnes)	Other applic. (tonnes)	Total (tonnes)
2009–10	86 200	89 200	118 000	0	711 900	241 900	84 600	390 100	1 721 900
2014–15	89 900	143 200	150 400	0	817 400	258 100	111 000	527 400	2 097 300
2019–20	92 000	208 900	181 200	0	971 600	209 800	139 400	693 700	2 496 700
2024–25	106 500	283 000	213 000	200	1 046 500	236 100	167 200	842 900	2 895 400
2029–30	127 400	363 200	267 300	1 000	1 118 500	252 900	191 400	972 600	3 294 300
2034–35	154 000	448 500	336 000	2 800	1 206 000	272 000	212 200	1 160 300	3 791 900
2039–40	186 500	538 000	407 600	5 400	1 305 700	293 100	236 300	1 405 100	4 377 800
2044–45	225 800	633 800	493 300	7 900	1 417 200	315 900	273 000	1 701 300	5 068 300
2049–50	272 300	740 200	595 200	10 000	1 542 500	340 300	324 700	2 052 700	5 877 700

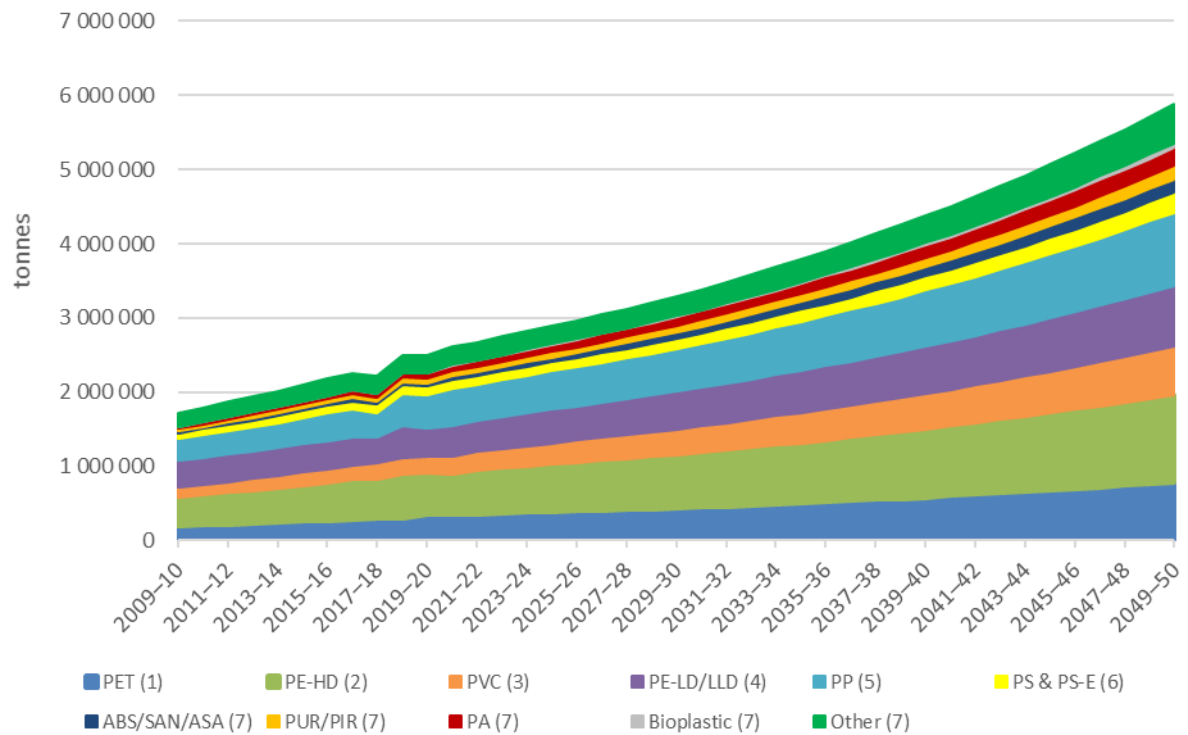
Note: 'Unidentified applications' are allocated to the other application areas on a pro-rated basis.

EoL arisings by polymer type

Figure 11 shows projections of Australian plastics EoL arisings by polymer type to 2049–50. By 2049–50, EoL arisings of HDPE are projected to be nearly 1.2 million tonnes (20%) of all EoL arisings. This will be followed by PP at 1.0 million tonnes (17%), LDPE at 0.8 million tonnes (14%), and PET at a little under 0.8 million tonnes (13%).



Figure 11 – Australian plastics EoL arisings 2009–10 to 2049–50, by polymer type



Note: See Table 1 on page 9 for polymer type abbreviation full names.



Table 17 – Australian plastics EoL arisings 2009–10 to 2049–50, by polymer type

Year	PET (1)	PE-HD (2)	PVC (3)	PE-LD/LLD (4)	PP (5)	PS & PS-E (6)	ABS/SAN/ASA (7)	PUR/PIR (7)	PA (7)	Bioplastic (7)	Other (7)	Total
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)
2009–10	196 000	383 000	132 000	366 000	289 000	82 000	24 000	39 000	23 000	1 000	188 000	1 722 000
2014–15	260 000	479 000	179 000	377 000	352 000	101 000	33 000	51 000	41 000	2 000	223 000	2 097 000
2019–20	345 000	556 000	229 000	380 000	450 000	113 000	46 000	63 000	70 000	7 000	238 000	2 497 000
2024–25	391 000	633 000	285 000	453 000	519 000	123 000	62 000	75 000	98 000	8 000	249 000	2 895 000
2029–30	441 000	715 000	346 000	506 000	578 000	137 000	85 000	89 000	115 000	13 000	270 000	3 294 000
2034–35	506 000	806 000	412 000	568 000	657 000	161 000	107 000	106 000	138 000	19 000	313 000	3 792 000
2039–40	586 000	911 000	483 000	638 000	751 000	190 000	127 000	126 000	168 000	28 000	370 000	4 378 000
2044–45	680 000	1 034 000	563 000	718 000	862 000	225 000	151 000	149 000	205 000	41 000	439 000	5 068 000
2049–50	789 000	1 176 000	655 000	808 000	994 000	265 000	181 000	178 000	248 000	62 000	522 000	5 878 000

Note: In Table 17 and Figure 11 'Unknown polymer' are allocated to the other polymer types on a pro-rated basis.



3.4 Plastics recovery in 2019–20

3.4.1 Recovery quantities

Table 18 and Figure 12 present overall plastics recovery in 2019–20, broken down into the destination of recovered recyclate for reprocessing (i.e., local reprocessing for local use, local reprocessing for export or export for reprocessing). These estimates include scrap plastics sent to energy recovery fates.

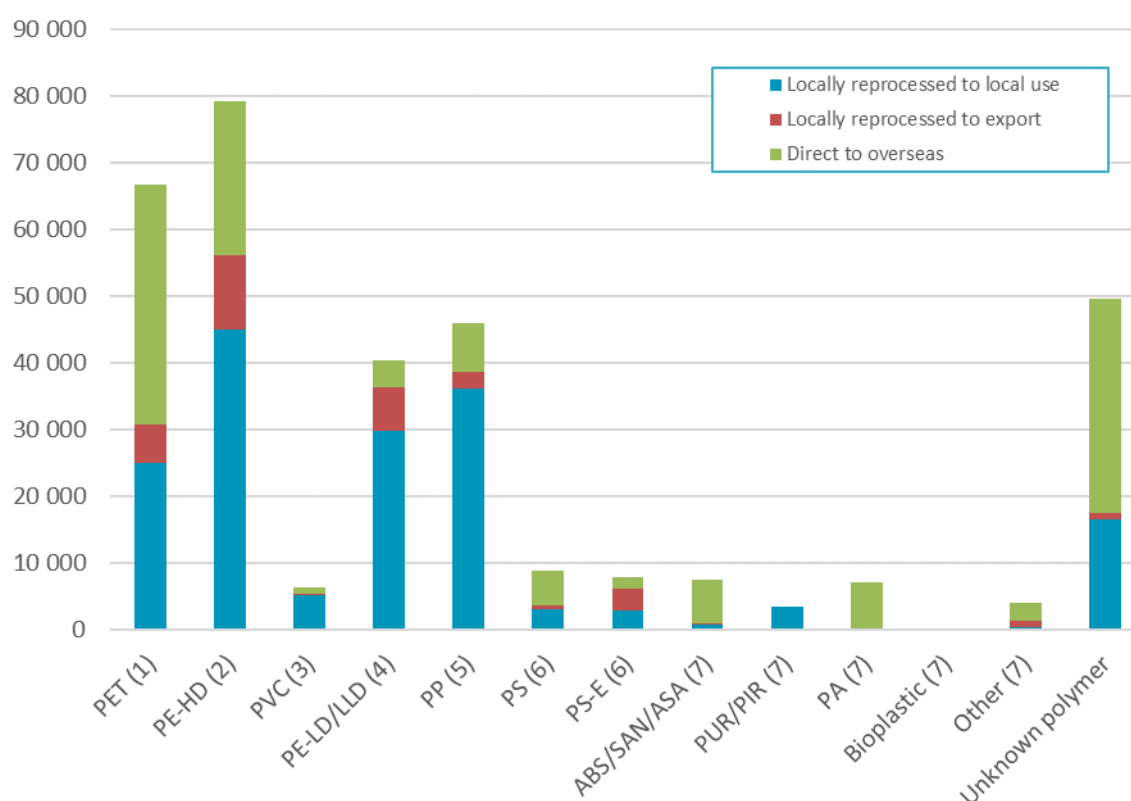
Table 18 – Australian plastics reprocessing destination by polymer type in 2019–20 (tonnes)

Polymer type	Locally reprocessed to local use	Locally reprocessed to export	Exported for reprocessing	Total recovery
PET (1)	25 000	5 700	35 900	66 600
PE-HD (2)	45 000	11 100	23 000	79 100
PVC (3)	5 200	100	1 100	6 400
PE-LD/LLD (4)	29 800	6 500	4 000	40 300
PP (5)	36 200	2 400	7 300	45 900
PS (6)	3 100	600	5 100	8 800
PS-E (6)	2 900	3 200	1 700	7 800
ABS/SAN/ASA (7)	700	200	6 600	7 500
PUR/PIR (7)	3 400	0	0	3 400
PA (7)	200	0	7 000	7 200
Bioplastic (7)	100	0	0	100
Other (7)	400	1 000	2 600	4 000
Unknown polymer	16 600	800	32 100	49 500
Total	168 600	31 600	126 400	326 600

Of the locally reprocessed plastics, 51.6% went to local use and 9.7% was exported. Of the remaining 38.7% of scrap plastic exported for reprocessing, 57% are estimated to be from packaging sources (both B2C and B2B packaging), 22% from 'Other' applications (primarily used clothing exports), and 10% from electrical and electronic sources (primarily NTCRS sourced scrap plastics).



Figure 12 – Australian plastics reprocessing destination by polymer type in 2019–20 (tonnes)



Application area sources of recyclate

Presented in Table 19 and Figure 13 are national sources of recyclate in 2018–19 by polymer type and application area.

Plastics recovery from packaging applications dominates overall recovery, with packaging from B2C and B2B packaging sources making up 47% and 20% of total recovery respectively. Recovery from all other application areas contributes around 33% of the total, with major recovery routes being C&D (built environment) material recovery (mainly into energy recovery), e-waste recycling and the export of used clothing (under other application areas).

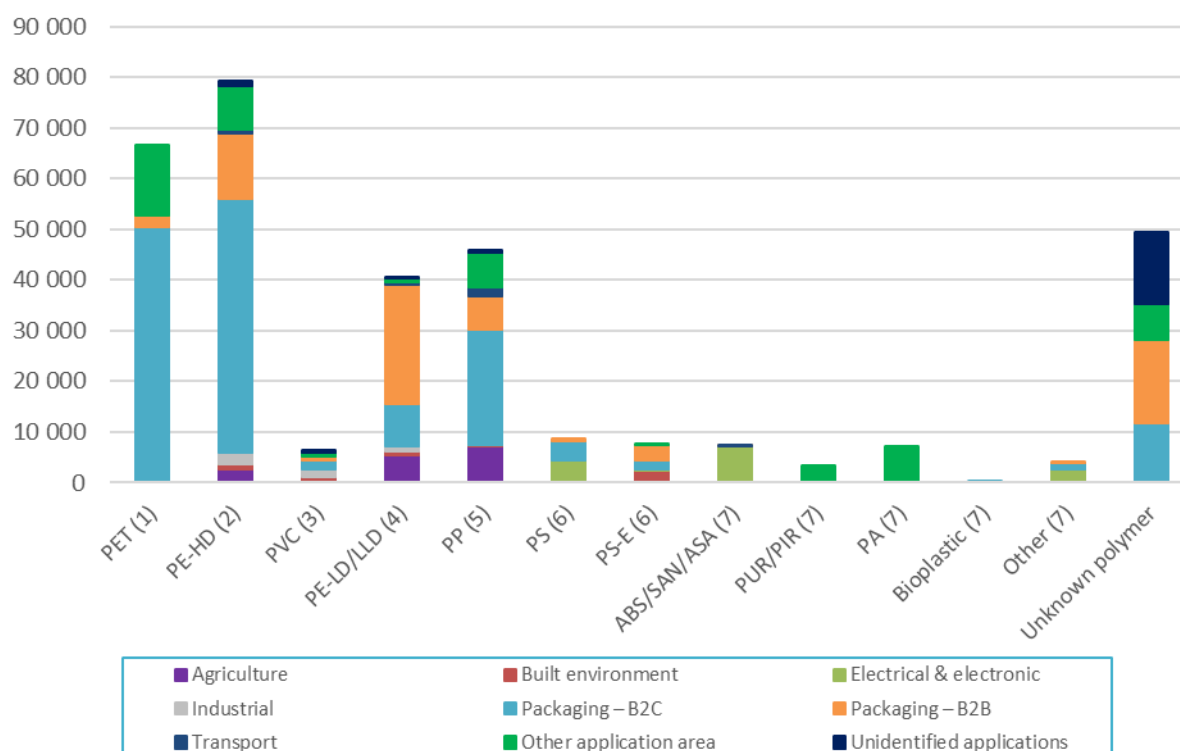


Table 19 – Application area sources of recyclate by polymer type in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Unidentified applications	Total
PET (1)	0	0	300	0	50 200	2 200	0	14 000	0	66 700
PE-HD (2)	2 600	1 000	100	2 100	50 200	13 000	600	8 700	900	79 100
PVC (3)	0	1 200	0	1 500	1 800	600	0	900	300	6 400
PE-LD/LLD (4)	5 500	600	0	1 000	8 500	23 500	500	600	300	40 400
PP (5)	7 200	100	100	0	22 900	6 600	1 700	6 900	500	45 900
PS (6)	300	0	4 100	0	3 900	500	0	0	0	8 800
PS-E (6)	300	2 100	100	0	1 800	3 200	0	300	0	7 800
ABS/SAN/ASA (7)	0	200	6 900	0	0	100	300	0	0	7 500
PUR/PIR (7)	0	0	0	0	0	100	0	3 400	0	3 500
PA (7)	0	0	0	0	100	0	0	7 000	0	7 200
Bioplastic (7)	0	0	0	0	100	0	0	0	0	100
Other (7)	0	0	2 700	0	1 200	100	0	0	0	4 000
Unknown polymer	0	0	100	0	11 700	16 500	0	7 000	14 100	49 500
Total	15 800	5 200	14 300	4 700	152 300	66 400	3 000	48 900	16 200	326 600



Figure 13 – Application area sources of recyclate by polymer type in 2019–20 (tonnes)



Application area destinations of locally reprocessed recyclate

Presented in Table 20 and Figure 14 are the destinations of locally reprocessed recyclate in 2019–20 by polymer type and application area. This data is obtained through the survey of local reprocessors and includes processed scrap plastics that local reprocessors sell into both local and export markets.

The data reported here represents locally reprocessed recyclate only. It excludes unprocessed scrap plastics sent directly to export as sufficiently detailed information on the destination applications is not available either through the Australian Border Force (ABF) reported data or through export brokers.

The quantity of scrap plastics to local reprocessors in 2019–20 (including product subsequently sold to export markets of 31 700 tonnes) was 200 300 tonnes, and the direct to export quantity was 126 300 tonnes.

Scrap plastics into energy recovery went from around 10 000 tonnes in 2017–18, to 72 000 tonnes in 2018–19, and then fell back to 16 000 tonnes in 2019–20. See Section 3.6 for more details on this change.

The manufacture of packaging containing recycled content (across both B2C and B2B packaging formats) accounted for 54 200 tonnes or 27% of processed scrap plastics. The manufacture of products for the built environment consumed another 20% of recovered plastics.

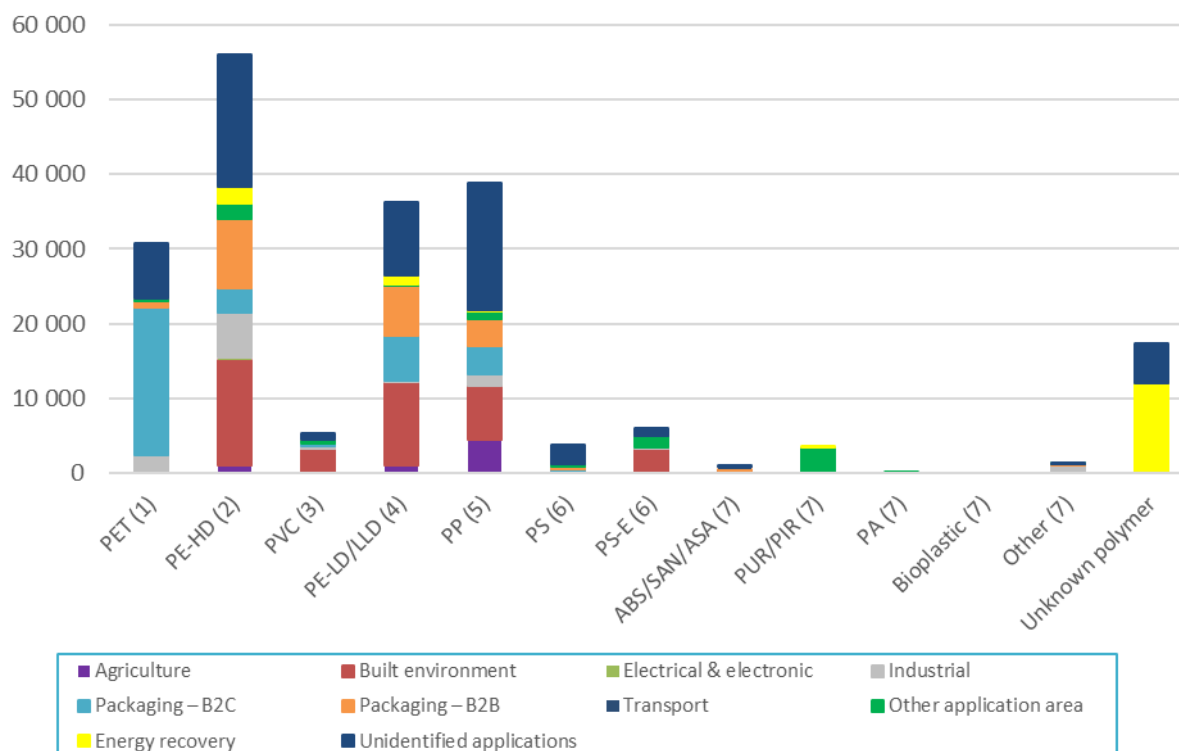


Table 20 – Application area destinations of recyclate from local reprocessors, by polymer type, in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Energy recovery	Unidentified applications	Total
PET (1)	0	0	0	2 400	19 700	900	0	300	100	7 400	30 800
PE-HD (2)	1 100	14 000	400	6 000	3 300	9 300	0	2 000	2 200	17 700	56 100
PVC (3)	0	3 100	100	400	200	0	100	500	100	900	5 300
PE-LD/LLD (4)	1 000	11 200	0	100	6 100	6 700	0	100	1 200	9 800	36 300
PP (5)	4 500	7 200	0	1 500	3 900	3 500	0	1 100	200	16 900	38 600
PS (6)	300	100	0	0	100	300	0	500	0	2 500	3 700
PS-E (6)	0	3 300	0	200	0	0	0	1 500	0	1 100	6 100
ABS/SAN/ASA (7)	0	400	0	0	0	100	300	0	0	200	900
PUR/PIR (7)	0	0	0	0	0	0	0	3 400	100	0	3 500
PA (7)	0	0	0	0	0	0	0	200	0	0	200
Bioplastic (7)	100	0	0	0	0	0	0	0	0	0	100
Other (7)	0	100	0	1 000	0	100	0	100	0	100	1 300
Unknown polymer	0	0	0	0	0	0	0	0	12 000	5 300	17 300
Total	7 000	39 400	500	11 600	33 400	20 800	300	9 500	15 900	61 900	200 300



Figure 14 – Application area destinations of recyclate from local reprocessors, by polymer type, in 2019–20 (tonnes)



3.4.2 Recovery by polymer type

Presented in Table 21 and Figure 15 is summary data of plastics recovery and EoL arisings in terms of polymer types.

The highest recovery rate observed in 2019–20 was for PET at 21.6% (primarily sourced from packaging), followed by ABS/SAN/ASA (primarily from e-waste) at 18.4%, and EPS (primarily from packaging) also at 18.4%. The recovery of these polymers is underpinned by two national product stewardship schemes, which are the Australian Packaging Covenant and the National Television and Computer Recycling Scheme (NTCRS).

The lowest recovery rates were for Bioplastics (1.6%), Other (7) polymer types (1.9%), and PVC (3.1%).

It is important to note that these recovery rates include both pre-consumer manufacturing scrap recovery and post-consumer recovery, and are an overall recovery rate, not a post-consumer recovery rate only. This offers a fuller picture of recovery across the supply chain.

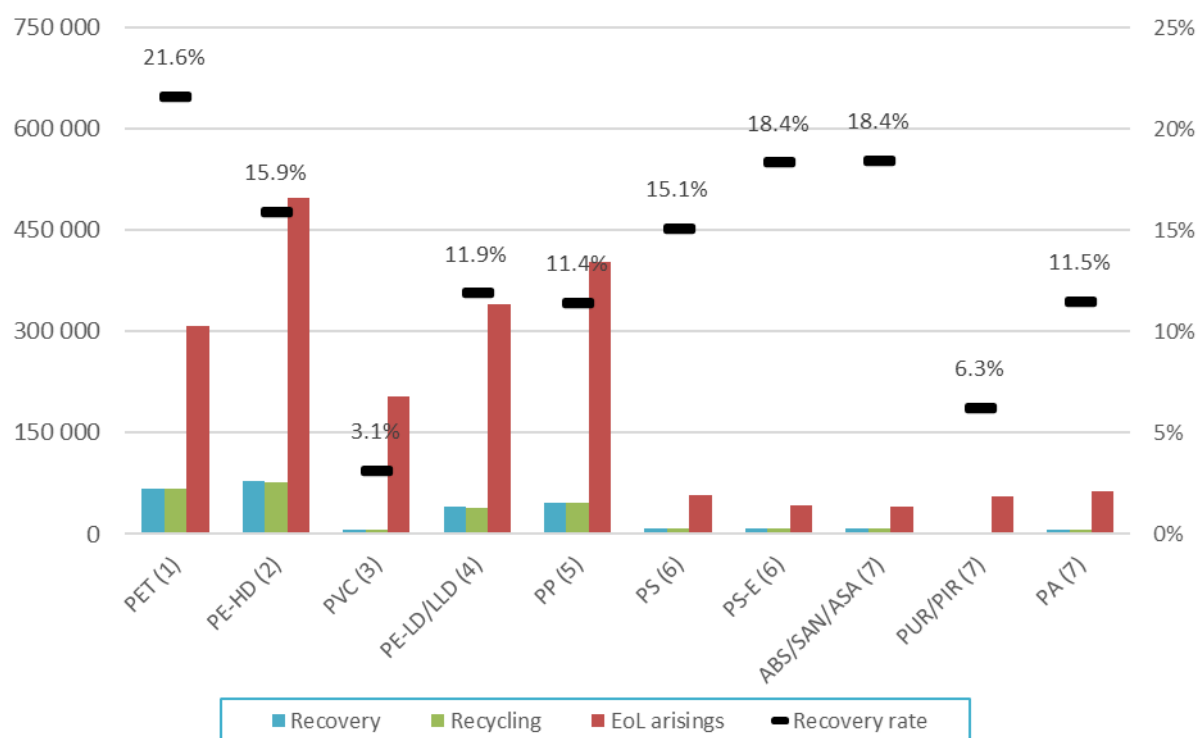


Table 21 – Plastics recovery, recycling, EoL arisings and recovery rate by polymer type in 2019–20 (tonnes and % recovery rate)

Polymer type	Recovery ¹	Recycling	EoL arisings	Recovery rate
PET (1)	66 700	66 500	308 600	21.6%
PE-HD (2)	79 100	76 900	496 900	15.9%
PVC (3)	6 400	6 300	204 500	3.1%
PE-LD/LLD (4)	40 400	39 100	339 900	11.9%
PP (5)	45 900	45 700	402 600	11.4%
PS (6)	8 800	8 800	58 300	15.1%
PS-E (6)	7 800	7 800	42 500	18.4%
ABS/SAN/ASA (7)	7 500	7 500	40 700	18.4%
PUR/PIR (7)	3 500	3 400	56 000	6.3%
PA (7)	7 200	7 200	62 800	11.5%
Bioplastic (7)	100	100	6 400	1.6%
Other (7)	4 000	4 000	213 200	1.9%
Unknown polymer	49 500	37 400	264 100	18.7%
Total	326 600	310 700	2 496 700	13.1%

1. Includes scrap plastics sent to energy recovery, and scrap plastics reprocessed from both pre-consumer and post-consumer sources.

