Final

National Waste Report 2020

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Abbreviations and glossary

ABS	Australian Bureau of Statistics
ACOR	Australian Council of Recycling
ACT