Figure 15 – Plastics recovery, recycling and EoL arisings by polymer in 2019–20 (tonnes and % recovery rate)





3.4.3 Recovery by application area

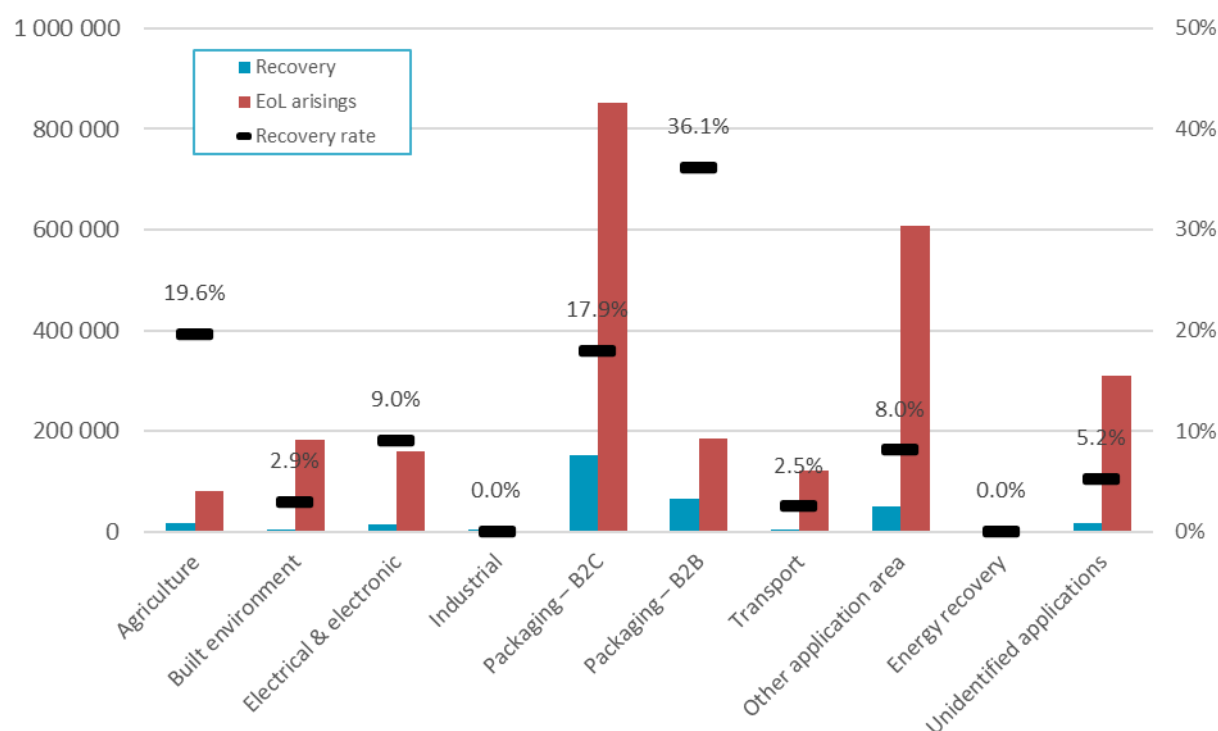
Presented in Table 22 and Figure 16 is summary data of plastics recovery and EoL arisings in terms of the application areas for plastics.

Table 22 – Plastics recovery and EoL arisings by application area in 2019–20 (tonnes and % recovery rate)

Application area	Recovery	EoL arisings	Recovery rate
Agriculture	15 800	80 600	19.6%
Built environment	5 200	183 000	2.9%
Electrical & electronic	14 300	158 800	9.0%
Industrial	4 700	N/R	N/R
Packaging – B2C	152 300	851 200	17.9%
Packaging – B2B	66 400	183 800	36.1%
Transport	3 000	122 200	2.5%
Other application area	48 900	607 700	8.0%
Unidentified applications	16 200	309 400	5.2%
Total	326 600	2 496 700	13.1%

Note: N/R indicates data was not reported.

Figure 16 – Plastics recovery and EoL arisings by application area in 2019–20 (tonnes and % recovery rate)





The quantity of plastic packaging recovery and the recovery rate of 21.1% (combined B2C and B2B packaging) are relatively good compared to all other application areas for plastics. As stated earlier, it is important to note that these recovery rates include both pre-consumer packaging manufacturing scrap recovery and post-consumer packaging recovery, and are an overall recovery rate, not a post-consumer recovery rate only.

There was also a noteworthy jump of nearly 10 000 tonnes in the recovery of EoL plastics from agricultural applications. At least 3 large reprocessors reported significant increases in the quantities of pre-consumer and post-consumer materials received from the agricultural application area. The specific sources of this material are not known in more detail.

At 19.6% and 9.0%, the recovery rates for plastics recovered agricultural and electrical and electronic (E&E) applications respectively are the next highest after packaging. The 'Other application area' recovery rate was 8.0%, with clothing recovery contributing 62% (30 100 tonnes) of this recovery.

In absolute terms, the recovery rates across all application areas continue to be poor to very poor.

3.4.4 Recovery by waste stream

When assessed from a waste/disposal stream perspective, discarded materials are often divided into three waste streams, which are:

- Municipal sector – this sector is dominated by kerbside collections.
- C&I sector – this sector includes both manufacturing scrap and post-consumer industrial recovery (e.g. LDPE pallet film).
- C&D sector – this sector includes both construction waste (e.g. EPS offcuts from waffle pod installation and PVC pipe offcuts) and plastics generated through demolition activities.

Presented in Table 23 and Figure 17 is plastics recovery by waste stream during 2019–20. In aggregate, 57% of plastics were recovered from the municipal sector, 41% from the C&I sector, and 2% from the C&D sector.

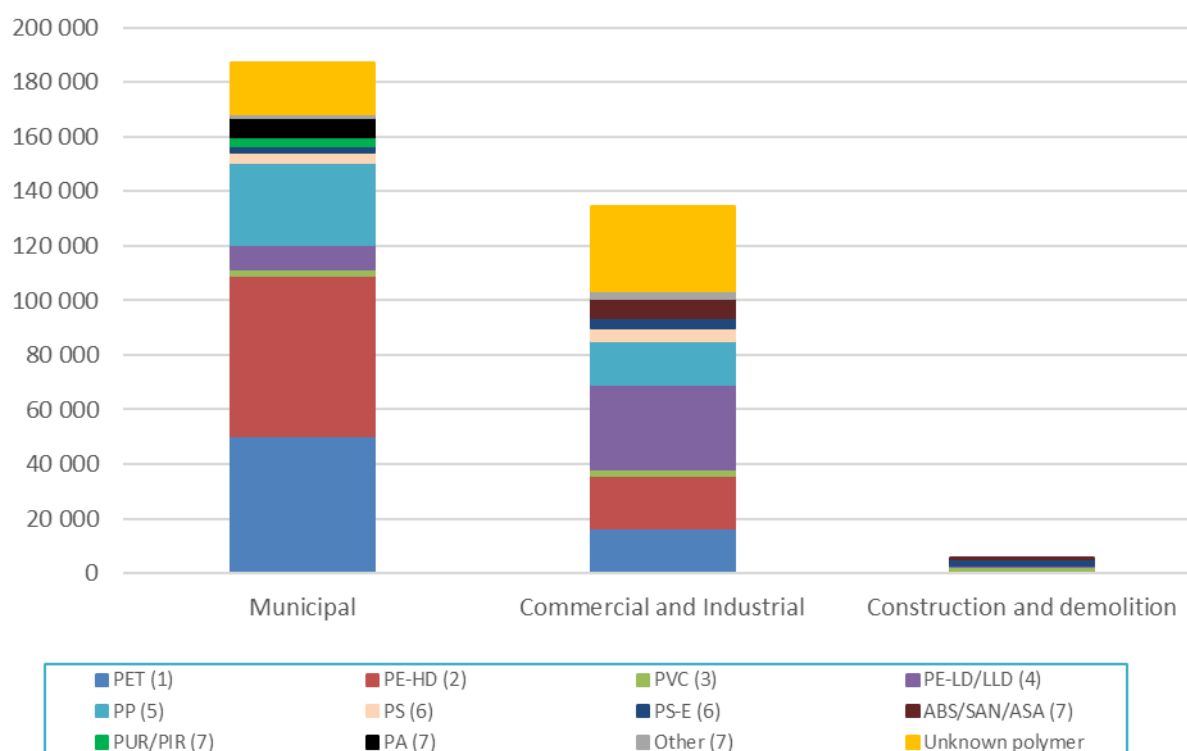
Note that material recovered through container deposit schemes (CDS) is included under the 'Municipal' waste stream in the following table. There were 32 200 tonnes of PET and HDPE packaging collected through CDS programs nationally in 2019–20 (APCO, 2021).



Table 23 – Waste stream sources of recyclate by polymer type in 2019–20 (tonnes)

Polymer type	Municipal	Commercial and Industrial	Construction and demolition	Total
PET (1)	50 200	16 500	0	66 700
PE-HD (2)	58 800	19 200	1 000	79 100
PVC (3)	2 600	2 500	1 200	6 400
PE-LD/LLD (4)	9 000	30 800	600	40 400
PP (5)	29 800	16 000	100	45 900
PS (6)	3 900	4 900	0	8 800
PS-E (6)	2 200	3 500	2 100	7 800
ABS/SAN/ASA (7)	0	7 200	200	7 500
PUR/PIR (7)	3 400	100	0	3 500
PA (7)	7 200	0	0	7 200
Bioplastic (7)	100	0	0	100
Other (7)	1 200	2 800	0	4 000
Unknown polymer	18 700	30 800	0	49 500
Totals	187 200	134 200	5 200	326 600

Figure 17 – Waste stream sources of recyclate by polymer type in 2019–20 (tonnes)





3.4.5 Recovery by waste account industry classification

As a pilot exercise this year, scrap plastics sent to local reprocessors have also been quantified in terms of the Australian Bureau of Statistics (ABS) experimental waste account industry classifications as defined in the ABS publication 4602.0.55.005 (ABS, 2020). This schema is based on the experimental environmental-economic accounts produced by the ABS, which are in turn based on the United Nations System of Environmental-Economic Accounting (SEEA).

The reason for presenting the scrap plastics recovery data in this form is that the industry/sector of use, and the application areas (the classification applied elsewhere in this report) are different types of data, and there is value in having more detail on where EoL plastics are arising in the economy by source industry. It also moves this plastics dataset towards alignment with this developing classification framework, so might support the needs of more data users in the future.

The new waste account industry classifications have only been applied to scrap plastics going to local reprocessors, as sufficiently detailed data on directly exported (unprocessed) scrap plastics was not available to apply the classifications to this material.

The waste account level recovery data is provided in Table 24 and Figure 18. Of the 200 300 tonnes that was reprocessed locally, it is estimated that 32% was recovered from the household sector, 25% was from the 'All other industries' industry classification, and 33% was manufacturing scrap sourced from the plastic products and packaging manufacturing sector.

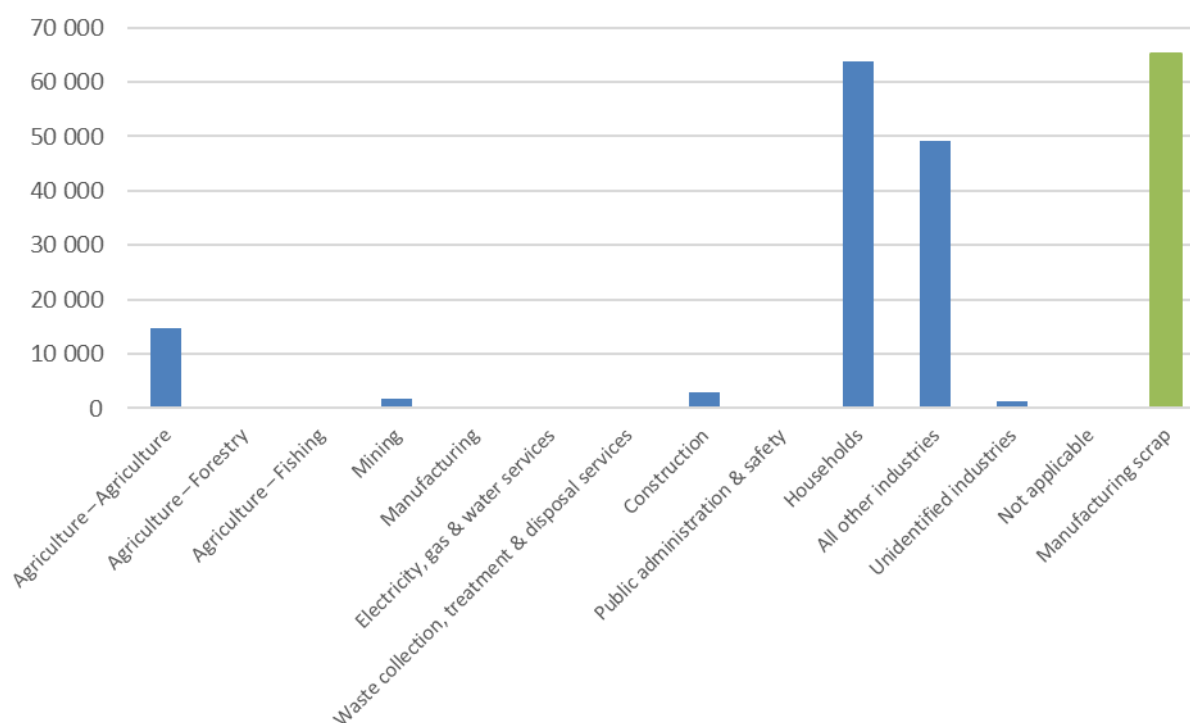
Table 24 – Recovery by waste account industry classification in 2019–20 (tonnes)

Industry classification	Total
Agriculture – Agriculture	14 800
Agriculture – Forestry	0
Agriculture – Fishing	400
Mining	1 800
Manufacturing	65 300
Electricity, gas & water services	400
Waste collection, treatment & disposal services	0
Construction	2 900
Public administration & safety	400
Households	63 800
All other industries ¹	49 200
Unidentified industries	1 200
Direct exports	126 300
Totals	326 600

1. Includes ANZSIC divisions: Wholesale trade; Retail trade; Accommodation and food services; Transport, postal and warehousing; Information media and telecommunications; Financial and insurance services; Rental, hiring and real estate services; Professional, scientific and technical services; Administrative and support services; Education and training (private); Health care and social assistance (private); and Arts and recreation services.



Figure 18 – Recovery by waste account industry classification in 2019–20 (tonnes)



3.5 Scrap plastics to export

This section of the report provides more detailed data on the application areas and polymer types of scrap plastics sent directly to export, prior to any reprocessing activities. The level of data detail available for scrap plastics exports, through the ABS Customs data, is lower than that which can be obtained through the direct survey of local reprocessors, and so the estimates provided here should be seen as indicative only.

Data on used tyre exports is included in this section of the report, except where otherwise identified. This data is included because Australia's export of used tyres is significant and tyres are primarily composed of in-scope plastics, which are; synthetic and natural rubbers (7), nylon (7) and PET (1) materials. The tyre exports exclude the estimated steel fraction of the tyres.

Including tyres in the data in this section of the report does not skew or complicate the reporting of the main time-series data series in previous sections of the report. Note that more detailed data on overall tyre flows is provided in Section 4.1.

In 2019–20, approximately 345 000 tonnes of scrap plastics were reported as exported from Australia under the related scrap export codes. This estimate includes the plastics fractions of tyres, used clothing and e-waste. Another 214 000 tonnes (including tyres) were reprocessed and used locally. This represents an approximate 3:2 split between overseas and local destinations for scrap plastics.

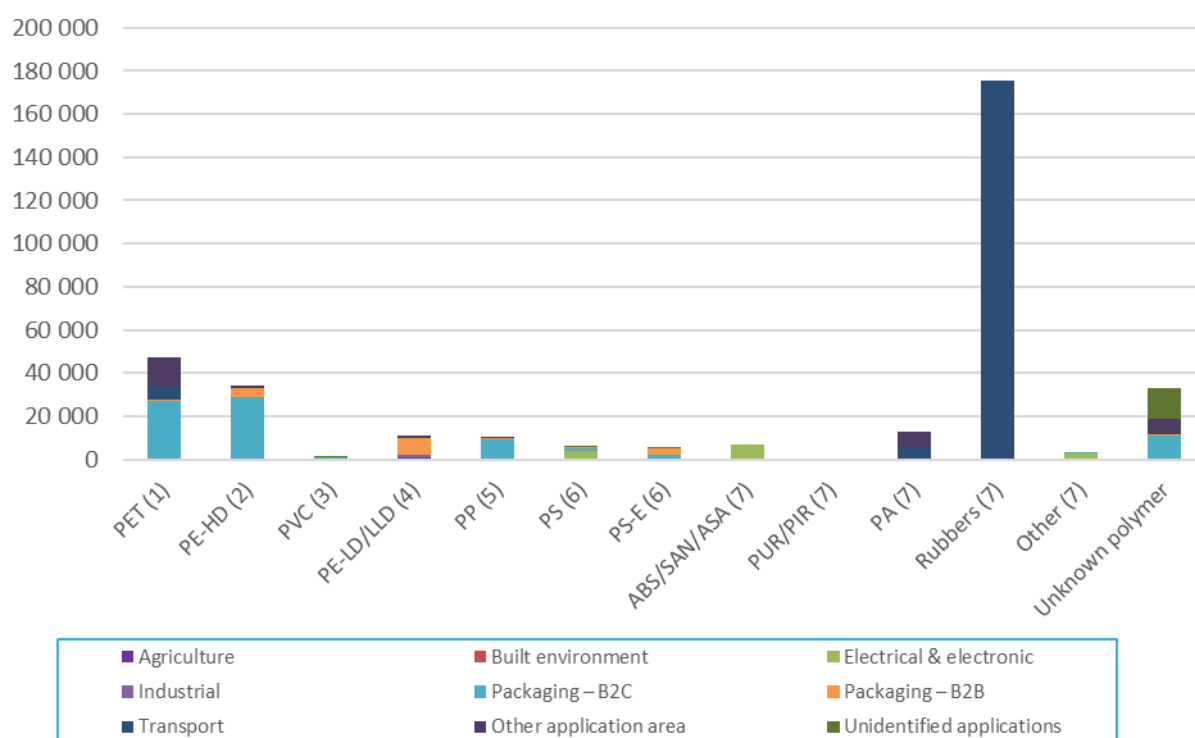
The export quantities are dominated by tyres (rubbers), packaging (PET and HDPE), and clothing (PET and PA), a proportion of which will be reused overseas and then enter overseas waste streams. The other significant identifiable exports are ABS/SAN/ASA and PS recovered from e-waste.



In terms of the source application areas, transport (tyres) is the largest source of exported scrap plastics, followed by the packaging application area.

Figure 19 and Table 25 present detailed data on exported scrap plastics in 2019–20 by polymer type and application area.

Figure 19 – Exports of scrap plastic by source application area and polymer type in 2019–20 (tonnes)



Note that the exported rubber was exported as whole or shredded tyres on about a 1:1 ratio in 2019–20 (TSA, 2020). Shredded tyres that are exported will most commonly be sent to energy recovery, whereas whole tyres can be further processed overseas for energy recovery, processed into tyre crumb, or can be re-treaded.



Table 25 – Sources of recyclate to export by application area and polymer type, in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Energy recovery	Unidentified applications	Total
PET (1)	0	0	0	0	27 200	400	5 700	14 000	0	0	47 300
PE-HD (2)	100	0	100	200	28 800	3 700	0	1 300	0	0	34 200
PVC (3)	0	100	0	0	1 000	0	0	0	0	0	1 100
PE-LD/LLD (4)	1 100	0	0	800	300	7 900	500	0	0	0	10 600
PP (5)	0	0	100	0	9 100	500	0	0	0	0	9 700
PS (6)	0	0	4 100	0	1 200	400	0	0	0	0	5 700
PS-E (6)	200	200	100	0	1 800	2 600	0	0	0	0	4 900
ABS/SAN/ASA (7)	0	0	6 800	0	0	0	0	0	0	0	6 800
PUR/PIR (7)	0	0	0	0	0	0	0	0	0	0	0
PA (7)	0	0	0	0	0	0	5 700	7 000	0	0	12 700
Rubbers (7)	0	0	0	0	0	0	175 200	0	0	0	175 200
Bioplastic (7)	0	0	0	0	0	0	0	0	0	0	0
Other (7)	0	0	2 700	0	900	0	0	0	0	0	3 600
Unknown polymer	0	0	0	0	10 900	900	0	7 000	0	14 100	32 900
Total	1 400	300	13 900	1 000	81 200	16 400	187 100	29 300	0	14 100	344 700



Presented in Table 26 are the destination countries for scrap plastics exports from Australia in 2019–20, compared to export quantities for 2018–19 and 2017–18. Note that the destination countries for tyres are not known in sufficient detail so tyre exports are excluded from this table. Exports to Malaysia and Indonesia fell significantly in 2019–20, which was mostly due to the sharp drop in scrap plastics exports for energy recovery.

Table 26 – Australian scrap plastics destination countries from 2017–18 to 2019–20 (ranked by 2019–20 values)

Destination country	2019–20 export quantity (tonnes)	2018–19 export quantity (tonnes)	2017–18 export quantity (tonnes)
Malaysia	50 700	61 100	44 500
United Arab Emirates	17 300	17 200	0
Hong Kong (SAR of China)	14 400	9 300	15 500
Indonesia	11 100	57 600	28 000
Thailand	8 200	9 800	24 600
Taiwan	6 000	9 300	4 600
Vietnam	3 300	2 900	13 200
Pakistan	2 600	2 700	0
Latvia	2 000	0	0
Korea	2 000	0	0
All other countries	16 600	27 500	15 300
Unknown destinations	23 700	45 100	49 200
Totals	158 000	242 500	194 900

Note 1: Tyre exports are excluded from this table, as accurate data on destination countries was not available.

1. UAE quantities relate to worn clothing. Clothing export data unavailable for 2017–18.

Source: Envisage Works and ABS & IndustryEdge (2021)

3.6 Scrap plastics to energy recovery

This section of the report provides more detailed information on the types of scrap plastics sent to energy recovery in 2019–20, including tyres.

There is a generally growing trend in energy recovery from plastics in Australia, dominated by the export of shredded and whole tyres, and the manufacture of a waste-based fuel ('processed engineered fuel' or PEF) that is produced in South Australia and New South Wales, for combustion in local and overseas cement kilns.

In 2019–20 there were 204 800 t of scrap plastics sent to energy recovery related fates. Of this, nearly 87% (177 300 t) was rubber from tyres, which was almost entirely exported. Another 6% (12 000 t) was the polyester or nylon-based fabric that is incorporated into passenger tyres.



Only 8% (16 000 t) of total scrap plastics sent to an energy recovery fate was not tyres related, and instead was from a range of built environment and packaging related sources. This material was almost entirely made into PEF for use in local and overseas cement kilns. Of this, 4 000 t was exported, and the other 12 000 t was combusted in local cement kilns.

This PEF production has varied dramatically over the last three years. National production was around 10 000 t in 2017–18, but jumped sharply in 2018–19 to an estimated 75 000 t. However, in 2019–20 the market fell sharply to 16 000 t. This was mostly due to the implementation of import restrictions in receiving countries, and COVID-19 related transport and manufacturing impacts.

Figure 20 – Scrap plastics to energy recovery by polymer type, in 2019–20 (tonnes on log₁₀ scale)

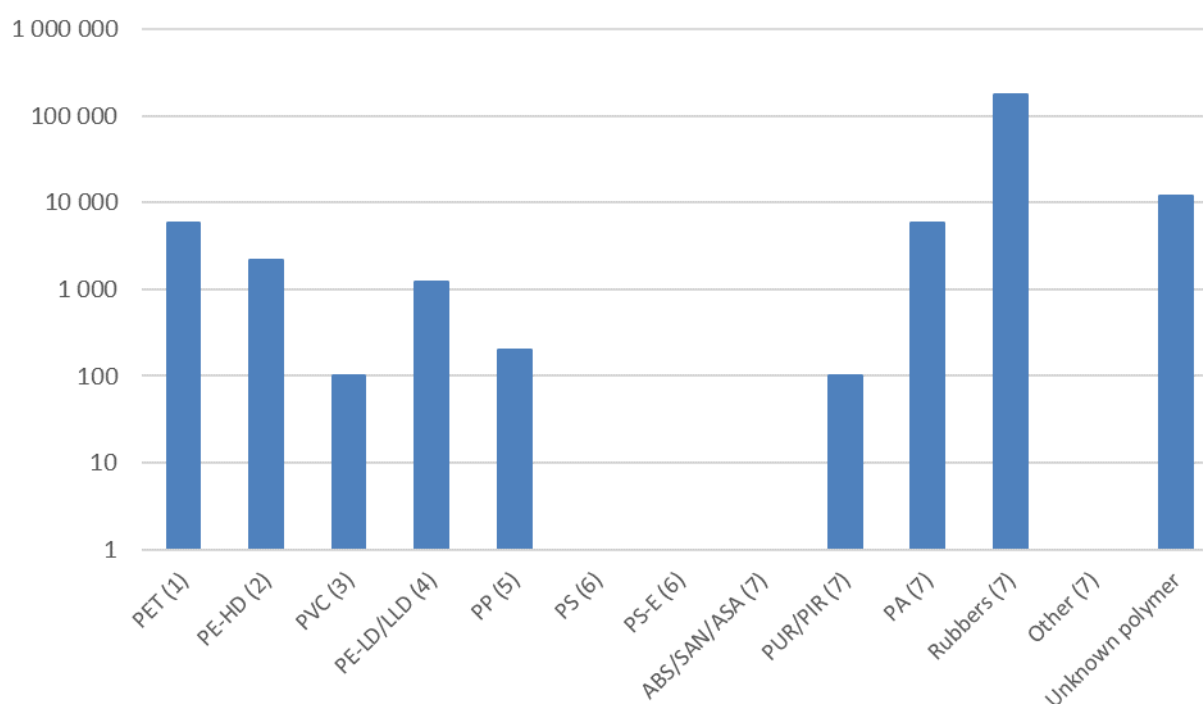




Table 27 – Scrap plastics to energy recovery by polymer type, in 2019–20 (tonnes)

Polymer type	Quantity
PET (1)	5 900
PE-HD (2)	2 200
PVC (3)	100
PE-LD/LLD (4)	1 200
PP (5)	200
PS (6)	0
PS-E (6)	0
ABS/SAN/ASA (7)	0
PUR/PIR (7)	100
PA (7)	5 800
Rubbers (7)	177 300
Bioplastic (7)	0
Other (7)	0
Unknown polymer	12 000
Total	204 800

3.7 Recycled content of plastic products

This section of the report provides information on the recycled content of locally manufactured products. There was insufficient information available to determine the recycled content of imported finished products.

In 2019–20, 1 355 700 tonnes of plastic resins went into local plastic product manufacturing. This included locally manufactured virgin resin (22.1%), imported resin (65.6%), and locally processed or overseas sourced recycle into local manufacturing (12.3%).

During the same period, there was 166 400 tonnes of local manufacturing using locally sourced (94%) or imported recycle (6%), meaning the average proportion of recycled content used across all local plastic product manufacturing was 12.3%. The quantity of plastic recycle includes material sourced from both pre-consumer and post-consumer scrap sources.

Tyres and other rubber are excluded from this calculation as there is no local manufacturing of tyres, and they do not currently contain any recycled content.

It is worth noting that this estimated recycled content assumes that the plastic recycle all goes into 100% plastic products. However, the use of plastic recycle with other materials in product manufacture, such as wood fibre into synthetic timbers, changes the proportions. Therefore the overall recycled plastic content of these mixed material products will be less than stated, but not less, if the plastics fraction of the product were considered separately.



Provided in 21 and Table 28 are estimated local manufacturing of plastic products, local use of recyclate (locally sourced and imported), and the recycled content percentage rate of locally manufactured products, by application area.

B2B (business-to-business) packaging and industrial applications have the highest recycled content rates, at 23.4% and 21.1% respectively. The B2B packaging recycling rate is underpinned by the recyclate going into applications such as plant pots, plastic pallets, bins, pallet slips (sheets) and B2B films.

The high recycled content rate for the 'Industrial' application area may be due to an underestimation of the amount of plastics going into this application area. When surveyed, plastic product manufacturers and plastic reproducers may not correctly identify the application area the recyclate goes into, or not know, or just not answer with enough specificity. This may have resulted in an overestimation of the true recycled content rate for this application area and should be interpreted with care.

Figure 21 – Recycled content of locally manufactured products, by application area, in 2019–20 (tonnes)

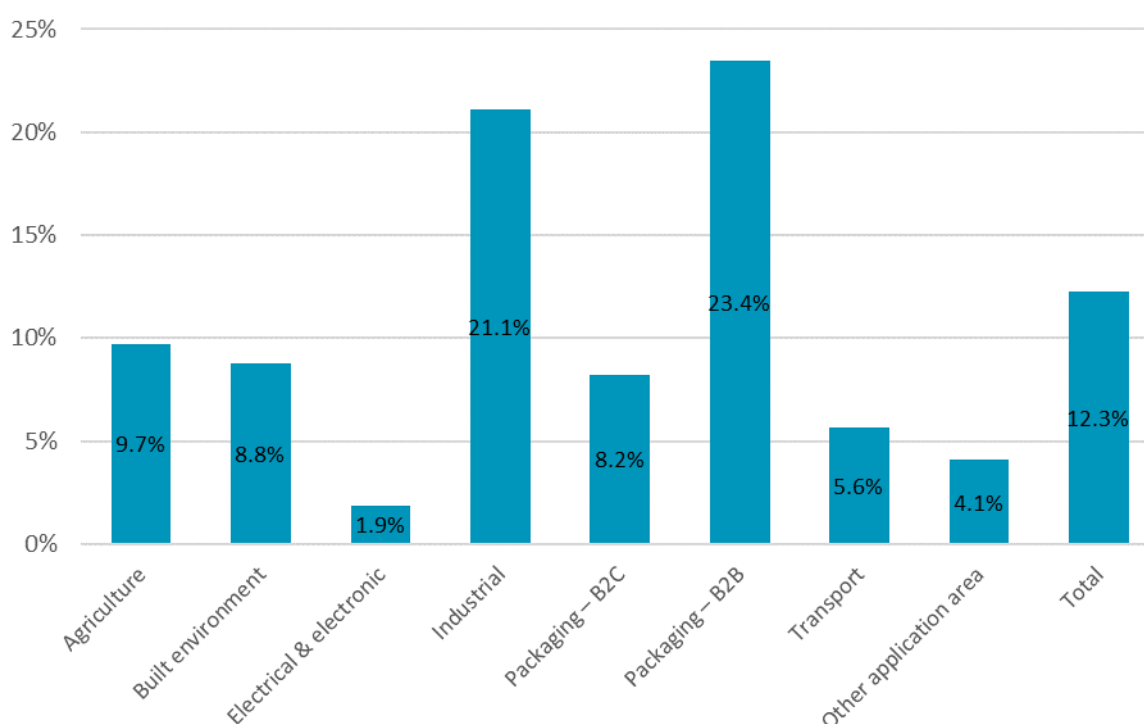


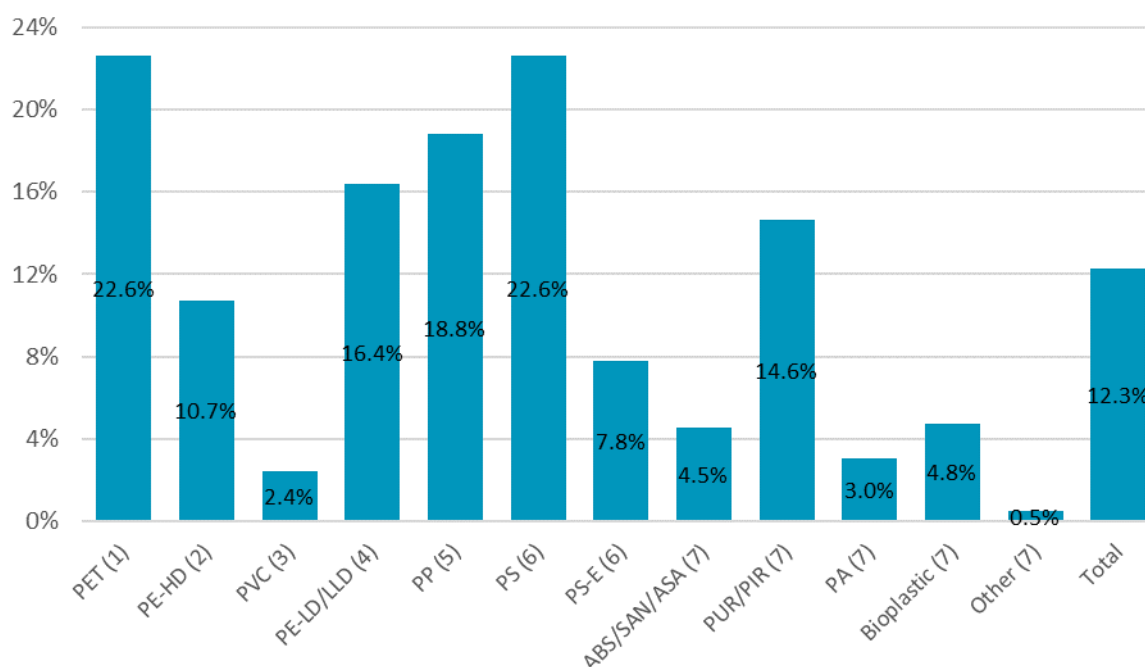


Table 28 – Recycled content of locally manufactured products, by application area, in 2019–20

Polymer type	Local manufacturing (tonnes)	Local recycle use (tonnes)	Recycled content (%)
Agriculture	69 000	6 700	9.7%
Built environment	442 200	38 800	8.8%
Electrical & electronic	26 600	500	1.9%
Industrial	16 600	3 500	21.1%
Packaging – B2C	447 900	36 800	8.2%
Packaging – B2B	81 900	19 200	23.4%
Transport	7 100	400	5.6%
Other application area	167 000	6 800	4.1%
Unidentified applications	97 400	53 700	N/A
Total	1 355 700	166 400	12.3%

Provided in Figure 22 and Table 29 are estimated local manufacturing of plastic products, local use of recycle (locally sourced and imported), and the recycled content percentage rate of locally manufactured products, by polymer type.

Figure 22 – Recycled content of locally manufactured products, by polymer type, in 2019–20 (tonnes)





Some key observations are:

- Locally manufactured PET has the highest recycled content rates at 22.6%, which is underpinned by post-consumer PET recyclate going back into B2C (business-to-consumer) packaging production (mostly PET beverage bottles).
- PS also has a relatively high recycled content rate of 22.6%, probably underpinned by the diversion of PS into mixed polymer products (e.g. synthetic timber).
- Polypropylene (PP) product has a relatively high recycling content rate of 18.8% underpinned by the manufacture of plant pots for the horticultural sector (B2B packaging).
- Polyurethane (PUR) products in the built environment application area have a relatively high recycled content rate at 14.6%, which is mostly due to imported PUR recyclate going into carpet underlay.

Table 29 – Recycled content of locally manufactured products, by polymer type, in 2019–20

Polymer type	Local manufacturing (tonnes)	Local recyclate use (tonnes)	Recycled content (%)
PET (1)	139 500	31 500	22.6%
PE-HD (2)	415 200	44 600	10.7%
PVC (3)	217 900	5 300	2.4%
PE-LD/LLD (4)	179 900	29 500	16.4%
PP (5)	193 000	36 300	18.8%
PS (6)	13 700	3 100	22.6%
PS-E (6)	38 500	3 000	7.8%
ABS/SAN/ASA (7)	17 600	800	4.5%
PUR/PIR (7)	43 800	6 400	14.6%
PA (7)	6 600	200	3.0%
Bioplastic (7)	2 100	100	4.8%
Other (7)	79 900	400	0.5%
Unknown polymer	8 000	5 200	N/A
Total	1 355 700	166 400	12.3%



3.8 Location of plastic product manufacture

This section of the report provides more detailed information on the application area and polymer type splits for plastic product consumption (*including tyres*), in terms of the location of product manufacture (local or overseas). This data extends on the source location detail provided in Section 3.2.1, but with the modified groupings of:

- Local manufacturing using locally produced or imported virgin polymers.
- Local manufacturing using locally produced or imported recycled polymers.
- Imports of plastics in finished and semi-finished goods (e.g. plastics components requiring further manufacturing steps).
- Total plastic product consumption (including tyres).

As mentioned above, the data provided in this section of the report has modified groupings from those in Section 3.2.1. The groupings in Section 3.2.1 are the same as those adopted in previous years and are provided to give ongoing consistency in reporting. However, the groupings in this section have been adjusted to differentiate more clearly on the use of virgin and recycled polymers going into local manufacturing, which is of particular interest to many stakeholders.

Please note that the data presented in this section of the report also includes tyres, which is not included in the data presented across Sections 3.1–3.4.

High-level comments on the data presented in this section of the report are:

- Total plastic product consumption (including tyres) was 4 036 000 t in 2019–20.
- 29.5% (1 189 600 t) of consumption was local manufacturing using locally produced or imported virgin polymers.
- 4.4% (179 300 t) of consumption was local manufacturing using locally produced or imported recycled polymers.
- 66.1% (2 667 100 t) of consumption was imports of plastics in finished and semi-finished goods.

Local manufacturing using locally produced or imported virgin polymers.

Presented in Figure 23 and Table 30 is application area and polymer type level data on local manufacturing of products using virgin polymers in 2019–20.



Figure 23 – Local manufacturing using locally produced or imported virgin polymers, by destination application area and polymer type, in 2019–20 (tonnes)

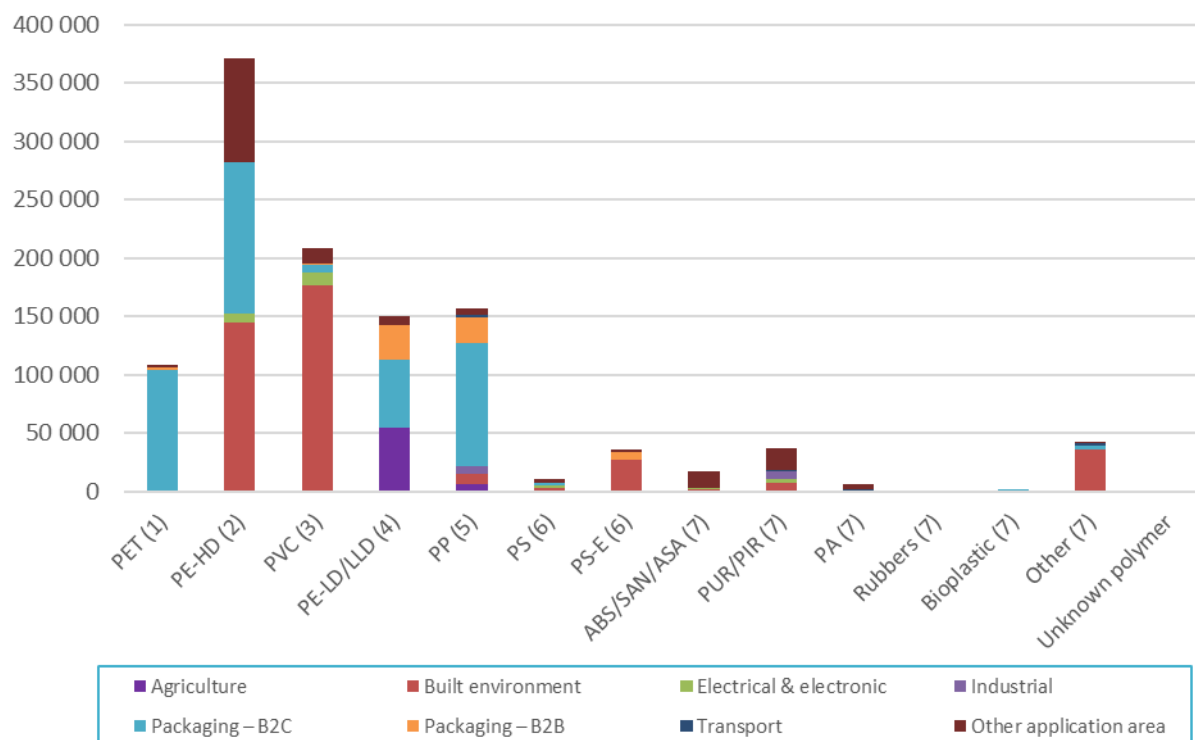




Table 30 – Local manufacturing using locally produced or imported virgin polymers, by destination application area and polymer type, in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Unidentified applications	Total
PET (1)	1 100	0	0	0	102 600	2 200	0	2 200	0	108 100
PE-HD (2)	0	144 500	7 400	0	129 700	0	0	88 900	100	370 600
PVC (3)	0	176 600	10 600	0	6 400	2 100	0	12 800	4 300	212 800
PE-LD/LLD (4)	54 100	0	0	0	59 100	29 500	0	7 500	100	150 300
PP (5)	6 600	8 000	0	6 700	105 600	22 200	2 700	5 100	0	156 900
PS (6)	0	2 400	2 400	0	2 400	0	0	3 400	0	10 600
PS-E (6)	0	26 700	0	0	0	6 700	0	2 200	0	35 600
ABS/SAN/ASA (7)	0	1 700	1 700	0	0	0	0	13 400	0	16 800
PUR/PIR (7)	200	7 000	3 700	6 300	0	0	1 600	18 600	0	37 400
PA (7)	100	1 000	0	0	0	0	1 000	4 200	100	6 400
Rubbers (7)	0	0	0	0	0	0	0	0	0	0
Bioplastic (7)	200	0	0	0	1 700	0	0	0	0	1 900
Other (7)	0	35 600	300	0	3 600	0	1 400	1 200	37 300	79 400
Unknown polymer	0	0	0	0	0	0	0	800	2 000	2 800
Total	62 300	403 500	26 100	13 000	411 100	62 700	6 700	160 300	43 900	1 189 600



Local manufacturing using locally produced or imported recycled polymers

Presented in Figure 24 and Table 31 is application area and polymer type level data on local manufacturing using recycled polymers in 2019–20.

Figure 24 – Local manufacturing using locally produced or imported recycled polymers, by destination application area and polymer type, in 2019–20 (tonnes)

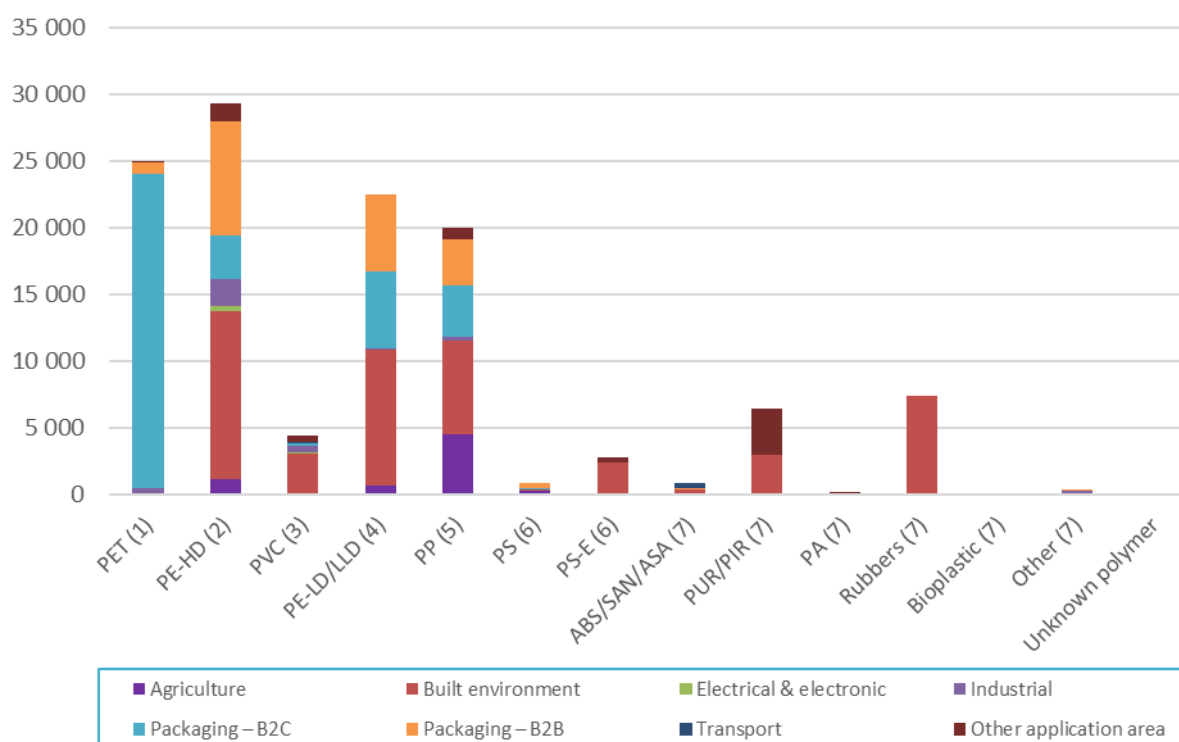




Table 31 – Local manufacturing using locally produced or imported recycled polymers, by destination application area and polymer type, in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Unidentified applications	Total
PET (1)	0	0	0	500	23 500	900	0	100	6 500	31 500
PE-HD (2)	1 100	12 600	400	2 000	3 300	8 600	0	1 300	15 300	44 600
PVC (3)	0	3 100	100	400	200	0	100	500	900	5 300
PE-LD/LLD (4)	700	10 100	0	100	5 800	5 800	0	0	7 000	29 500
PP (5)	4 500	7 000	0	300	3 900	3 400	0	900	16 300	36 300
PS (6)	300	100	0	0	100	300	0	0	2 300	3 100
PS-E (6)	0	2 400	0	0	0	0	0	400	200	3 000
ABS/SAN/ASA (7)	0	400	0	0	0	100	300	0	0	800
PUR/PIR (7)	0	3 000	0	0	0	0	0	3 400	0	6 400
PA (7)	0	0	0	0	0	0	0	200	0	200
Rubbers (7)	0	7 400	0	0	0	0	0	0	5 500	12 900
Bioplastic (7)	100	0	0	0	0	0	0	0	0	100
Other (7)	0	100	0	200	0	100	0	0	0	400
Unknown polymer	0	0	0	0	0	0	0	0	5 200	5 200
Total	6 700	46 200	500	3 500	36 800	19 200	400	6 800	59 200	179 300



Imports of plastics in finished and semi-finished goods

Presented in Figure 25 and Table 32 is application area and polymer type level data on imports of finished and semi-finished goods in 2019–20.

Figure 25 – Imports of plastics in finished and semi-finished goods, by destination application area and polymer type, in 2019–20 (tonnes)

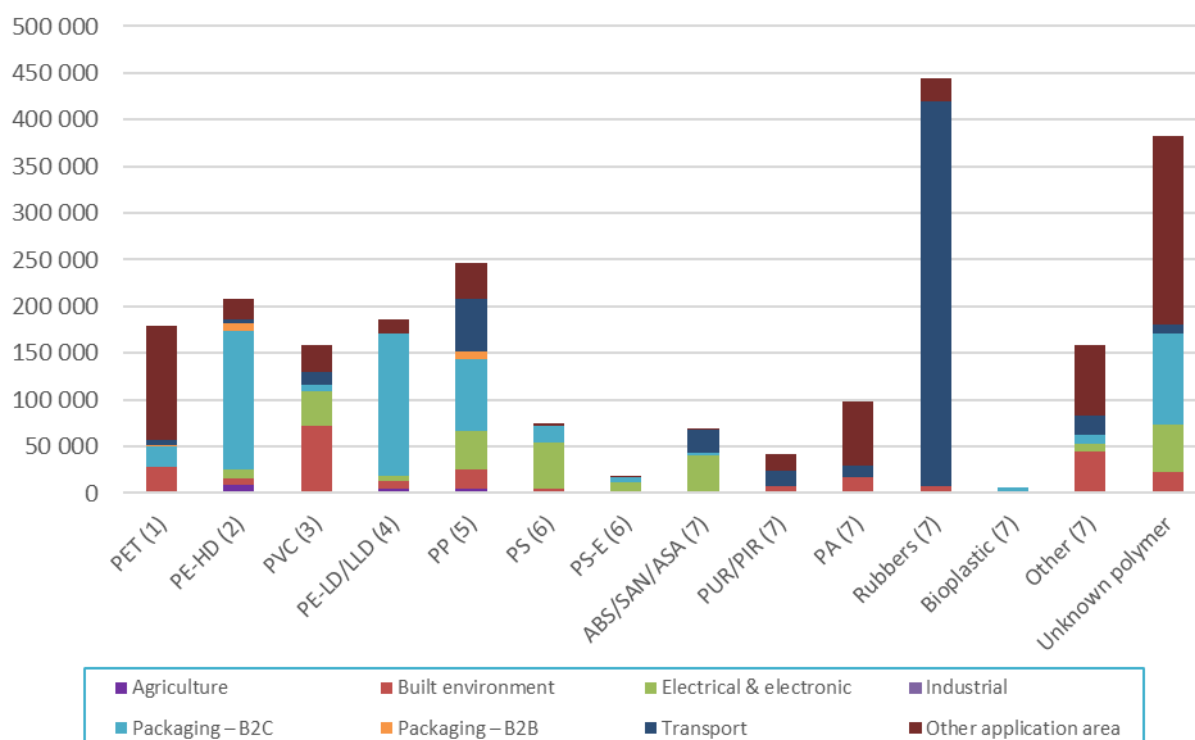




Table 32 – Imports of plastics in finished and semi-finished goods, by destination application area and polymer type, in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Unidentified applications	Total
PET (1)	2 200	26 200	0	0	21 200	2 000	4 700	123 600	34 900	214 800
PE-HD (2)	8 300	7 900	9 700	0	147 700	8 900	3 100	22 100	20 300	228 000
PVC (3)	400	71 600	36 700	0	7 400	0	14 100	27 800	14 000	172 000
PE-LD/LLD (4)	4 500	9 000	4 500	0	152 700	0	0	16 000	4 100	190 800
PP (5)	5 400	19 900	41 000	0	76 700	8 900	56 200	38 600	40 800	287 500
PS (6)	0	4 400	50 100	0	17 700	0	0	2 900	0	75 100
PS-E (6)	0	0	12 300	0	5 000	0	0	200	0	17 500
ABS/SAN/ASA (7)	0	0	40 600	0	2 400	0	25 600	100	0	68 700
PUR/PIR (7)	0	7 700	0	0	0	0	16 600	17 000	200	41 500
PA (7)	2 200	14 900	0	0	100	0	12 300	68 100	1 500	99 100
Rubbers (7)	0	6 900	800	0	0	0	412 400	24 400	128 900	573 400
Bioplastic (7)	0	0	0	0	6 500	0	0	0	0	6 500
Other (7)	600	44 500	7 100	0	10 500	0	20 000	76 100	25 900	184 700
Unknown polymer	600	21 700	50 700	0	97 800	0	9 300	202 700	124 700	507 500
Total	24 200	234 700	253 500	0	545 700	19 800	574 300	619 600	395 300	2 667 100



Total plastic product consumption (including tyres)

Presented in Figure 26 and Table 33 is application area and polymer type level data on total plastic product consumption in 2019–20.

Figure 26 – Total plastic product consumption (including tyres), by destination application area and polymer type, in 2019–20 (tonnes)

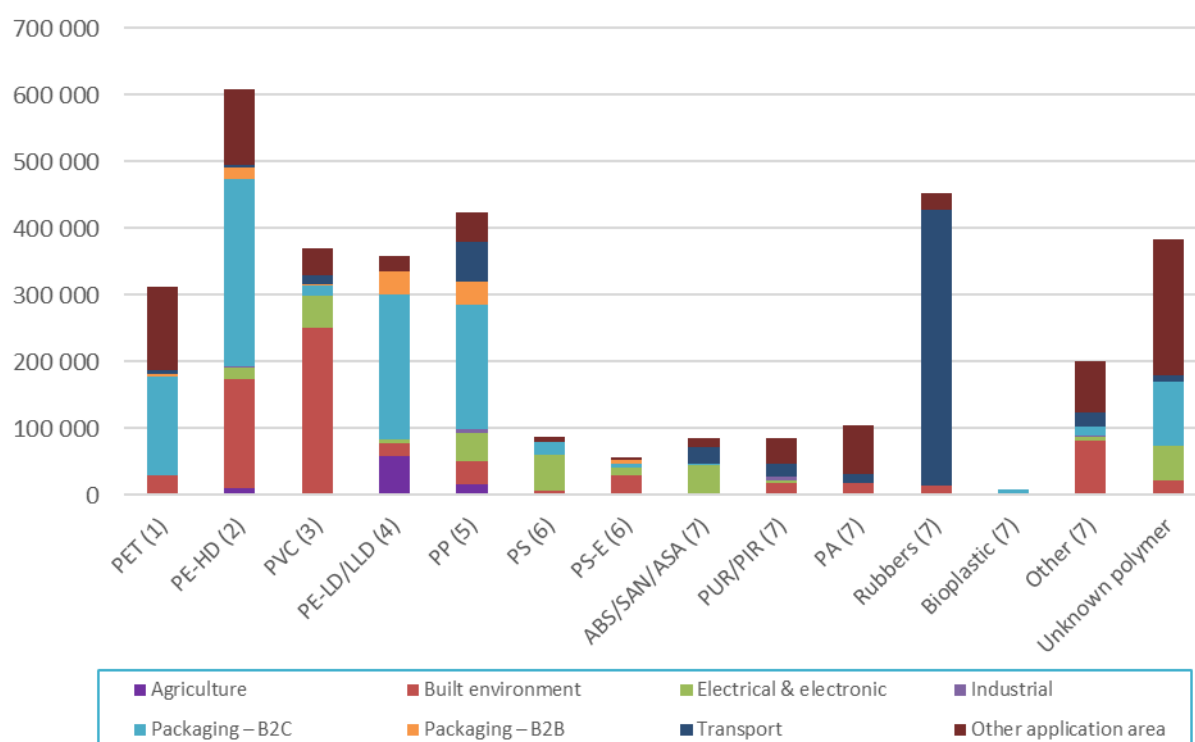




Table 33 – Total plastic product consumption (including tyres), by destination application area and polymer type, in 2019–20 (tonnes)

Polymer type	Agriculture	Built environment	Electrical & electronic	Industrial	Packaging – B2C	Packaging – B2B	Transport	Other applic. area	Unidentified applications	Total
PET (1)	3 300	26 200	0	500	147 300	5 100	4 700	125 900	41 400	354 400
PE-HD (2)	9 400	165 000	17 500	2 000	280 700	17 500	3 100	112 300	35 700	643 200
PVC (3)	400	251 300	47 400	400	14 000	2 100	14 200	41 100	19 200	390 100
PE-LD/LLD (4)	59 300	19 100	4 500	100	217 600	35 300	0	23 500	11 200	370 600
PP (5)	16 500	34 900	41 000	7 000	186 200	34 500	58 900	44 600	57 100	480 700
PS (6)	300	6 900	52 500	0	20 200	300	0	6 300	2 300	88 800
PS-E (6)	0	29 100	12 300	0	5 000	6 700	0	2 800	200	56 100
ABS/SAN/ASA (7)	0	2 100	42 300	0	2 400	100	25 900	13 500	0	86 300
PUR/PIR (7)	200	17 700	3 700	6 300	0	0	18 200	39 000	200	85 300
PA (7)	2 300	15 900	0	0	100	0	13 300	72 500	1 600	105 700
Rubbers (7)	0	14 300	800	0	0	0	412 400	24 400	134 400	586 300
Bioplastic (7)	300	0	0	0	8 200	0	0	0	0	8 500
Other (7)	600	80 200	7 400	200	14 100	100	21 400	77 300	63 200	264 500
Unknown polymer	600	21 700	50 700	0	97 800	0	9 300	203 500	131 900	515 500
Total	93 200	684 400	280 100	16 500	993 600	101 700	581 400	786 700	498 400	4 036 000



3.9 Plastics flows by state/territory

This section contains the analysis of each Australian jurisdiction's consumption, EoL arisings and recovery of plastics, as well as data on interstate flows of scrap plastics for reprocessing and reprocessor numbers in each jurisdiction.

Data in this section of the report also includes tyre flows, which were not included in the data presented in Sections 3.1–3.4 of this report.

3.9.1 Plastics consumption by state/territory

Consumption data for each jurisdiction is estimated based upon the jurisdiction's population as a proportion of the national population. The population data used for this purpose is provided in Table 2 on page 13.

Presented in Figure 27 and Table 34 is plastics consumption by jurisdiction and polymer type in 2019–20.

Figure 27 – Plastics consumption by jurisdiction and polymer type in 2019–20 (tonnes)

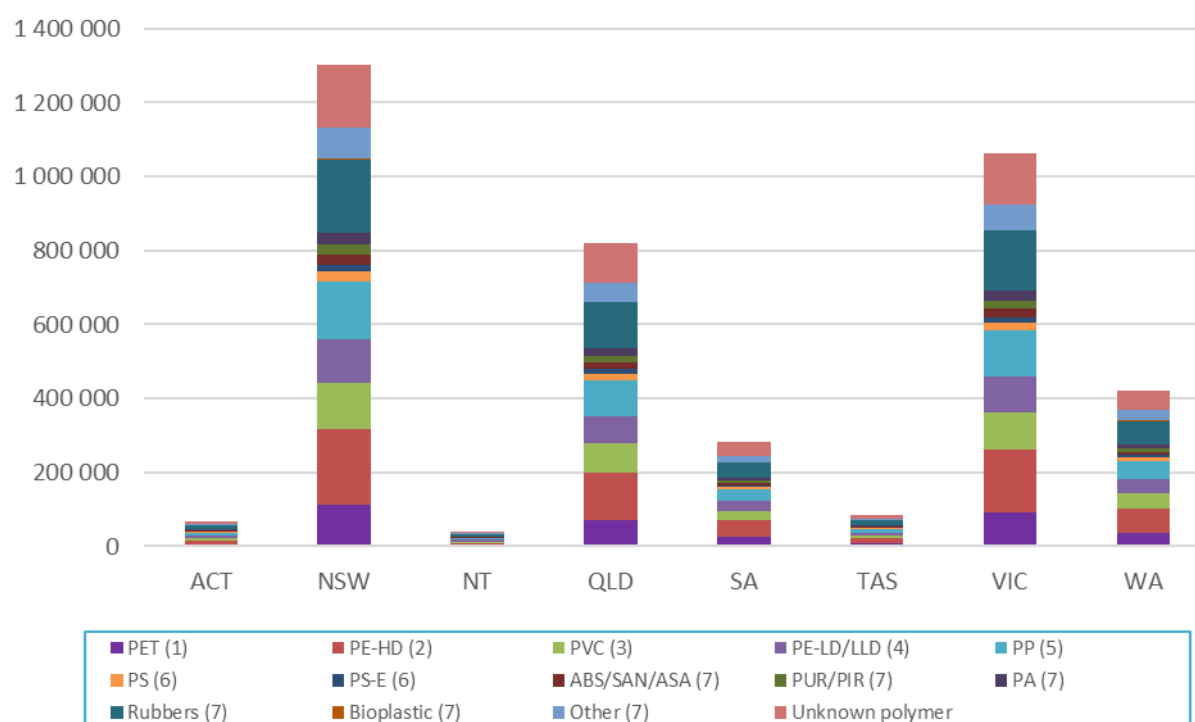




Table 34 – Plastics consumption by jurisdiction and polymer type in 2019–20 (tonnes)

Polymer type	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
PET (1)	6 000	113 200	3 400	71 300	24 500	7 500	92 300	36 700	354 900
PE-HD (2)	10 800	205 300	6 200	129 300	44 500	13 600	167 500	66 600	643 800
PVC (3)	6 600	124 400	3 800	78 300	27 000	8 200	101 500	40 300	390 100
PE-LD/LLD (4)	6 200	118 300	3 600	74 500	25 600	7 800	96 500	38 400	370 900
PP (5)	8 100	153 300	4 700	96 500	33 200	10 100	125 000	49 700	480 600
PS (6)	1 500	28 300	900	17 800	6 100	1 900	23 100	9 200	88 800
PS-E (6)	900	17 800	500	11 200	3 900	1 200	14 500	5 800	55 800
ABS/SAN/ASA (7)	1 400	27 500	800	17 300	6 000	1 800	22 400	8 900	86 100
PUR/PIR (7)	1 400	27 200	800	17 100	5 900	1 800	22 200	8 800	85 200
PA (7)	1 800	33 900	1 000	21 300	7 300	2 200	27 600	11 000	106 100
Rubbers (7)	10 400	197 100	6 000	124 200	42 700	13 000	160 800	63 900	618 100
Bioplastic (7)	100	2 700	100	1 700	600	200	2 200	900	8 500
Other (7)	4 400	84 400	2 600	53 100	18 300	5 600	68 800	27 400	264 600
Unknown polymer	8 900	168 100	5 100	105 900	36 400	11 100	137 100	54 500	527 100
Total	68 500	1 301 500	39 500	819 500	282 000	86 000	1 061 500	422 100	4 080 600



3.9.2 Plastics End-of-Life (EoL) arisings by state/territory

As for consumption, EoL arisings in 2019–20 for each jurisdiction are approximated based upon the jurisdiction's population as a proportion of the national population.

Figure 28 and Table 35 present plastics EoL arisings by jurisdiction and polymer type in 2019–20. It is estimated that there was a total of 3 036 000 t of EoL arisings. This compares with the 4 081 000 t of consumption during the same period, giving a percentage ratio of EoL arisings to consumption of 74%, which is the average across all applications and polymer types. This difference in consumption and end-of-life arisings in any given year represent the build-up of plastics product in use (stocks) in that year.

Figure 28 – Plastics EoL arisings by jurisdiction and polymer type in 2019–20 (tonnes)

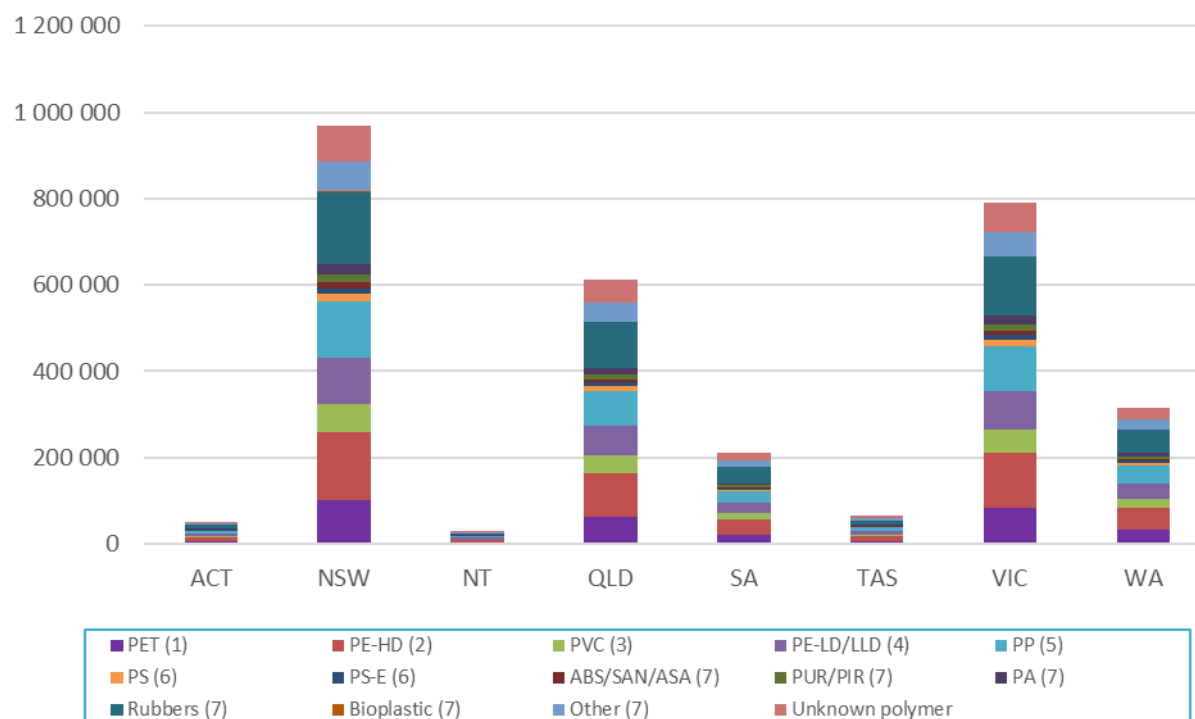




Table 35 – Plastics EoL arisings by jurisdiction and polymer type in 2019–20 (tonnes)

Polymer type	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
PET (1)	5 300	99 900	3 000	62 900	21 700	6 600	81 500	32 400	313 300
PE-HD (2)	8 400	158 500	4 800	99 800	34 300	10 500	129 300	51 400	497 000
PVC (3)	3 400	65 200	2 000	41 100	14 100	4 300	53 200	21 200	204 500
PE-LD/LLD (4)	5 700	108 400	3 300	68 300	23 500	7 200	88 400	35 200	340 000
PP (5)	6 800	128 400	3 900	80 900	27 800	8 500	104 700	41 600	402 600
PS (6)	1 000	18 600	600	11 700	4 000	1 200	15 200	6 000	58 300
PS-E (6)	700	13 600	400	8 500	2 900	900	11 100	4 400	42 500
ABS/SAN/ASA (7)	700	13 000	400	8 200	2 800	900	10 600	4 200	40 800
PUR/PIR (7)	900	17 900	500	11 300	3 900	1 200	14 600	5 800	56 100
PA (7)	1 300	24 700	800	15 500	5 300	1 600	20 100	8 000	77 300
Rubbers (7)	8 800	167 700	5 100	105 600	36 300	11 100	136 800	54 400	525 800
Bioplastic (7)	100	2 100	<100	1 300	400	100	1 700	700	6 400
Other (7)	3 600	68 000	2 100	42 800	14 700	4 500	55 500	22 100	213 300
Unknown polymer	4 400	84 200	2 600	53 000	18 300	5 600	68 700	27 300	264 100
Total	51 100	970 200	29 500	610 900	210 000	64 200	791 400	314 700	3 042 000



3.9.3 Plastics recovery by state/territory

Presented in Figure 29 and Table 36 is plastics recovery by source jurisdiction and polymer type in 2019–20. The source jurisdiction is where the EoL plastics are generated, not where recovery occurs.

Figure 29 – Recovery by source jurisdiction and polymer type in 2019–20 (tonnes)

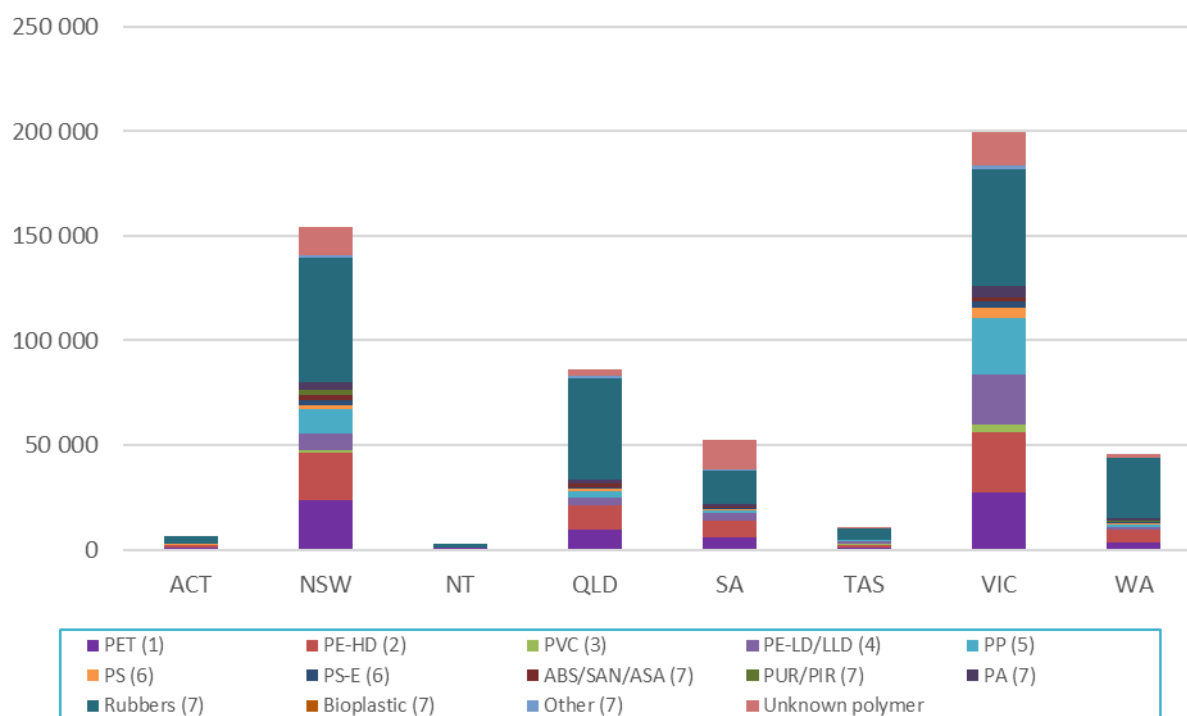




Table 36 – Recovery by source jurisdiction and polymer type in 2019–20 (tonnes)

Polymer type	ACT ¹	NSW	NT	QLD	SA	TAS	VIC	WA	Australia
PET (1)	1 100	23 400	800	9 700	6 100	1 000	27 600	3 200	72 800
PE-HD (2)	1 200	22 900	100	11 200	7 700	1 400	28 400	6 100	79 100
PVC (3)	0	1 500	0	300	200	400	3 700	300	6 400
PE-LD/LLD (4)	0	7 500	0	3 400	3 500	1 000	23 900	1 000	40 400
PP (5)	100	11 700	0	3 100	1 400	700	27 200	1 600	45 900
PS (6)	100	1 800	0	1 200	700	0	4 500	400	8 800
PS-E (6)	100	2 500	0	1 100	500	100	3 100	400	7 800
ABS/SAN/ASA (7)	200	2 600	100	1 600	400	100	2 000	500	7 500
PUR/PIR (7)	0	2 400	0	100	100	0	300	500	3 500
PA (7)	100	4 000	0	2 000	900	200	5 400	900	13 400
Rubbers (7)	3 700	59 300	1 900	48 300	16 400	5 700	56 000	28 700	220 000
Bioplastic (7)	0	0	0	0	0	0	0	0	100
Other (7)	100	1 200	0	800	200	0	1 500	200	4 000
Unknown polymer	0	13 700	0	3 100	14 300	300	16 200	1 900	49 500
Totals	6 800	154 700	2 900	85 900	52 500	10 800	199 800	45 700	559 000

1. There is likely to be some transfer of scrap plastics from the ACT to NSW that is not reported by reprocessors, or ACT sourced material that is sent to export via NSW ports and is not allocated to the ACT as the source jurisdiction in Customs declarations. For these reasons the ACT recovery is likely to be higher than reported here.



Presented in Figure 30 is per capita plastics recovery, including tyres, for each jurisdiction nationally. This includes the plastic fractions of tyres and other scrap plastics sent overseas for reprocessing or energy recovery. Including tyres, average recovery was 22.0 kg per person in 2019–20.

Presented in Figure 31 is per capita plastics recovery, excluding tyres, for each jurisdiction nationally. The national average recovery was 13.4 kg per person in 2019–20, compared with 15.5 kg per person in 2018–19. This fall in per capita recovery was mostly due to the reduction in NSW sourced scrap plastics sent to energy recovery, as discussed in more detail in Section 3.6.

Figure 30 – Per capita recovery (including tyres) by source jurisdiction in 2019–20 (tonnes)

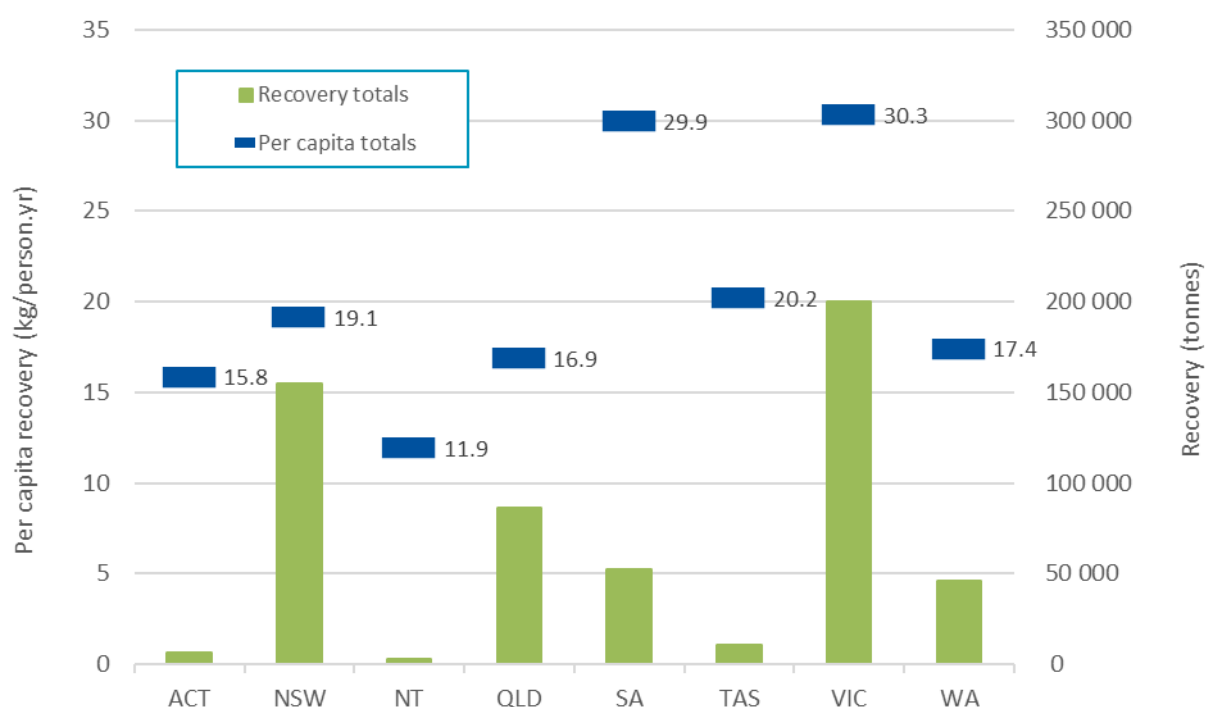
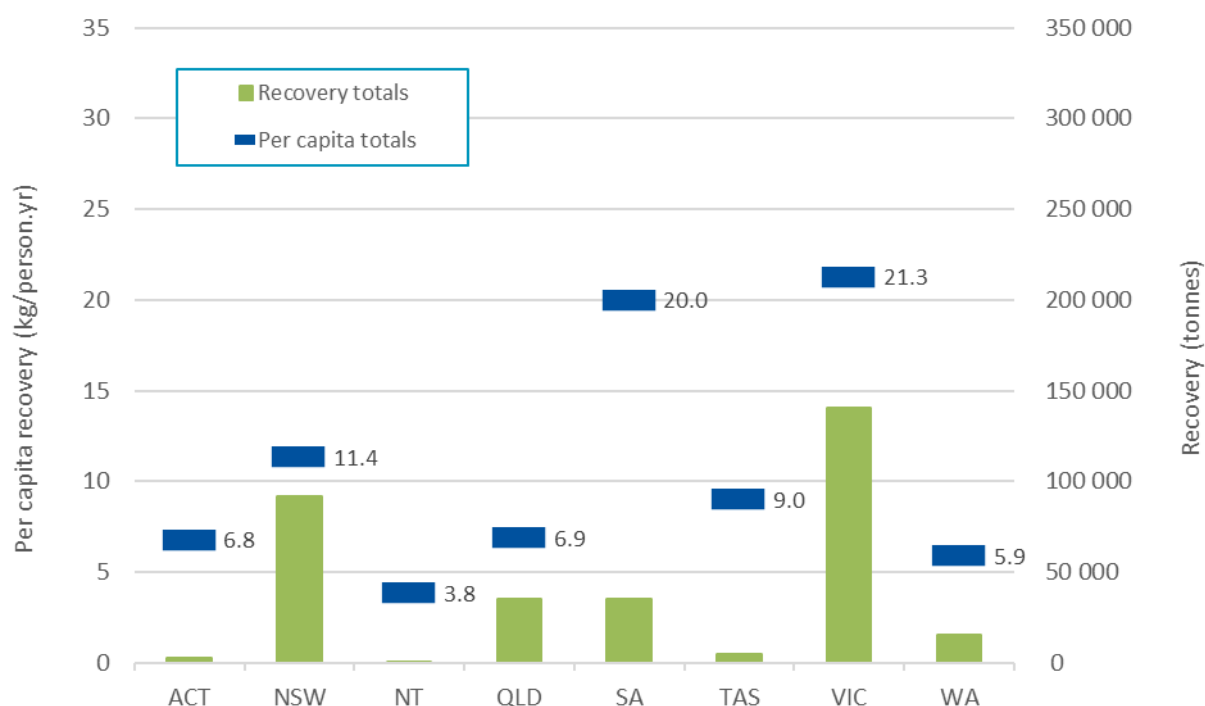




Figure 31 – Per capita recovery (excluding tyres) by source jurisdiction in 2019–20 (tonnes)



Presented in Table 37 and Figure 32 are recovery rates by source jurisdiction and polymer type (including tyres) in 2019–20. Victoria and South Australia have the highest recovery rates at 25%, followed by Tasmania and NSW. The Victorian rate is bolstered by the disproportionately large amounts of manufacturing scrap generated in and recovered from Victoria.

Figure 33 presents the same data but excluding tyres.



Table 37 – Recovery rates by source jurisdiction and polymer type in 2019–20 (%)

Polymer type	ACT ¹	NSW	NT	QLD	SA	TAS	VIC	WA	Average
PET (1)	21%	23%	25%	15%	28%	16%	34%	10%	23%
PE-HD (2)	15%	14%	1%	11%	22%	14%	22%	12%	16%
PVC (3)	0%	2%	0%	1%	1%	9%	7%	1%	3%
PE-LD/LLD (4)	0%	7%	0%	5%	15%	14%	27%	3%	12%
PP (5)	2%	9%	0%	4%	5%	8%	26%	4%	11%
PS (6)	13%	10%	8%	10%	17%	4%	30%	7%	15%
PS-E (6)	14%	19%	0%	13%	18%	6%	28%	9%	18%
ABS/SAN/ASA (7)	26%	20%	20%	19%	16%	7%	19%	13%	18%
PUR/PIR (7)	0%	14%	0%	1%	4%	0%	2%	8%	6%
PA (7)	6%	16%	6%	13%	16%	9%	27%	11%	17%
Rubbers (7)	42%	35%	37%	46%	45%	51%	41%	53%	42%
Bioplastic (7)	0%	2%	0%	3%	0%	0%	3%	0%	2%
Other (7)	2%	2%	2%	2%	1%	0%	3%	1%	2%
Unknown polymer	0%	16%	0%	6%	79%	5%	24%	7%	19%
State/territory average	13%	16%	10%	14%	25%	17%	25%	15%	18%

1. There is likely to be some transfer of scrap plastics from the ACT to NSW that is not reported by reprocessors, or ACT sourced material that is sent to export via NSW ports and is not allocated to the ACT as the source jurisdiction in Customs declarations. For these reasons the ACT recovery rates are likely to be higher than reported here.



Figure 32 – Recovery rates by source jurisdiction (including tyres) in 2019–20 (tonnes)

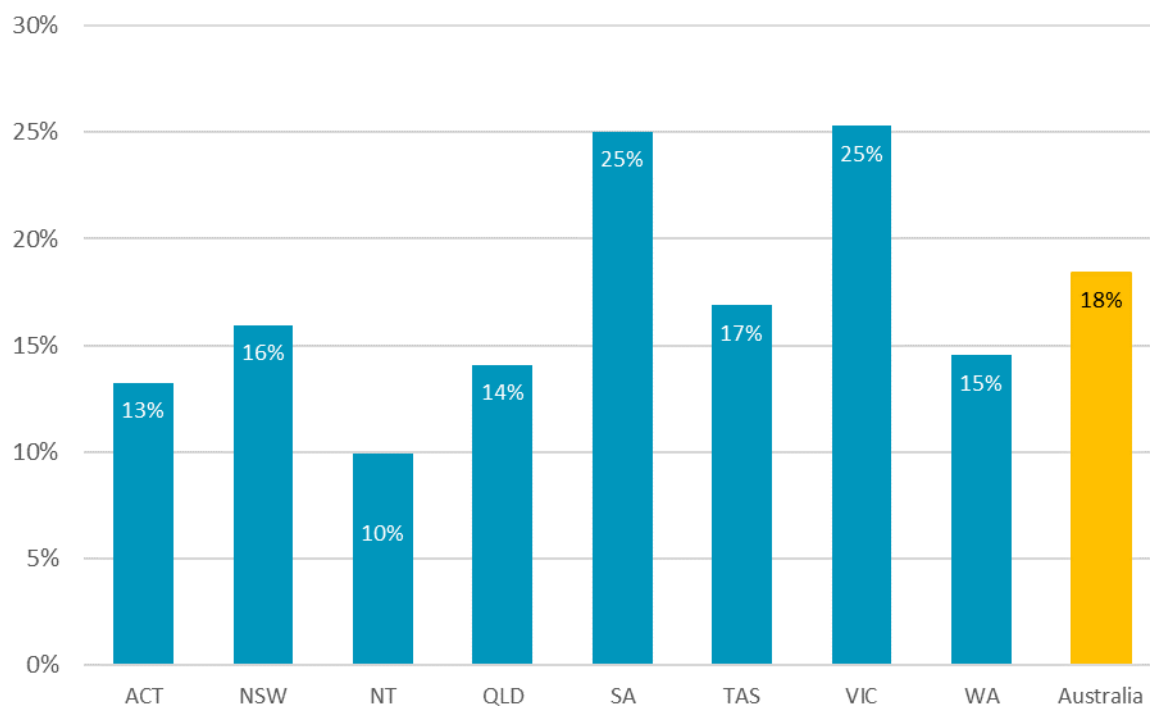
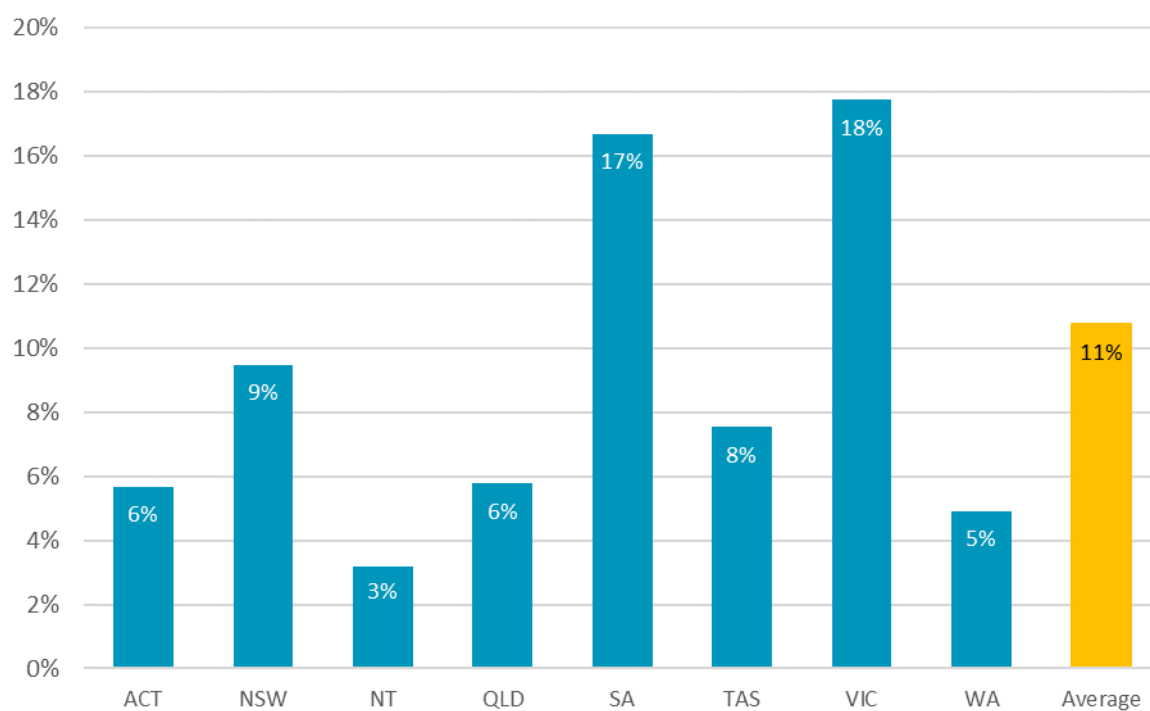


Figure 33 – Recovery rates by source jurisdiction (excluding tyres) in 2019–20 (tonnes)





3.9.4 Cross-border recyclate flows

Presented in Table 38 and Figure 34 is data on recyclate movements to intrastate (same state), interstate and overseas reprocessors by source jurisdiction in 2019–20.

Of total national scrap plastics recovery of 326 500 tonnes there were 157 100 tonnes of scrap plastics (48%) that were reprocessed within the generating jurisdiction. An estimated 43 100 tonnes (13%) were transferred to other jurisdictions for reprocessing, and the remaining 126 300 tonnes (39%) were exported for reprocessing.

Note that tyres data is excluded from the data presented here, due to insufficient detail being available on interstate transfers. For context, there were 232 000 tonnes of tyre rubber and fabric recovered in 2019–20, of which an average of 80% were sent overseas, and 20% went to local reprocessors.

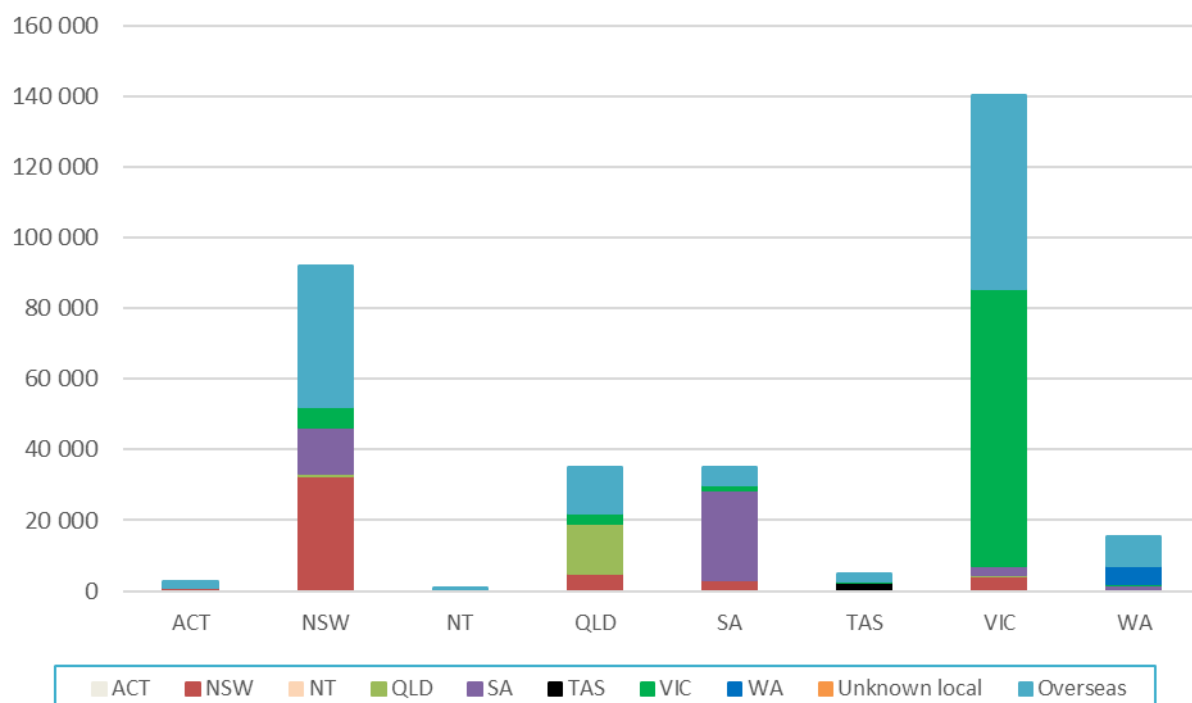


Table 38 – Recyclate to intrastate (same state), interstate and overseas reprocessors by source jurisdiction in 2019–20 (tonnes)

Destination jurisdiction	Source jurisdiction								Total
	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	
ACT	0	0	0	0	0	0	0	0	0
NSW	1 000	32 400	0	5 100	3 200	200	4 300	500	46 700
NT	0	0	0	0	0	0	0	0	0
QLD	0	1 000	0	13 800	0	0	300	0	15 100
SA	0	12 900	200	300	25 300	0	2 600	1 300	42 600
TAS	0	0	0	0	0	2 200	0	0	2 200
VIC	0	5 700	0	2 600	1 400	300	78 300	200	88 500
WA	0	0	0	0	0	0	0	5 100	5 100
Overseas	1 800	39 900	700	13 400	5 200	2 200	54 800	8 300	126 300
Total	2 800	91 900	900	35 200	35 100	4 900	140 300	15 400	326 500



Figure 34 – Recyclate to intrastate (same state), interstate and overseas reprocessors by source jurisdiction in 2019–20 (tonnes)





4 SELECTED PLASTIC PRODUCT FLOWS

4.1 Tyre sales and recovery

This year, consumption and recovery of tyres is included in the project scope, drawing on detailed 2019–20 data provided by Tyre Stewardship Australia (TSA, 2020). Tyres data is included in the report as tyre flows are significant and tyres are primarily composed of in-scope plastics, which are; synthetic and natural rubbers (7), nylon (7) and PET (1) materials.

Tyre flows have been reported in earlier sections of the report, but not in the core historical plastics consumption and recovery datasets (with some clearly stated exceptions), as inclusion of a large-scale product group such as tyres would result in an apparent jump in plastics consumption of around 15%, which would cause several issues for national waste reporting.

Provided in this section of the report are 2019–20 estimates of:

- Tyre sales in terms of weight and equivalent passenger (tyre) units (EPUs)¹.
- Tyre sales in terms of tyre material types.
- Tyre recovery in terms of weight and EPUs.
- Tyre recovery fates.

Unlike earlier sections of the report, the data presented in this section is for all components of tyres, including steel reinforcing. On average, new tyres contain around 76% natural and synthetic rubber (including rubber additives), 22% steel and 2% synthetic fabrics. The fabric component is generally present in passenger tyres only. Refer to Table 40 for more detailed estimates of the composition of new tyres by tyre group.

There were 558 000 t of new tyres placed onto the Australian market in 2019–20, or nearly 59 million EPUs. These were somewhat evenly spread across the three main tyre groups, with sales being 37% passenger tyres, 35% truck tyres, and 28% off-the-road (OTR) tyres.

Table 39 – Australian tyres sales in 2019–20, by tyre group

Flow	Passenger (tonnes or EPUs)	Truck (tonnes or EPUs)	OTR ¹ (tonnes or EPUs)	Total (tonnes or EPUs)
Sales (tonnes)	206 000	197 000	155 000	558 000
Sales (EPUs)	21 700 000	20 700 000	16 300 000	58 700 000

Source: Tyre Stewardship Australia (2020).

1. Off-the-road (OTR) tyre – Tyres for mining sites and heavy industry applications.

¹ An equivalent passenger unit (EPU) is the estimated weight of an average passenger tyre. A new EPU weight is 9.5 kg/EPU (a new tyre going onto market), and the weight of a used tyre EPU (the tyre at end-of-life) is 8.0 kg/EPU.



Table 40 – Australian tyres sales in 2019–20, by material type and tyre group

Material	Passenger (tonnes)	Truck (tonnes)	OTR (tonnes)	Total (tonnes)
Rubber – natural	32 000	58 000	45 000	135 000
Rubber – synthetic	60 000	25 000	19 000	104 000
Metal – steel wire	33 000	49 000	39 000	121 000
Plastic fibre/fabric – nylon	6 000	0	0	6 000
Plastic fibre/fabric – polyester	6 000	0	0	6 000
Rubber additive – carbon black	24 000	24 000	18 000	66 000
Rubber additive – silica	24 000	24 000	18 000	66 000
Rubber additive – zinc oxide	2 000	4 000	3 000	9 000
Rubber additive – sulfur	2 000	2 000	2 000	6 000
Rubber additive – other	16 000	12 000	9 000	37 000
Totals	205 000	198 000	153 000	556 000

Source: Tyre Stewardship Australia (2020).

Table 41 shows there are an estimated 460 000 t of tyres reaching end-of-life, compared with the nearly 560 000 t of tyre sales in 2019–20. Much of this difference is accounted for by tyre wear losses, which are typically around 16% (or nearly 90 000 tonnes of 2019–20 new tyre sales) of the new tyre weight (TSA, 2020).

Table 41 also shows that, of the total tyres reaching end-of-life in Australia in 2019-20, 15.0% were sent to local reprocessing facilities and 57.2% were sent to export for recovery (including locally shredded tyres which are then exported). The remaining 27.7% were not recovered and were almost entirely sent to onsite disposal (the majority of OTR tyres) and landfill, with a small proportion of this stockpiled or illegally dumped.

Table 41 – EoL tyres collections in 2019–20, domestic and export fates

Flow	Passenger (tonnes)	Truck (tonnes)	OTR (tonnes)	Total (tonnes)
Domestic recovery	13 200	53 000	3 000	69 200
Exported recovery	157 600	93 300	12 300	263 200
Not recovered ¹	20 400	16 400	90 700	127 500
Total	191 200	162 700	106 000	459 900

Source: Tyre Stewardship Australia (2020).

1. 'Not recovered' includes tyres to onsite disposal (mainly relating to OTR tyres), disposal to landfill, and a small amount of to long-term stockpiling.



Table 42 provides more detailed information on the domestic and export destination fate for EoL tyres based on available detail on the application fates. The major Australian fates of EoL tyres are onsite disposal (relating to OTR tyres almost exclusively), tyres sent for reprocessing into tyre crumb (with a preference for truck tyres with a higher natural rubber content), and tyres sent to landfill.

While domestic fates can be reported at the application areas, this level of detail is not available for the 263 200 tonnes exported in 2019–20. However, it is known that the majority of exported passenger tyres will be sent to energy recovery, along with some of the exported truck and OTR tyres (TSA, 2020).

Table 42 – EoL tyres collections in 2019–20, domestic and export fates by application

Fate	Fate location	Passenger (tonnes)	Truck (tonnes)	OTR (tonnes)	Total (tonnes)
Casings & seconds	Local	1 700	23 300	0	25 000
Civil engineering	Local	1 400	1 300	900	3 600
Crumb, granules and buffings	Local	8 300	27 300	1 600	37 200
Pyrolysis	Local	1 800	1 100	500	3 400
Kilns/boilers/furnaces	Local	0	0	0	0
Stockpiles (>5,000)	Local	1 700	2 500	1 800	6 000
Landfill	Local	17 100	10 300	3 700	31 100
Onsite disposal (mining, other OTR)	Local	0	0	82 500	82 500
Dumping dispersed	Local	1 600	3 600	2 700	7 900
Export	Overseas	157 600	93 300	12 300	263 200
Total		191 200	162 700	106 000	459 900

Source: Tyre Stewardship Australia (2020).

4.2 Paint and other surface coatings

Polymers used in paints, adhesives and other coatings are included in the scope of the project for the first time this year. In this section of the report, paint consumption and recovery, (with a focus on the polymer component of the paint), are profiled in more detail. The inclusion of paint polymers in the project scope has increased overall plastics consumption relative to previous years to a minor extent.

Paints are typically composed of 4 main ingredient groups, which are: solvents, binders, pigments, and additives. Of these, only binders are considered to be 'plastics' and thus fall into the project scope. In approximate terms, around 25% of wet paint (both water-based and oil-based) is generally binder, and around 50% of dry paint is binder. A listing of the most common binders is provided in the following table.



Table 43 – Examples of paint ingredients that could be considered plastics

Ingredient	Function	Comments
Alkyd resin	Oil-based paint binder	Synthetic binder.
Ethylene vinyl acetate	Water-based paint binder	Synthetic binder.
Linseed oil	Oil-based paint binder	Natural binder. Considered out of scope.
Polyacrylic acid	Water-based paint binder	Synthetic binder.
Polyvinyl acetate	Water-based paint binder	Synthetic binder.
Styrene	Water-based paint binder	Synthetic binder.
Styrene acrylic	Water-based paint binder	Synthetic binder.
Vinyl acetate acrylic	Water-based paint binder	Synthetic binder.
Vinyl versatate	Water-based paint binder	Synthetic binder.

The most recent publicly available data on paint sales into the Australian market is for 2012–13 (Nolan Consulting, 2014). While dated, it is reported in the same source that paint sales are only changing slowly, so the data is expected to be reasonably indicative, although possibly conservative, of paint sales in 2019–20. A review of the import codes related to paint imports was inconclusive with respect to supporting the quantification of paint imports.

A summary of some of the main paint polymer related material flows is provided in Table 44. Paint consumption was nearly 200 000 tonnes in 2012–13, of which around 49 000 tonnes was polymer. This indicates that paint polymer consumption is around 1–2% of plastics consumption across all applications.

Based on 2012–13 data it is estimated that around 94% of paint is used as intended and 6% is unused. A significant proportion of the 6% unused paint is collected for safe disposal or recycling through the Paintback product stewardship scheme, or through state/territory operated household chemical collection programs. The 94% of the paint (polymer) that is used as intended will typically take many years to enter waste streams, but there is no reported recovery of used paint at end-of-life.

Table 44 – Indicative paint polymer consumption and disposal flows

Flow	Water based (tonnes)	Solvent based (tonnes)	Total (tonnes)	Comments
Consumption – wet paint	174 000	23 000	197 000	Total paint onto the market in 2012–13.
Consumption – paint solids	87 000	11 500	98 500	Paint solids onto the market in 2012–13.
Consumption – polymer	43 500	5 800	49 300	Polymer component only of paint onto the market in 2012–13.
Unused paint polymer available for recovery	2 600	300	2 900	Unused paint in 2012–13. Polymer component only.
Used paint polymer to disposal at some future time	40 900	5 500	46 400	Paint polymer used in 2012–13 that will go to disposal at some future year.



4.3 Single-use plastic products (SUPPs) consumption

This component of the project developed a dataset on national consumption of a range of key problematic/unnecessary single-use plastic products (SUPPs) across both packaging and non-packaging applications. This includes a significant expansion on the plastic retail carry bag consumption data reported in the 2018–19 report.

In addition to the SUPPs, there is also data presented on a number of the major competing non-SUPPs, including non-plastic disposable cutlery (e.g., wood-based), paper plates and paper straws. This data is provided for comparison purposes, and to assist with tracking any shifts in relative usage over time.

This information will assist in measuring the progress of various SUPPs phase outs across Australia, including across the jurisdictions and at the national level.

For the purposes of this study, and where relevant, food service related SUPPs are defined as a form of packaging. These include take-away food related products such as; clamshell packaging, plastic plates and bowls, coffee cups and lids, cutlery, straws, and drink stirrers.

The list of SUPPs and major competing non-SUPPs that have been quantified in this study is provided in the following table.

Table 45 – Single-use plastic products list

Product	Product group	Comments
Single-use HDPE supermarket bags (≤ 35 microns)	Shopping bags	Thinner film supermarket bags that have largely been banned or phased out nationally.
Reusable HDPE supermarket bags (> 35 microns)	Shopping bags	Thicker film supermarket bags that are still in use nationally.
Reusable LDPE supermarket bags	Shopping bags	Thicker film supermarket bags that are still in use nationally.
Reusable non-woven PP bags	Shopping bags	Includes NWPP ¹ cooler bags.
Single-use HDPE produce bags	Shopping bags	-
Hot cups	Disposable cups & lids	PCPB ² based hot cups.
Cold cups	Disposable cups & lids	Includes PCPB, PET and PLA based cold cups.
Hot cups lids	Disposable cups & lids	Typically PS or PLA based lids.
Cold cups lids	Disposable cups & lids	Typically PS or PLA based lids.
Plastic cutlery	Disposable cutlery	Includes PLA based cutlery.
Non-plastic cutlery	Disposable cutlery	Includes wood based cutlery.
Plastic plates	Disposable plates	Includes bowls.
Paper plates	Disposable plates	Includes bagasse plates. Includes bowls.
Plastic drink stirrers	Drink stirrers	Single-use drink stirrers only.
Non-plastic drink stirrers	Drink stirrers	Single-use drink stirrers only.
EPS/PS beverage containers	EPS/PS beverage containers	-



Product	Product group	Comments
EPS/PS food containers	EPS/PS food containers	-
Plastic straws	Straws	-
Paper straws	Straws	-
Degradable plastics	Material group	Oxo-degradable pro-degradant modified HDPE, LDPE and PP, going into all applications.
Biodegradable plastics	Material group	Claimed biodegradable but not AS/NZS certified compostable plastics. Includes PBAT, PHA and PLA, going into all applications ³ .
Certified compostable plastics	Material group	AS/NZS certified compostable plastics, going into all applications.
EPS void fill – moulded	Material group	Moulded EPS void fill, for example commonly used as fill for electrical and electronic goods.
EPS void fill – peanuts	Material group	Loose EPS void fill, for example EPS peanuts.

1. NWPP – Non-woven polypropylene.

2. PCPB – Polymer coated paperboard.

3. PBAT – Polybutylene adipate terephthalate / PHA – Polyhydroxyalkanoates / PLA – Polylactic acid.

The market consultation and other data collection activities undertaken for the SUPPs quantification work was extensive. The major data sources were:

- **Packaging and single-use plastic product manufacturer surveys.**
- **Interviews with the major supermarkets.**
- **Brand-owner surveys.**
- **Interviews with composters nationally.**
- **Australian Customs import data.**
- **IBISWorld reports.**
- **RetailWorld supermarket sales publications.**
- **In-store surveys** – To identify use and brand-owners of single-use plastic items. To purchase products where required to determine unit weights, and support calculation of verification estimates of sales.
- **Existing research reports and analysis** – Prior research undertaken by the consulting team (e.g., plastic bags / plastic sacks) and other sources.

The SUPPs consumption estimates are provided in terms of total units, tonnes, and per capita consumption. An 'indicative accuracy' rating has also been provided, based on the market coverage of surveys or other data sources, and level of cross-verification that was possible.

The estimates of national consumption for the targeted SUPPs are summarised in the following table.



Table 46 – Australian use of the targeted SUPPs in 2019–20

Product	Weight	Number	Average weight	Per capita	Indicative accuracy ⁷
	(tonnes)	(million units)	(g/unit)	(units/person.yr)	(±%)
Single-use HDPE supermarket bag ($\leq 35 \mu\text{m}$)	200	30	5.4	1.2	±50% or less
Reusable HDPE supermarket bag ($> 35 \mu\text{m}$)	7 800	530	14.8	20.7	±20% or less
Reusable LDPE supermarket bag	15 900	550	29.1	21.6	±10% or less
Reusable non-woven PP bag ¹	7 300	70	97.7	2.9	±20% or less
Single-use HDPE produce bag	2 800	1 140	2.4	45.1	±10% or less
Single-use LDPE bag (boutique type)	1 600	50	29.1	2.2	±20% or less
Hot cups	22 500	1 840	12.2	72.7	±10% or less
Cold cups ²	12 600	910	13.9	35.7	±20% or less
Hot cups lids	6 100	1 470	4.2	57.9	±10% or less
Cold cups lids	2 300	590	3.9	23.2	±20% or less
Plastic cutlery	1 900	390	4.9	15.3	±25% or less
Non-plastic cutlery	1 100	290	3.9	11.3	±10% or less
Plastic plates ³	900	80	10.8	3.2	±25% or less
Paper plates ³	3 000	160	19.4	6.1	±10% or less
Plastic drink stirrers	100	270	0.3	10.5	±50% or less
Non-plastic drink stirrers	100	180	0.8	7.0	±10% or less
EPS/PS beverage containers	600	170	3.3	6.9	±25% or less
EPS/PS food containers	400	40	9.5	1.7	±25% or less
Plastic straws	800	1 280	0.6	50.5	±50% or less
Paper straws	1 000	850	1.2	33.7	±50% or less
Degradable plastics ^{4,5}	2 100	390	5.4	15.5	±50% or less
Biodegradable plastics ^{4,6}	1 100	70	15.2	2.8	±100% or less
Certified compostable plastics ⁴	8 900	580	15.2	23.0	±50% or less
EPS void fill – moulded	12 500	190	66.2	7.4	±20% or less
EPS void fill – peanuts	100	140	0.4	5.5	±100% or less

1. Includes non-woven PP cooler bags and polyester bags.

2. Includes PCPB, PET and PLA based cold cups.

3. Includes bowls.

4. Degradable, biodegradable and AS/NZS certified compostable plastics includes any use in other SUPPs that are listed.

5. Oxo-degradable prodegradant modified HDPE, LDPE and PP, into all applications.

6. Biodegradable estimate excludes AS/NZS certified compostable plastics.

7. The accuracy range is an estimate (based on survey data), relative to the stated value (weight), of the range within which the true value can be found.

Table 47 compares the estimated Australian use of retail carry bags across 2019–20, 2018–19 and 2016–17 (Envisage & SRU, 2020). It is important to note that the estimates generally have large year-on-year uncertainty ranges due to variability in stakeholder reporting, and often large reported accuracy ranges.



Across the bag types estimated in both 2016–17 and 2019–20, plastic bag consumption has dropped by 70% by number and 22% by weight across this three-year period. The reduction in usage by number between 2018–19 and 2019–20 may be due to consumers becoming more accustomed to taking their own reusable bags to the supermarket.

Table 47 – Australian use of retail carry bags in 2019–20, 2018–19 and 2016–17

Product	2019–20 estimates		2018–19 estimates ¹		2016–17 estimates ¹		Change from 2016–17
	Weight	Number	Weight	Number	Weight	Number	
	(tonnes)	(million units)	(tonnes)	(million units)	(tonnes)	(million units)	(% unit)
Single-use HDPE SM bag ($\leq 35 \mu\text{m}$)	200	30	7 000	1 300	30 700	5 660	-90%
Reusable HDPE SM bag ($> 35 \mu\text{m}$)	7 800	530					
Reusable LDPE SM bag	15 900	550	14 700	510	5 100	180	206%
Reusable non-woven PP bag	7 300	70	7 200	70	1 800	20	250%
Single-use HDPE produce bag	2 800	1 140	2 300	1 050	4 700	1 890	-40%
Single-use LDPE bag (boutique type)	1 600	50	1 500	50	3 100	100	-50%
Total	35 600	2 370	32 700	2 980	45 400	7 850	-70%

1. HDPE supermarket bag split by film thickness ($\leq 35 \mu\text{m}$ and $> 35 \mu\text{m}$) not determined in 2016–17 and 2018–19.

The significant increases in consumption of reusable LDPE bags and reusable NWPP bags between 2016–17 and 2019–20 have been more than offset by the even greater drop in single-use HDPE bags, and a fall in the use of single-use LDPE boutique bags.

Australian manufacturing of single-use HDPE retail carry bags effectively ceased in 2017, and since that time, almost all bags have been imported, with only small and occasional runs of local HDPE bag manufacturing occurring. A larger proportion of single-use and reusable LDPE carry bag manufacture still occurs locally (approximately 5–10% of consumption in 2019–20, down from 10–20% in 2016–17).

Across the period of 2002–2007, annual reviews of national single-use HDPE carry bags (only) were undertaken to track the progress of a phase-out initiative by the former Environment Protection and Heritage Council (EPHC) (Hyder, 2008). For comparison purposes, the data from this EPHC reporting activity, and the analysis undertaken for this project are summarised in the table below.



Table 48 – Australian use of single-use HDPE carry bags

Year	Number of bags	Weight of bags
	(billions)	(tonnes)
2002	5.95	32 700
2003	5.24	28 800
2004	4.73	26 000
2005	3.92	21 500
2006	3.36	18 100
2007	3.93	21 200
2016–17	5.66	30 700
2018–19	1.30	7 000
2019–20 ^a	0.56	8 000

a. Includes HDPE supermarket bags of both $\leq 35 \mu\text{m}$ and $>35 \mu\text{m}$ in film thickness.

It can be seen from the available time-series data that single-use HDPE plastic bag consumption has fallen by 90% since 2016–17, driven by the WA and QLD bans from 1 July 2018, and the Victorian ban from 1 November 2019.

In addition, a significant contributor to the fall in consumption has been the Coles and Woolworths phase-out of free single-use shopping bags from their stores nationally from July 2018.

Over the last decade the following single-use plastic carry bag bans have been implemented:

- SA 2009 (less than 35 microns banned)
- ACT 2011 (less than 35 microns banned)
- NT 2011 (less than 35 microns banned)
- TAS 2013 (less than 35 microns banned)
- WA 1 July 2018 (35 microns or less banned)
- QLD 1 July 2018 (less than 35 microns banned)
- VIC 1 November 2019 (35 microns or less banned)
- NSW No ban currently in place, however the Coles and Woolworths phase out of free single-use shopping bags in place from July 2018.

4.4 Plastics from e-waste

E-waste plastics are typically; high impact polystyrene (HIPS), ABS, polycarbonate, polymethyl methacrylate (PMMA), PVC, and PP. A range of epoxy and phenol resins, and polyesters, are also used in circuit boards.



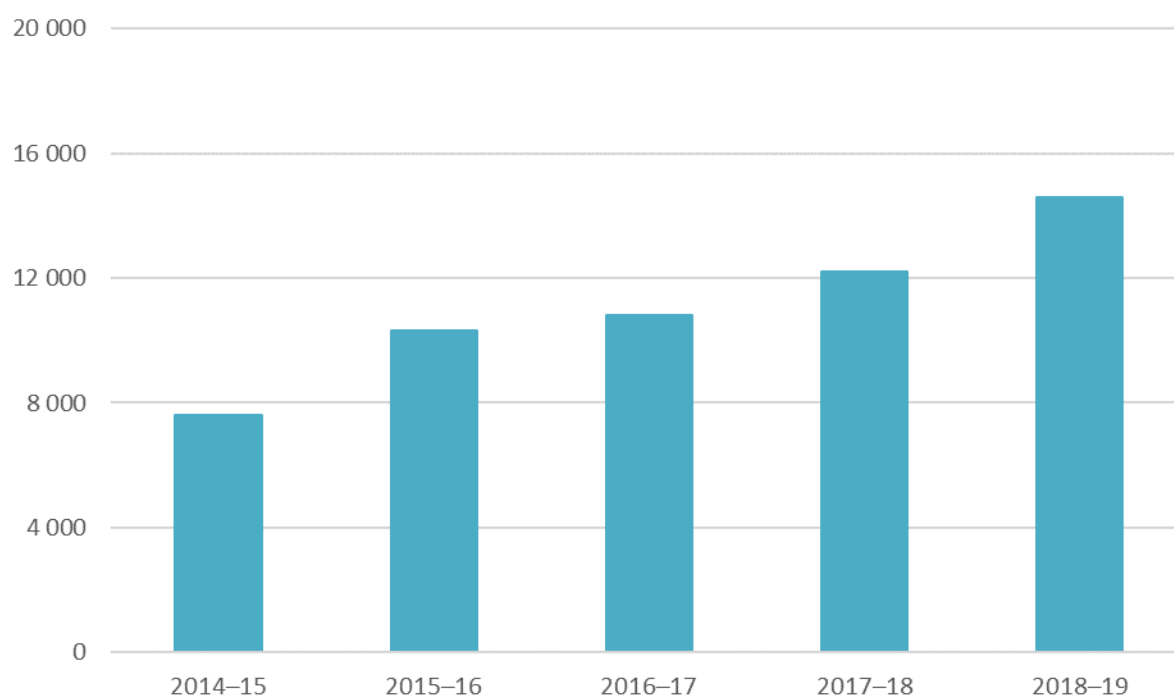
Australia's National Television and Computer Recycling Scheme (NTCRS) gives Australian households and small businesses free access to industry-funded collection and recycling services for televisions and computers, including printers, computer parts and peripherals. The most recent available data on plastics recovered from e-waste has been drawn from reporting undertaken by the 4 NTCRS coregulatory arrangement² (scheme) operators, and one other source. These sources are:

- ANZRP Annual Report 2018/19 (ANZRP, 2019).
- Ecycle Solutions Pty Ltd Annual Report 2019 (Ecycle, 2019).
- Electronic Product Stewardship Australasia - Product Stewardship Televisions and Computers - Annual Report 2018/19 (EPSA, 2019).
- MRI PSO Product Stewardship Arrangement 2018-19 Annual Report (MRI PSO, 2020).
- MobileMuster advice on mobile phone recovery in 2019–20 (MobileMuster, 2021).

Note that the NTCRS reporting is for 2018–19, and not for the target year of 2019–20.

Presented in Figure 35 and Table 49 is the available data on e-waste plastics recovery through the NTCRS and MobileMuster. E-waste related plastics recovery has increased by over 90% across the 5 years for which data is available.

Figure 35 – E-waste plastics recovery 2014–15 to 2018–19 (tonnes)



² The NTCRS coregulatory arrangements organise the collection and recycling of e-waste in accordance with the *Recycling and Waste Reduction Act 2020* and the *Product Stewardship (Televisions and Computers) Regulations 2011*.



Table 49 – E-waste plastics recovery 2014–15 to 2018–19

Year	Recovery
	(tonnes)
2014–15	7 600
2015–16	10 300
2016–17	10 800
2017–18	12 200
2018–19	14 600



5 RECOVERY OPTIONS FOR PLASTIC PRODUCTS

5.1 Reprocessing options

The resource efficiency hierarchy (or waste hierarchy) provides a guide to the selection of waste minimisation and recovery strategies which maximise the conservation and efficient use of resources. Avoidance is always preferable to recovery, however there are a number of beneficial options available for the recovery of plastic products.

This section provides an overview of the current and potential future recovery options for plastic products here in Australia.

It is also important for recoverability to be considered at the design stage to minimise the product's environmental impacts at end-of-life. This is now often considered during packaging design in Australia but is rarely considered for plastics used in other applications. However, gradual improvements in awareness are happening in the building industry, regarding the life cycle impacts of building products. This is illustrated by the significantly increasing use of environmental product declarations for building products selection, over the last few years. This may eventually lead to improvements in the end-of-life outcomes for plastics going into the built environment.

The feasibility and environmental benefit of each recovery option will depend on the design of the product, its durability and the availability of a suitable recovery system. For this reason, an important distinction needs to be made between short-life products such as packaging, and more durable products such as appliances, furniture and building products.

The environmental impacts and benefits of durable (longer life) products, such as electrical and electronic appliances, furniture, cars and building products over their life cycle, are more likely to be associated with the use stage of the product, rather than the production stage. However, long-life products should also consider recovery options at end-of-life.

The following sections provide a summary of the current status of each recovery option for plastics products in Australia.

5.1.1 Product repair, reuse or remanufacture

Reuse is usually an environmentally preferable end of life option, as based on the extensive life cycle assessment (LCA) literature comparing many types of single-use and reusable products. However, the feasibility of reuse will depend on complex economic and practical considerations.

Reuse is increasingly being used as an approach for sustainability strategy for distribution packaging. For example, returnable (or reusable) plastic crates are now commonly used for transporting fruit and vegetables from growers all the way to the supermarket shelf and have avoided the consumption of huge quantities of single-use cardboard boxes and EPS crates.

There remains huge potential for reusable packaging systems to replace single-use packaging systems. It has been calculated that, across a diverse range of reusable packaging systems, on average, every kilogram of reusable packaging systems avoids the use of 12.8 kg of single-use packaging (APCO, 2020a, p. 99).



There is some reuse of automotive parts, and significant local reuse and export of used clothing for reuse overseas. Remanufacturing is undertaken on a much smaller scale, usually for electrical or electronic products such as toner cartridges and photocopiers.

5.1.2 Mechanical recycling

Mechanical recycling is the main recovery pathway for scrap plastics in Australia. In Australia mechanical recycling can include the following processes, and combinations of processes:

- Sorting and shredding/granulation.
- Sorting, shredding/granulation and pelletising.
- Sorting, shredding/granulation and product manufacture.
- Compaction and extrusion.
- Compaction, extrusion and product manufacturing.

The infrastructure for collection and reprocessing is relatively well established for some products such as packaging. It is also generally preferable to chemical recycling because it maintains the economic value of the polymer at a relatively high level and reduces the amount of energy required to manufacture new plastic products.

This recovery option is most economically viable for plastics that are available in large quantities, in a clean and homogenous (or sortable) form, and in locations with reasonable access to recycling facilities. Mixed plastics can also be recycled in this way, however they are more challenging as they either need to be separated or recycled into a reduced range of mixed polymer product types, such as bollards, decking and outdoor furniture. These mixed polymer products often have long lifespans and may be recycled back into similar products at end-of-life.

While mechanical recycling can offer a high-value recovery pathway for single polymer plastics, it is often not suitable for plastic products made out of multiple polymer types or that are contaminated with other materials. It also has little success recycling the huge quantity and diversity of plastic fibre-based materials contained in textiles, such as clothing and carpets. For example, of the estimated 2.5 million tonnes of synthetic plastic products reaching end-of-life (excluding tyres) in 2019–20, less than 13% of this material was mechanically recycled.

5.1.3 Chemical recycling

The chemical recycling of plastics, also called advanced or feedstock recycling, is the chemical processing (rather than mechanical) of post-consumer waste plastics to mixtures of chemicals that are typically quite different from the original plastic. There is a diverse range of chemical recycling technologies (mostly under development or early commercialisation) that can process waste plastics into a range of hydrocarbon products. The commercial viability of many of these technologies is a developing area.

Refer to Section 5.5.2 for a more detailed discussion of chemical recycling.



5.1.4 Biological recycling

Biological recycling (i.e., through composting or anaerobic digestion) is undertaken on a very small scale for packaging made from certified compostable plastics, but facilities are limited, and contamination of compost products is a significant concern. National coverage of kerbside organics collection systems that accept compostable plastics is currently low.

A handful of large composters were surveyed nationally as part of this project, but minimal data was available on the receipt of certified compostable plastics. Based on this consultation it appeared that receipt of these materials was no more than a few hundred tonnes nationally in 2019–20.

5.1.5 Energy recovery

Energy can be recovered from plastics through controlled combustion or conversion to a liquid fuel (which is subsequently burnt). Energy recovery may be a good option for plastics that are not suitable for mechanical recycling, such as contaminated products. There is now some controlled combustion occurring in Australia, however there is no known conversion to liquid fuels.

There is growing energy recovery from plastics in Australia, dominated by the manufacture of a construction and demolition sector (C&D) waste-based fuel that is manufactured at the time of reporting in South Australia and New South Wales, for combustion in local and overseas cement kilns. However, in 2019–20 timber was the main energy source in this fuel.

There is also the thermal treatment of medical waste in Australia, which contains a reasonably high proportion of plastics, however this is typically undertaken without energy recovery.

There is an ongoing challenge to ensure that energy recovery does not undermine efforts to maximise mechanical recycling, or indirectly undermine efforts to improve product and packaging design for mechanical recycling.

5.2 Reprocessor numbers by state/territory

This section of the report provides data on plastics reprocessing from Australian sources for the 2019–20 financial year. Data was obtained for 87 reprocessing facilities nationally, out of 93 facilities believed to have been active during 2019–20. Data was obtained through direct survey of 78 reprocessors and estimated for 9 facilities, and incorporated into the survey dataset.

Note that these estimates exclude tyre reprocessing facilities, as detailed data on tyre reprocessing facilities numbers and locations were not available this year.

Many reprocessors handle more than one polymer type, resulting in improved depth to the reprocessing market. For example, in NSW there are 20 reprocessing facilities included in the survey dataset, however between them these facilities handled a total of 49 polymer types in aggregate across the facilities.

As can be seen in the Table 50 there is a fairly deep national capacity for reprocessing polymers 1–6, albeit with gaps in geographic coverage, particularly in smaller jurisdictions.



Table 50 – Reprocessor counts by facility location and polymer types reprocessed in 2019–20

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
Number of reprocessors	0	20	0	11	10	3	34	9	87
Polymer reprocessed	Number of reprocessors in the jurisdiction reprocessing the polymer type								
PET (1)	0	4	0	1	N/R	0	6	1	12
PE-HD (2)	0	13	0	7	N/R	2	16	7	45
PVC (3)	0	4	0	2	N/R	1	6	2	15
PE-LD/LLD (4)	0	8	0	6	N/R	1	11	4	30
PP (5)	0	9	0	8	N/R	1	12	4	34
PS (6)	0	1	0	2	N/R	0	7	0	10
PS-E (6)	0	5	0	3	N/R	1	12	1	22
ABS/SAN/ASA (7)	0	3	0	1	N/R	0	3	0	7
PU (7)	0	1	0	1	N/R	0	0	0	2
Nylon (7)	0	0	0	1	N/R	0	2	0	3
Bioplastic (7)	0	0	0	0	N/R	1	0	0	1
Other (7)	0	1	0	0	N/R	0	2	1	4
Unknown polymer	0	0	0	0	N/R	0	1	2	3
Total count	0	49	0	32	N/R	7	78	22	188

Note: N/R indicates data was not reported.



5.3 New reprocessing capacity

During the reprocessor surveys for the project, reproducers were also surveyed for the following information:

- Current capacity (tonnes per annum) by polymer type – This is the maximum quantity that the facility could receive and practically reprocess with existing equipment and resources, under its current licence conditions.
- Spare capacity (tonnes per annum) – This is the unused quantity at the facility, in excess of actual reprocessing. Calculated as current capacity minus actual reprocessed quantity
- Planned capacity (tonnes per annum) by polymer type – This is the quantity beyond current capacity for which the facility is seeking (or has received) a licence increase, and new capital works will be required, which are either planned or under construction.

The outcomes from the reprocessor capacity survey are summarised in the Table 51. The key results are:

- 52 companies (of 81) responded to the current and planned capacity questions.
- Reported reprocessing for 2019-20 was 200 300 tonnes.
- Current capacity at 364 800 tonnes is 45% higher than actual 2019–20 reprocessing. Most of the spare capacity relates to HDPE, LDPE, and PP.
- At the end of 2020 there was around 182 800 tonnes of planned new capacity, most of which does not have a confirmed project go-ahead or planning approvals in place. Around 65% of this new capacity relates to PET and HDPE, and mostly to post-consumer packaging reprocessing of these polymers.

Table 51 – Australian reprocessor current and planned capacity increases in the next 5 years

Polymer	2019–20 reprocessing (tonnes)	Current capacity (end 2020)			Planned capacity ¹ (increase from current)		Current + Planned (tonnes)
		Current ¹ (tonnes)	Spare (tonnes)	(%)	(tonnes)	(%)	
PET (1)	30 800	45 200	14 500	32%	60 300	133%	105 500
PE-HD (2)	56 100	109 100	53 100	49%	58 800	54%	168 000
PVC (3)	5 300	11 600	6 300	54%	11 100	96%	22 600
PE-LD/LLD (4)	36 300	87 900	51 600	59%	21 800	25%	109 700
PP (5)	38 600	60 200	21 600	36%	22 600	38%	82 800
PS (6)	3 700	10 600	6 900	65%	7 500	71%	18 100
PS-E (6)	6 100	14 500	8 400	58%	500	4%	15 000
ABS/SAN/ASA (7)	900	1 400	500	36%	100	5%	1 500
PUR/PIR (7)	3 500	4 400	900	20%	100	3%	4 500
PA (7)	200	600	400	67%	0	0%	600
Bioplastic (7)	100	100	0	0%	0	0%	100
Other (7)	1 300	1 800	500	28%	0	0%	1 800
Unknown	17 300	17 400	0	0%	0	0%	17 400
Total	200 300	364 800	164 500	45%	182 800	50%	547 700

1. May include energy recovery related reprocessing for current capacity and planned capacity increases.



It is important to note that the reprocessing capacity estimates provided in Table 51 should be interpreted with care as they do not provide information on the availability of scrap plastics compatible with the reprocessing capacity, or on the level of reprocessing value-add that can be undertaken with any spare capacity, and so the ability to find an end-market.

5.4 End-market uses

After reprocessing, recovered plastics are used to manufacture new products, which can have new applications often quite different from those of the original use. Outlined in Table 52 are many of the typical uses of recovered plastics in Australia.

Table 52 – Typical uses of recovered plastics in Australia

Polymer	Major uses of recovered polymer	Minor uses of recovered polymer
PET	Beverage bottles.	Timber substitutes, geo-textiles, pallets and fence posts.
PE-HD	Milk bottles, 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	Industrial and garden hose, profiles, pipes and conduit.	Gumboots, mats, resilient flooring, mudflaps and coving (decorative building mouldings).
PE-LD/LLD	Film (incl. builders' and agricultural film, concrete lining, freight packaging, garbage bags, shopping bags), agricultural piping.	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.
PS-E	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.
ABS/SAN/ASA	Injection moulded products.	Automotive components, laminate edging, sheet extrusion, coffin handles, drainage covers, auto parts and a range of injection moulded products.
Polyurethane	Carpet underlay.	Mattresses.
Nylon	Injection moulded products.	Furniture fittings, wheels and castors and a range of injection moulded products.
Rubbers	Fuel for cement kilns, soft-fall applications, and binders, glues & adhesives.	Crumb rubber in spray seals, crumb rubber in explosives, whole tyres in civil works, and crumb rubber in steelmaking.
Bioplastic	Food serveware and packaging applications.	Agriculture.



Other and mixed

Timber substitute products in general and piping.

Fence posts, bollards, garden stakes, kerbing, marine structures, post and rail systems, scaffold pads, piggery boards, shipping dunnage, rail bridge transoms.

5.5 Innovative new end-markets

There are numerous significant new end-markets for scrap plastics either under development or at some stage of commercialisation. This section of the report profiles a handful of the most promising, and potentially large-scale, options.

5.5.1 Recyclate as a binder in asphalt

Crumb rubber can be used as a polymer modified binder in the production of sprayed seals and asphalt to increase flexibility and reduce the impacts of road surface cracking. There is the possibility that scrap plastics from non-packaging sources could also supply a significant proportion of this potential market. Flexible (soft) plastic formats may be preferred for this application (The CIE & APC, 2019, p. 40).

The market for bitumen in Australia is in the order of 800,000 tonnes per year and products using rubber generally incorporate 10–25% rubber by weight (REC, 2017, p. xvii), suggesting this is a significant opportunity.

5.5.2 Closed loop chemical recycling of plastics

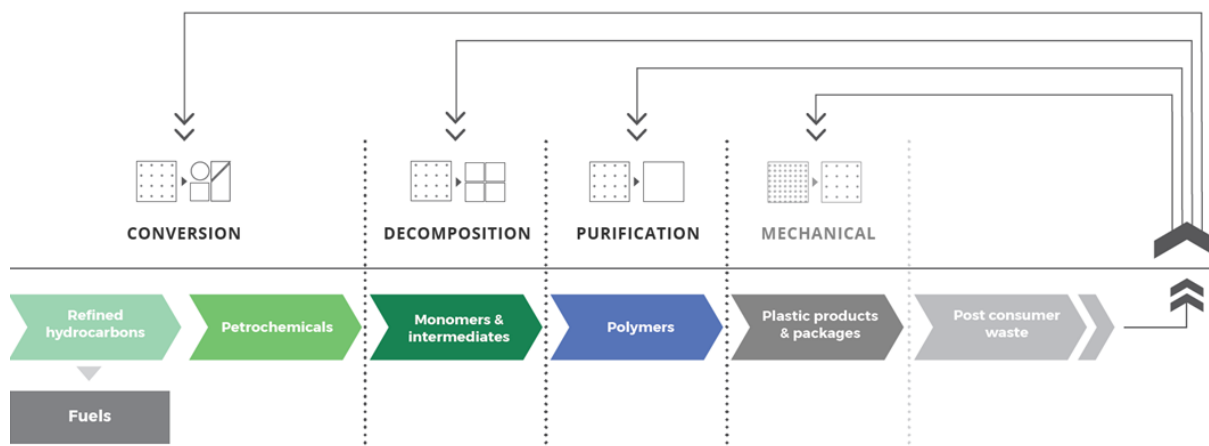
Chemical recycling is the chemical processing (rather than mechanical) of post-consumer waste plastics. Chemical recycling typically converts the plastic polymers to a mixture of shorter chain liquid or gaseous hydrocarbons that are suitable for further purification, separation and chemical synthesis processes, potentially similar to the processing of crude oil into fuels and chemicals.

Chemical recycling complements mechanical recycling, as it can process plastics that are difficult to recover mechanically. These challenging EoL plastics include soft plastics, multi-layer packaging and plastic that has been degraded by repeated mechanical recycling. Chemical recycling can be a part of a new closed loop system that produces virgin equivalent plastics from lower quality scrap plastic inputs.

There is a diverse range of chemical recycling technologies (mostly under development or early commercialisation) that can process waste plastics into a range of hydrocarbon products. The commercial viability of many of these technologies is a developing area. There is a [Closed Loop Partners](#) (2019) report that provides a good summary of the plastics chemical recycling technology landscape. The technology groups and products outlined in that report are reproduced in Figure 36.



Figure 36 – Plastics recycling technology groups and potential products



Source: Closed Loop Partners (2019, p. 25)

Many of the chemical recycling technologies are suitable for either biobased or fossil-based hydrocarbons, so could be part of the transition to lower dependency on non-renewable resources, and do not necessarily ‘lock-in’ dependency on fossil reserves.

One chemical recycling proponent in Australia is Licella Pty Ltd, which is currently undertaking a feasibility assessment with a number of partners, for a 20 000 tonne per year facility in Victoria. Licella’s Catalytic Hydrothermal Reactor (Cat-HTR™) technology uses supercritical water to de-polymerise EoL plastics into an intermediate ‘Plasticrude’. This Plasticrude, similar to fossil crude, can be refined into new plastics and other products using the existing petro-chemical infrastructure in Victoria.

The Licella process targets HDPE, LDPE and PP as the preferred infeed polymers. However, the process is tolerant of contamination with most other polymers (except for chlorinated and fluorinated polymers, e.g. PVC), and is also tolerant of water and many organic materials.

Chemical recycling facilities are generally reported to be highly scalable. Of course, this depends on the availability of suitable infeed material, and the sufficiency of offtake markets for the liquid/gaseous hydrocarbons that are produced.

With less than 13% of plastics going to mechanical reprocessing in 2019–20, and this rate growing only incrementally over the last 10–20 years, there is a demonstrable need for new reprocessing approaches for many forms of EoL plastic products and packaging.

To meet APCO’s 2025 National Packaging Targets, including a commitment to use an average of 20% recycled content in plastic packaging by 2025 (APCO, 2020c, p. 3), the demand for food-grade recycled content is expected to grow significantly. Without local supply, packaging manufacturers may be forced to source packaging or recycled polymer from overseas.



5.5.3 Recycled plastics-based railway sleepers

Integrated Recycling has created the Duratrack recycled plastic railway sleeper from its patented formulation that is resistant to environmental degradation. Duratrack sleepers have a design life of 50 years compared with the 10 to 20-year lifespan of a timber sleeper, are recyclable at the end of their service life, and are used to replace both timber and concrete sleepers.

In 2021 the sleeper was approved for slow speed applications by Metro Trains Melbourne and V/Line, and is being considered for various Level Crossing Removals and Regional Rail Revival projects as part of Victoria's Big Build program.

Duratrack is also currently undertaking trials with Queensland Rail and the Australian Rail Track Corporation (ARTC), the latter in conjunction with the Institute of Railway Technology at Monash University.

Each Duratrack sleeper is made from Integrated Recycling's patented formulation and contains around 85% recycled plastics sourced from post-consumer rigid and flexible polyethylenes and polystyrene.

For every kilometre of track installed using Duratrack sleepers between 64 tonnes and 99 tonnes (depending on the gauge) of recycled plastics will be incorporated into the sleepers. With thousands of kilometres of timber sleeper-based railway track requiring replacement nationally over the next 5 years alone, the Duratrack sleeper is an excellent example of the rail industry's use of recycled content materials and potential to support a more circular economy.



6 KEY TRENDS IN PLASTICS

This section of the report looks at major trends and influences on plastics consumption and recovery both domestically and internationally, and outlines market commentary (as received from plastics reprocessors) and other trends or activities around plastics.

6.1 International developments

6.1.1 Plastic packaging levy in the EU

Midway through 2020, the European Union (EU) passed legislation for a levy of €0.80 /kg (currently AUD1.25 /kg) on non-recyclable plastic packaging placed on each member state's market. The levy became effective 1 January 2021.

In 2018, around 10 million tonnes of plastic packaging was sent to landfill or energy recovery. This implies that, at full implementation, the EU tax could raise AUD12.5 billion per year. It is understood that the revenue raised by the levy will be used to contribute funding to the EU's COVID-19 economic recovery plan.

6.1.2 Single-use plastic product bans in the EU

In 2018, the European Commission proposed a Single Use Plastics (SUP) Directive targeting the 10 single-use plastic products most commonly littered or lost to the environment. The legislation aims to reduce plastic litter in the EU by more than 50% for the targeted items and will come into force in mid-2021. The plastic products covered by the ban include:

- Cotton buds with plastic sticks.
- Cutlery and plates, beverage stirrers and straws.
- Sticks for balloons.
- Expanded polystyrene (EPS) food containers, beverage containers and cups.
- Oxo-degradable plastics.

SUPPs with less widely available alternatives in some circumstances, have substitution or avoidance targets that are due to come into force in 2026.

6.1.3 Plastic packaging tax in the UK

The United Kingdom (UK) Government is currently undertaking consultation on the implementation of a new *Plastic Packaging Tax* (PPT) to apply to plastic packaging produced in, or imported into, the UK. The tax is proposed to come into force from 1 April 2022 and will be charged at a rate of £200 per tonne (currently AUD0.36 per kg).

The PPT will not apply to any plastic packaging which contains at least 30% recycled plastic, or any packaging which is not predominantly plastic by weight. Locally manufactured, and both filled (containing goods) and unfilled (to be filled in the UK) imported plastic packaging will be subject to the tax.



6.1.4 PET beverage recycled content requirements in California

Californian lawmakers approved legislation on 30 August 2020 requiring beverage companies to use recycled plastic. If signed, the bill will be the first minimum recycled-content law of its kind for plastic bottles in the USA.

The bill (legislation) requires that all plastic bottles covered by the Californian container redemption program average at least 15% post-consumer resin (PCR) starting in 2022. The post-consumer recycled content requirement will then increase to 25% in 2025 and 50% in 2030.

As the bill applies to material under the container redemption program, it will mostly impact PET bottle recycling rates. It does not appear that it applies to aluminium cans or liquid paper board (LPB) based beverage packaging.

Under the bill, manufacturers missing the targets are subject to penalty fees, which are nearly AUD600 per tonne for every tonne of PCR content that is missed. It is proposed that the penalty money will be hypothecated to support increasing the collection rates and processing capacity for plastic beverage bottles.

6.1.5 Single-use plastic product bans in China

China is currently implementing an extensive range of new policies to ban various plastic bag formats, plastic film applications, and numerous other single-use plastic products. The policies will come into force via a staged approach from 2020 to 2025.

Banned or restricted plastic products will include:

- Plastic shopping bags with thickness less than 25 microns by the end of 2020, and all non-degradable plastics bags by the end of 2022 or 2025 (depending on location).
- PE agricultural mulch film with thickness less than 10 microns.
- EPS tableware.
- Cotton swabs with a plastic tube.
- Personal care/beauty products containing plastic beads.
- Single-use tableware and straws.
- Single-use plastics products in hotels.
- Non-degradable plastic packaging and packaging tape for postal packaging.

There are ongoing acceptable uses for some of the SUPPs above. However, this will clearly have an enormous impact on SUPPs consumption in China, and likely significant ramifications globally in relation to the relative cost and availability of SUPPs and non-SUPP alternatives.

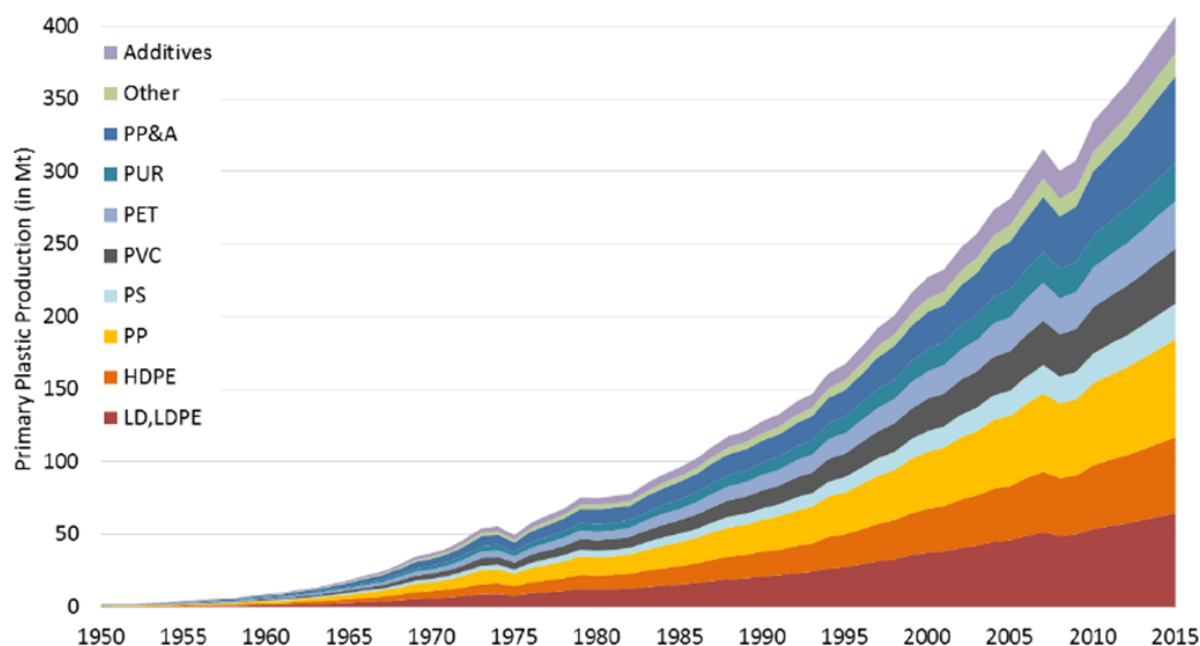
6.1.6 Increasing virgin resin production megatrend

There are large increases in global virgin resin capacity currently coming online, which are likely to generally push down virgin resin prices over the next few years.



Virgin (primary) resin production has seen enormous growth over the last 70 years, and this is forecast to continue with the massive new capacity builds that are taking place globally, but particularly in China, the Middle East, and the USA (Carbon Tracker, 2020, p. 38). Growth in global virgin resin production to 2015, by polymer type, is presented in Figure 37.

Figure 37 – Global virgin plastics production 1950–2015



Source: Geyer, et. al. (2017b)

Note: PP&A stands for polyester, polyamide, and acrylic fibres.

It is estimated that global PE capacity was around 110 million tonnes at the end of 2018, but there is another 28 million tonnes or 25% of new capacity scheduled to come online by 2023 (confidential source). Across the other major polymer types, the planned plastics production capacity increase might be as much as 50 million tonnes over approximately the same period (Carbon Tracker, 2020, p. 38), or around 20% growth in supply.

The implications this has for the price of virgin resin, and therefore for recycled plastics prices, are clear and significant. Ironically, due to this glut of virgin resin production capacity, virgin resin manufacturers will also struggle to make money, even while pushing more plastics into the current system. No one will win financially, except potentially the lower cost fossil hydrocarbon producers.

The environmental implications for this level of growth in virgin resin consumption are also significant and are covered in more detail in Section 7.

Over 2018–19 and 2019–20 there was specific feedback provided by local plastics reproducers on the growing problem (for plastics recycling) of cheap virgin resin, with the key points being:

- A price signal is required to value low carbon recycled content products.
- Regulation is required to drive the use of recycled plastics in new product manufacture.



- Virgin resin prices are flat or trending downwards, while reprocessed plastic prices have upwards pressure due to trends towards increased operational and capital costs.

In summary, the fossil hydrocarbon supply sector appears to be planning towards plastics as a major, if not the main growth market, for fossil hydrocarbons over the next 20 years or so, as electrification of transport and industrial processes expands. This is a major plastics trend with clear implications for both reducing plastics use and increasing circular flows of plastics.

6.2 Local commentary

This section of the report outlines a synthesis of feedback from the plastics reprocessing sector on the 2019–20 financial year and the second half of 2020. The comments have been grouped into the following themes:

- Product and packaging design.
- Sorting and reprocessing capacity.
- End-markets and the export ban.
- Business operations.
- The COVID-19 pandemic.
- Government support.

6.2.1 Product and packaging design

The following is a summary of the main comments received from plastics reprocessors, with respect to the implications of product design related aspects to scrap plastics during 2019–20. This was a significant theme in 2018–19, which continued in 2019–20:

- As in 2018–19, several reprocessors raised that PVC and PS based packaging should be phased out.
- Rigid plastic packaging should be standardised around the use of PET, HDPE, and PP polymers, and minimise the use of other polymer types.
- PET packaging with film seals and barrier layers (e.g., meat trays) should be phased out, as are not currently economic to recycle.
- Labels should be the same polymer as the container, for example PP labels on PP containers. Paper labels on PET packaging are also highly problematic.

6.2.2 Sorting and reprocessing capacity

The following is a summary of the main comments received from plastics reprocessors, with respect to sorting and reprocessing capacity related aspects for scrap plastics during 2019–20:

- Significant capital investment is underway or under consideration, and more is needed. New good-quality hot-wash flake capacity should be the focus to increase reprocessing capacity for high-value recyclate.
- Significant new reprocessing capacity is being built in Western Australia and Victoria. New reprocessing capacity for Western Australia is being evaluated by at least one major national reprocessor.



6.2.3 End-markets and the export ban

The following is a summary of the main comments received from plastics reprocessors, with respect to end markets for scrap plastics during 2019–20, and the implications of the export ban coming into force on 1 July 2021:

- Good demand by local manufacturers for recycled PET, HDPE, and PP in particular. Also, strong export demand for good quality processed single polymer recyclate, which will not be affected by the first round of scrap plastics export bans from 1 July 2021, and possibly not by the second round in mid-2022 either.
- Recycled PP (rPP) is a versatile polymer that can go into many products. There is strong local demand back into building products and horticulture (plant pots).
- Strong competition between local reprocessors for good quality PP for reprocessing. Not nearly enough supply at the current time.
- The introductions of the Container Deposit Scheme (CDS) in Western Australia in October 2020, Tasmania in 2022 and Victoria in 2023 (proposed) are anticipated by a number of major reprocessors in the market to have a significant positive impact on the supply of high-quality PET bottles for recycling.
- Several medium to large reprocessors commented that they are looking forward to the export ban as it will increase local supply and reduce competition from overseas buyers for high-quality scrap plastics. As a result, the bans will also increase employment in the sector.
- Several reprocessors commented that the export ban will 'flood' the local market with scrap, and significant new local end-markets are required to avoid the value of recyclate falling significantly.
- Manufacturers need to invest in equipment (e.g., for injection moulding) that is designed for recycled polymer. More focus on manufacturing upgrades, rather than sorting and reprocessing capacity, is now needed to drive end-markets.
- Non-pressure pipes are a massive potential end-market for recycled plastics from both flexible and rigid packaging and other applications. Government regulation and procurement could drive large amounts of scrap plastics into this significant area of potential local demand.
- A fundamental issue is that the manufacturing volume in Australia is less than the importing volume, so export of high-quality reprocessed scrap will continue to be necessary, along with significant and continuing development of local end-markets.

6.2.4 Business operations

The following is a summary of the main comments received from plastics reprocessors, with respect to business operations related aspects for scrap plastics during 2019–20:

- Numerous reprocessors reported (as they did in 2018–19) that energy costs are still too high, placing cost pressure on profit margins.



- Insurance is increasingly difficult (or impossible) to procure. This is having an impact on throughput in some cases and is also increasing costs where investment in fire safety and prevention upgrades to facilities are required in order to satisfy the demands of insurers. This issue was also reported as a significant in 2017–18 and 2018–19. The number of insurance providers servicing the reprocessing market has reduced, and local insurers for reprocessing facilities are reported to be no longer available.
- The high cost of recycling means lots of the lower grade polymer is not, and will not, be recycled.

6.2.5 The COVID-19 pandemic

The following is a summary of the main comments received from plastics reprocessors, with respect to COVID-19 pandemic related aspects for scrap plastics during 2019–20:

- The COVID-19 pandemic had a significant negative impact on some reprocessors, but many others did not report any issues. Those recyclers with a large exposure to the building sector were most impacted. This was mainly due to the sector generally slowing down nationally, during the pandemic. Reprocessors recycling plastics into packaging were less impacted as packaging consumption held up well, as did collection and sorting systems.
- Scrap prices fell significantly during the peak of the COVID-19 pandemic but have picked up strongly coming into 2021.
- Exports generally fell in 2019–20 and the second half of 2020 due to the pandemic. Both local and overseas cement kiln customers largely ceased receiving solid recovered fuel (SRF) / process engineered fuel (PEF) due the implementation of import restrictions in receiving countries, and COVID-19 related transport and manufacturing impacts.

6.2.6 Government support

The following is a summary of the main comments received from plastics reprocessors, with respect to points raised on government support for and/or intervention in scrap plastics markets during 2019–20:

- Numerous reports of funding requests and licence applications for capacity increases.
- Government grants are definitely useful; however, it is the operational costs and lack of end-markets that make reprocessing capacity expansions unviable, not the setup costs.
- State and federal governments should underpin end-market demand through procurement of products with a high-level of recycled content.
- Several reprocessors raised adopting legislation to incorporate minimum recycled content levels in new products as a key measure to support the reprocessing sector and increased recycling.
- Infrastructure grants based on dollar-for-dollar co-funding are often not possible for smaller operators to finance, so the larger operators effectively get preferential treatment with this grant funding structure due to larger capital reserves or access to funding.
- Governments could have a greater focus on supporting the development of regional recycling hubs for scrap plastics.



6.3 Bioplastics

6.3.1 What are bioplastics?

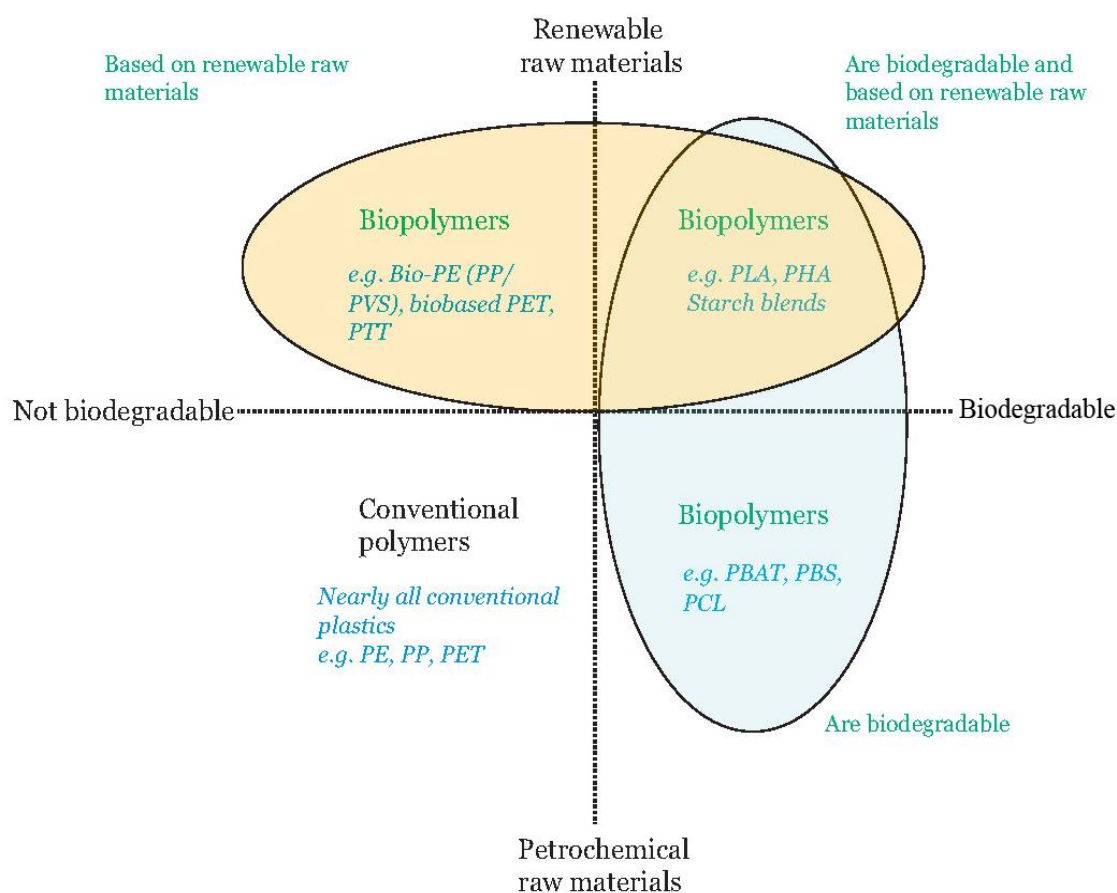
The term 'bioplastic' covers a large and diverse grouping of polymer types, which are generally defined as being biobased (at least partly sourced from renewables), biodegradable (break down at end-of-life), or both (EuBP, 2012a). In terms of biodegradability, bioplastics fall into three broad groupings, 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 38 is a graphical representation of the bioplastics groupings.

Figure 38 – Types of bioplastics



Source: Philip, et al. (2012)



In recent decades bioplastics produced from renewable resources have emerged and are the focus of significant research and investment. Bioplastics are becoming increasingly popular in consumer goods packaging as the costs of production decrease, and the diversity of bioplastics types and applications continues to grow.

Compostable plastics

Compostable plastics are an important subset of the 'biodegradable (but not biobased)' and 'biobased & biodegradable' bioplastics groups outlined above. Compostable plastic packaging and products are always biodegradable, but in addition to this are created to be suitable for composting under specific conditions after use. For an item to be called 'compostable' it must be certified to one of the two following Australian Standards (APCO, 2020d, p. 4):

- **Commercially compostable** – 'Commercially compostable' refers to an item that has been certified to the Australian Standard *AS 4736: 2006 Biodegradable plastics suitable for composting and other microbial treatment (Australian Industrial Composting Standard)* (Standards Australia, 2006). This standard is relevant to industrial and commercial scale composting facilities in Australia that are used to treat kerbside collected organics and organics from other collections.
- **Home compostable** – 'Home compostable' refers to an item that has been certified to the Australian Standard *AS 5810: 2010 Biodegradable plastics suitable for home composting (Australian Home Composting)* (Standards Australia, 2010). This standard is relevant to items that are certified to compost under home composting conditions in Australia.

6.3.2 Are bioplastics a better environmental choice than conventional alternatives?

The environmental life cycle impacts of bioplastics are wide-ranging, partly due to the evolving nature of both bioplastics and life cycle assessment (LCA) research. A high-level review was undertaken of the available literature and the summary findings are as follows:

- Biobased bioplastics generally result in lower greenhouse gas (GHG) emissions than conventional petro-chemical based plastics, but only if land use change (LUC) impacts are not considered.
- Biobased bioplastics result in reduced consumption of non-renewable energy sources, compared to conventional plastic alternatives.
- The climate change impacts of nitrous oxide (N₂O) emissions from biomass cultivation are minimally addressed in the literature and are likely to weigh against biobased bioplastics. With respect to bioplastics production, these emissions are usually related to nitrogen based fertiliser use.
- Biobased bioplastics are typically more water intensive than conventional alternatives. However, the environmental implications of this are not yet well understood and will be highly regional in significance.
- Bioplastics may generate higher environmental impacts than conventional plastics in relation to eutrophication and stratospheric ozone depletion. These impacts are mostly related to the agricultural production stage of the life cycle.



- The end-of-life impacts of biodegradable bioplastics are still unclear, and organics recovery systems in Australia are either under-developed or not compatible with many forms of biodegradable bioplastics.
- The end-of-life impacts of biobased ‘conventional’ polymers (e.g., bio-PET, bio-PE and bio-PP) are similar, or the same, to those of the equivalent petrochemical-based polymer types.

The environmental impacts resulting from the agricultural production required to produce biobased bioplastics need to be better understood and managed to maintain and improve any benefits gained by transitioning to these as alternatives.

Globally the production of some forms of bioplastics has only reached large scale commercialisation within the last decade, and production facilities are still improving their environmental performance. Many other bioplastics are still produced by small-scale or pilot plants. Biotechnology advances, efficiencies in large scale production, lower impact agricultural production, and improved waste organics recovery systems, all have the potential to contribute towards a significant reduction in the environmental impact of bioplastics over the next few decades.

6.3.3 Are bioplastics compatible with the recovery and reprocessing systems currently prevalent in Australia?

Many current recycling and composting systems in Australia were not designed to manage biodegradable bioplastics, and hence this means that biodegradable bioplastic-based packaging currently almost always goes to landfill.

A key issue is that it is often not possible to easily differentiate between conventional plastic films and certified compostable plastic films. Given the significant negative impact that even relatively small quantities of plastic film can have on compost quality, composters are forced to reject all plastic films and other plastic products. Confidential industry sources have reported that single-use plastics are the biggest problem and main contaminant by a large margin.

Of the 350 active reprocessing sites operating nationally in 2020, only a small proportion (perhaps 10–20) accept certified compostable bioplastics. However, this is almost always from closed supply sources (when there is training, labelling, and designated separation and collection systems, and compostable bioplastics are included in larger organic collections for composting), so the risk of contamination with conventional polymer films is low and acceptable. Industry members estimate that most metro areas have 1 or 2 composters at least that are accepting certified compostable plastics.

There is also the growing array of new biobased ‘conventional’ polymers (e.g. bio-PET, bio-PE and bio-PP), which are drop-in replacements for the petrochemical based equivalent polymer types. These types of biobased (non-degradable) polymers are compatible with current plastics packaging recovery and reprocessing systems but are not suitable for composting.

It is unlikely that wide-scale acceptance in Australia by plastics recyclers and organics composters of biodegradable bioplastics will occur any time soon due to the high cost of sorting the packaging and given the impact upon mainstream collection systems.



6.3.4 Do bioplastics compete with food supply and affordability?

The impact of using food crops to produce energy is becoming a more frequent feature of public debate as competition increases for the use of agricultural land for food, energy, and biomass production. While the impacts of biofuels have attracted more debate and research, the potential impacts of bioplastics are less understood.

Over the next decade or so it appears that the increased use of biobased bioplastics is compatible with food supply and affordability, both in Australia and globally, based on the available forecast increases in production, which are relatively low.

However, in the longer term, a significant shift to non-food competing crops will be required. This shift to the utilisation of non-food competing biomass feedstocks, such as by-products from food crops, forestry by-products and food production residues, appears to have a strong prospect of occurring over the next couple of decades.



6.3.5 Summary bioplastics types and applications

This section of the report provides a review of the major types of bioplastics used in (mostly) packaging and food service ware applications against a number of criteria of interest.

Bioplastics are being developed as both drop-in substitutes for conventional plastics (e.g. moving from conventional PE to bio-PE) and for biodegradability. Their functional performance will continue to improve as research and development progresses. As to price, for the foreseeable future biobased plastics will be sold at a significant premium due to higher feedstock costs.

Table 53 – Major types of bioplastics (end 2020)

Type of polymer	Chemical name	Examples of trade names and manufacturers		Is the raw material also a food crop	Biobased	Biodegradable	Potentially compostable
		Trade name	Manufacturer (country)				
PLA polyester	Poly-lactic acid (PLA)	Ingeo®	NatureWorks (USA)	Yes	Yes	Yes	Yes
		Revode	Zhejiang 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™	Futamura Group	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)	Succinity®	BASF (Germany)	No	Yes	Yes	Yes
	Aliphatic-aromatic copolyesters (AAC)	Ecoflex®	BASF (Germany)	No	No	Yes	Yes



Type of polymer	Chemical name	Examples of trade names and manufacturers		Is the raw material also a food crop	Biobased	Biodegradable	Potentially compostable
		Trade name	Manufacturer (country)				
	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
	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 54 – Typical applications of selected bioplastics (current to end 2020)

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 trays and clam shells.
	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.



Type of polymer	Trade name examples	Rigid applications	Flexible applications	Current packaging applications in the Australian market
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.
Synthetic polyesters	Succinity®	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.



7 PLASTICS INTO THE ENVIRONMENT

7.1 Impacts of plastics into the environment

7.1.1 Estimates of sources and fates

This section provides an overview of the leakage of plastics into the open environment. There is strong evidence that the environmental impacts of losses of plastics into the environment are significant and growing.

From an environmental leakage perspective, it is useful to group plastics into the size profiles summarised in the following table, which have differing transport (movement in the environment) characteristics, and levels and impacts of bioavailability.

Table 55 – Plastic size profile groups

Group	Size	Sources and examples
Macroplastics	>20 mm	PET bottle. Ghost (fishing) gear.
Mesoplastics	5–20 mm	Virgin resin pellets (nurdles)
Microplastics	0.1–5 mm	Microbeads, microfibres.
Nanoplastics	<0.1 mm	Microplastics (and above) breakdown products. Tyre dust. Microfibres.

Presented in Table 56 is a summary of indicative estimates of Australian plastics leakage to the open environment based on supporting analysis and literature reviews as undertaken for this project. The quantified leakage is from the identified major sources only, and true losses may be higher than the ranges provided for each of the leakage pathways.

Table 56 – Indicative estimates of annual Australian plastics leakage to the environment

Leakage group	Fate	Quantity (tonnes/yr)	Comments
Macroplastics – land	Land	1 000–10 000	Sources include uncollected litter and dumped plastic products, building sites, and many other sources of uncollected plastics. Estimate is indicative only.
Macroplastics – oceans	Oceans	1 000–2 000	Includes littered plastic packaging and cigarette butts that go into waterways. Includes commercial and recreational fishing gear.
Mesoplastics – oceans & land	Oceans & Land	200–2 000	Sources include resin pellets (nurdles), and plastic product and fragments from many other sources. Estimate is indicative only.
Microplastics – land	Land	500–1 000	Microfibres from clothing. Microplastics leakage to land via wastewater treatment biosolids spreading to land.
Microplastics – oceans & land	Oceans & Land	10 000–30 000	External plastic surfaces, artificial turf
Microplastics – oceans	Oceans	<100	Microplastics leakage to oceans via wastewater treatment plants.
Nanoplastics – oceans & land	Oceans & Land	80 000–100 000	Tyre dust. Excludes road wear/markings related plastics losses.
Total	Oceans & Land	93 000–145 000	Indicative leakage from identified major sources.

Sources: European Commission (2018, p. 10), REC (2017), Envisage Works and Infotech Research.



Note that disposal to landfill or other waste management treatment destinations are excluded from the estimates provided in Table 56, but disposal of biosolids (which contain microplastics) to land is considered leakage to the open environment.

EoL arisings of plastics is estimated to be a little over 3.0 million tonnes in 2019–20 (including tyres). This indicates that somewhere between 3–5% of plastics reaching end-of-life in 2019–20 were lost to the open environment, with around two thirds of this being tyre dust.

7.1.2 Ocean impacts

Many of the most common plastic polymers float, and some plastic items, such as weighted fishing nets, end up on the bottom. Regardless of the polymer density marine plastic litter can move around due to currents, weather and degradation, from seabed to sea surface to beaches. Plastics makes up an estimated 80–85% of marine litter by count (EC, 2018, p. 10), and 85–95% of debris by count on Australian beaches (Olivelli, et al., 2020; Tangaroa Blue, 2020).

The sinks for plastic pollution include ocean gyres, the water column (the water above the seabed), seabeds, wildlife (ingested), and coastal environments, particularly near riverine outflows. A recent extensive Australian study (Olivelli, et al., 2020) on plastic debris loads along the Australian coastline, found that it is possible that Australian, and by extension global coastlines, are more significant sinks for plastic pollution than may have previously been appreciated.

The impacts of plastic pollution on sea-life are significant. The Convention on Biological Diversity (CBD, 2012, p. 9) has listed 663 species of marine organisms affected by marine debris, of which over 80% related to plastic-based debris. As this report was published nearly a decade ago it would be reasonable to assume the problem is now much worse globally.

Some species mistake microplastics for food and ingest them leading to fatal problems such as gut blockage. Entanglement is also a well-documented potentially fatal problem.

There have been a number of studies that have found microplastics in marine biota. In some cases there is evidence of negative impacts on the biota digestive tracts. Microplastic toxicity in aquatic environment is likely to be size dependent as this can affect the ability of target species to assimilate the microplastics in a similar manner to the inhalation of particulates in air.

Microplastics have the ability to adsorb (attach) toxins onto their surface. This can present the microplastics as carriers of toxins but could also reduce the bioavailability of toxins already present in the aquatic environment. The role of microplastics as a carrier of problematic bioavailable substances into organisms is an area where much further research is required.

Sediment contamination with microplastics has been detected in all ocean environments due to the sinking of microplastics and accumulation over time. This phenomenon may be more prevalent at ocean discharge points for sewage treatment facilities but reporting of this has not been identified.

The inert and structurally robust nature of MPs provides longevity in the marine environment and enables the build-up of concentrations and impacts over time with continuing pollution. Levels are likely to increase over time unless new supply ceases.



7.1.3 Land impacts

De Souza, et al. (2019) examined common microplastic impacts on soil performance for plant growth at 0.2–2.0% concentrations of microplastics. The study conclusions included that there was an impact on soil structure and plant growth which may have been due to a number of factors including the alteration to water retention. De Souza found that the impact of the microplastic depended on the polymer type, with PES and PET increasing plant growth. These polymers being abundant in sewage sludge.

In order to build up to concentrations of 0.2 to 2.0% in the soil, the land would have required multiple applications of a substance such as biosolids from wastewater treatment, as the biosolids themselves contain the order of 1% by dry weight of microplastic (Okoffo, et al., 2020, p. A).

7.2 Reducing plastics losses to the environment

The recent extensive report *Breaking the Plastic Wave* (Pew & SystemIQ, 2020) covers the issue of global plastics consumption, end-of-life flows, and losses to the environment in detail. The report has a particular focus on losses of plastics to the oceans. The findings of this Pew & SystemIQ report are valuable and some are summarised in this section of the APFF report.

The report generally makes for grim reading, but also identifies and analyses the impact of 8 system interventions which could significantly reduce plastics use and losses to the environment.

The high-level findings from the report, in terms of 2016 plastics flows and 2040 flows under the business-as-usual (BAU) scenario that is modelled are:

- 11 million tonnes of plastics went into the oceans in 2016 (note that this is more than 3 times the entire Australian *consumption* of plastics in 2019–20).
- 29 million tonnes of plastics will go into the oceans by 2040.
- 80% of 2016 leakage to the environment is from flexible and multilayer plastics (mostly packaging).
- 11% of 2016 leakage to the environment is microplastics.
- Without considerable action to address plastic pollution, 50 kg of plastic will enter the ocean for every metre of shoreline.
- By 2040 waste plastics generation will double, plastics leakage into the oceans will triple, and the stock of plastics in the oceans will quadruple.

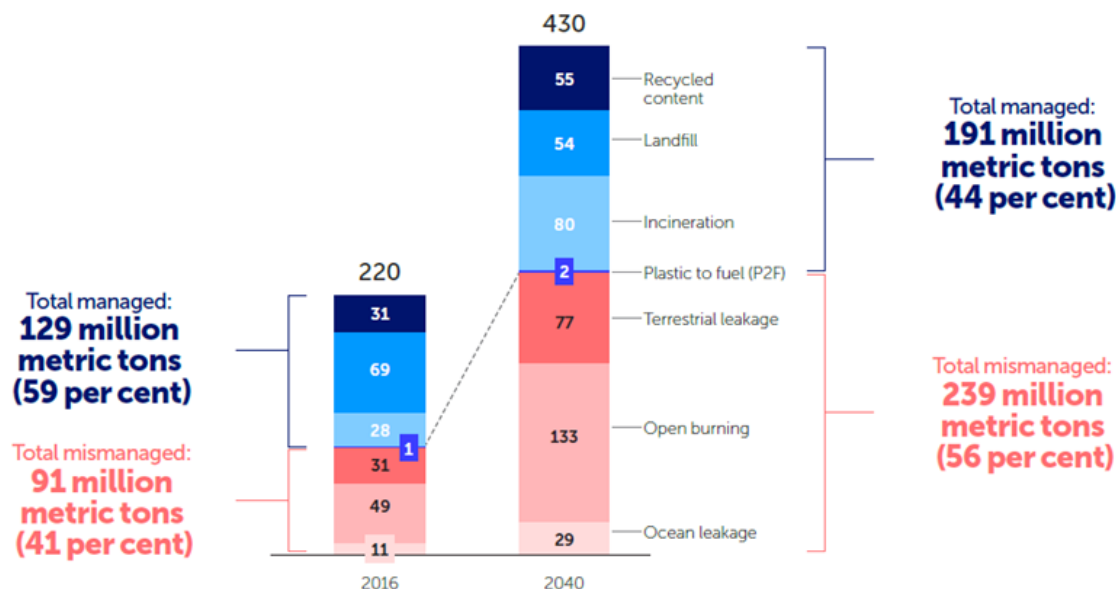
Provided in Figure 39 are the summary modelling results from the study for the business-as-usual (BAU) scenario. Without significant intervention, leakage of plastics into the environment, via both land (terrestrial) and ocean leakage, will grow from 42 million tonnes globally in 2016, to 106 million tonnes in 2040, an increase of 150%. Total annual plastic wastes generation, with the related production impacts for the virgin plastics that would make up most of this waste generation, is projected to double in the same time period.



Figure 39 – Fate of all plastic waste under the business-as-usual (BAU) scenario

Mismanaged plastic waste will grow from 91 million metric tons in 2016 to 239 million metric tons by 2040

Million metric tons of plastic waste (macroplastic and microplastic)



Source: Pew & SystemIQ (2020, p. 25)

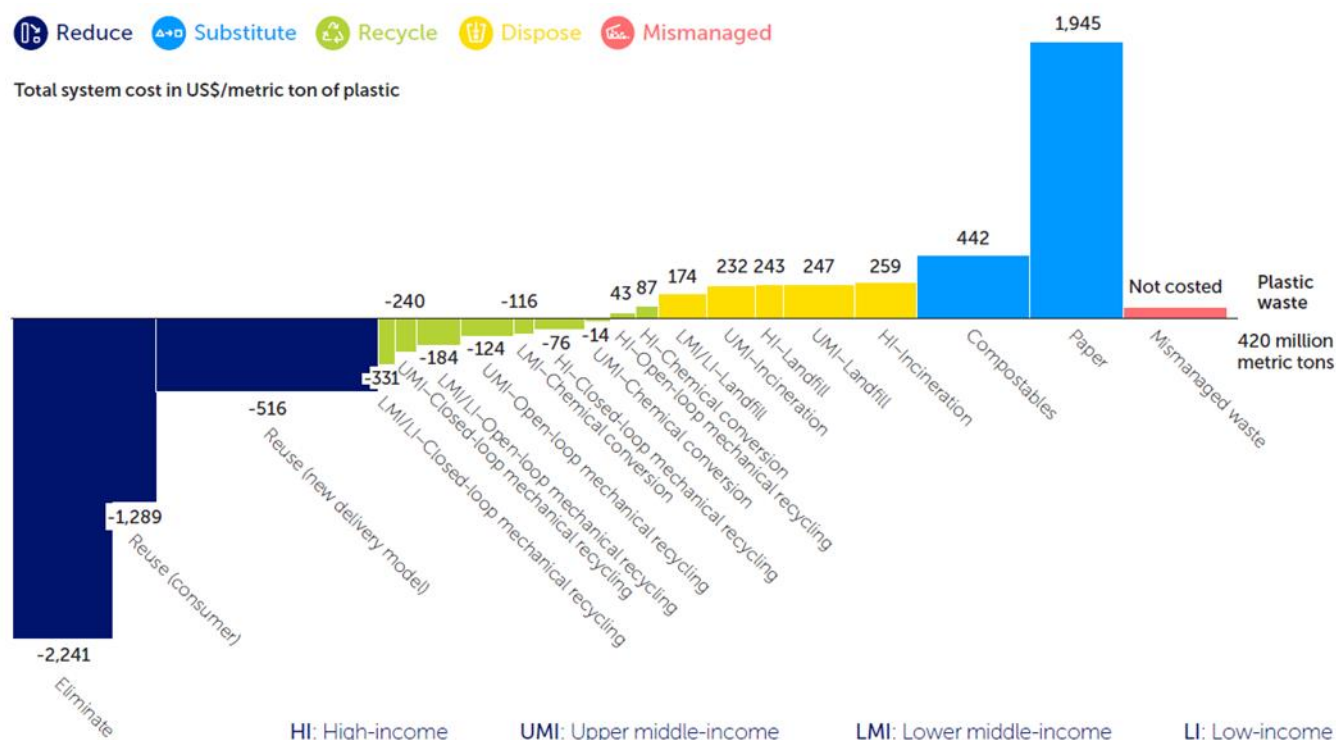
The PEW & SystemIQ report also modelled a system change scenario, which found that annual land-based plastic leakage into the ocean can be reduced by around 80 per cent compared with BAU, through the concurrent implementation of the following 8 system interventions:

1. *Reduce growth in plastic production and consumption through elimination, reuse, and new delivery models.*
2. *Substitute plastic with paper and compostable materials, avoiding one-sixth of projected plastic waste generation.*
3. *Design products and packaging for recycling to expand the share of economically recyclable plastic from an estimated 21 per cent to 54 per cent.*
4. *Expand waste collection rates in the middle-/low-income countries to 90 per cent in all urban areas and 50 per cent in rural areas and support the informal collection sector.*
5. *Double mechanical recycling capacity globally to 86 million metric tons per year.*
6. *Develop plastic-to-plastic conversion, potentially to a global capacity of up to 13 million metric tons per year.*
7. *Build facilities to dispose of the 23 per cent of plastic that cannot be recycled economically, as a transitional measure.*
8. *Reduce plastic waste exports by 90 per cent to countries with low collection and high leakage rates.*



The report identifies the main *existing* technologies and approaches that underpin the system interventions outlined above. It then also provides estimates of the costs and potential contribution (mass basis) to reducing or better managing waste plastics generation by 2040. These technologies, costs and contributions are summarised on a cost curve, see Figure 40 below. Note that the bar height in the table below provides the cost, and the bar width the estimated mass contribution.

Figure 40 – Costs and masses per treatment type in the system change scenario (by 2040)



The X axis of this chart shows the mass (million metric tons) of plastic waste per treatment type under the System Change Scenario in 2040. The Y axis represents the net economic cost (US\$) of that treatment, including opex and capex, for the entire value chain needed for that treatment type (for example, mechanical recycling costs include the cost of collection and sorting). Negative costs (on the left) represent a savings to the system relative to BAU, while positive costs reflect a net cost to the system for this treatment type. Costs near 0 mean that their implementation is near "cost neutral" to the system. Subsidies, taxes or other "artificial" costs have been excluded; this graphic reflects the techno-economic cost of each activity. The costs shown do not necessarily reflect today's costs, but costs that could be achieved after the system interventions are implemented, including design for recycling and other efficiency measures. Where costs in different archetypes were similar, we combined the figure stacks for simplification and took a weighted average of the cost per archetype. The cost of mismanaged waste, such as plastic in the environment, has not been factored in because we did not price the externalities that mismanaged waste causes.

Source: Pew & SystemIQ (2020, p. 41)

Notes: In the figure above – LI is low-income countries, LMI is lower middle-income countries, UMI is upper middle-income countries, and HI is high income countries.

As can be seen from the figure above nearly half of the proposed solution involves reducing (i.e., avoiding) plastics use (30%), or substituting plastics use of other materials (16%). Another 23% of waste plastics generation would be managed through expanded recycling.

The report laid out '10 critical findings', all of which are important, however 3 are particularly relevant to the Australian context:

- *Governments and industry leaders are stepping up with new policies and voluntary initiatives, but these are often narrow in focus or concentrated in low-leakage countries. By 2040, current government and industry commitments are likely to reduce annual plastic*



leakage to the ocean by only 7 per cent (± 1 per cent) relative to the Business-as-Usual Scenario.

- *There is no single solution to end ocean plastic pollution. Upstream and downstream solutions should be deployed together.*
- *Industry and governments have the solutions today to reduce rates of annual land-based plastic leakage into the ocean by about 80 per cent (82 ± 13 per cent) below projected BAU levels by 2040, while delivering on other societal, economic, and environmental objectives.*

The Pew & SystemIQ report is a valuable contribution to informing decision-making on reducing the environmental impacts of plastics use. It also makes clearer the consequences of taking a 'business-as-usual' approach to plastics use.

Operation Clean Sweep program

The Operation Clean Sweep® (OCS) program is a campaign started by the Plastics Industry Association (PLASTICS) and the American Chemistry Council (ACC) in the USA in 1992. The program was designed to help plastics manufacturing and reprocessing facilities reduce the accidental loss of pellets, flakes, and powders across the plastic pellet supply chain.

In Australia, the program was introduced by Tangaroa Blue Foundation in 2014, who work with Chemistry Australia and Plastics Stewardship Australia as joint licencees, with funding from Metropolitan Waste and Resource Recovery Group. Since then it has been funded by Tangaroa Blue Foundation with contributions from the Victorian Government.

The goal of Operation Clean Sweep® in Australia is straightforward and ambitious – to achieve zero supply chain pellet losses in Australia.

Currently 35 companies and organisations have taken the Operation Clean Sweep® pledge and have become program partners in Australia. These members consist of:

- 21 plastics product manufacturers
- 4 transport and logistics companies
- 6 industry associations
- 2 resin manufacturers
- 2 plastics reprocessors.

OCS is still working to develop quantitative measures for program outcomes. However, across the two time periods of July 2018 to June 2019 and July 2019 to June 2020, OCS conducted site audits for plastic resin pellets in Victoria across seventeen local councils and around Port Phillip Bay to build a picture of plastic feedstock losses from plastics supply chain facilities. During the audits there were 116 facilities inspected during both rounds, with 8 of these OCS pledged companies.

In terms of measuring the performance of the OCS program, the analysis of the data from the initial and follow-up audits was inconclusive, as there weren't sufficient OCS pledged companies audited to provide enough data for meaningful analysis. However, as the OCS membership base expands, and further audits are carried out, it is expected that this 'on-the-ground' dataset on the OCS program outcome will become useful for measuring the program's outcomes.

The OCS website is at <http://www.opcleansweep.org.au/>.



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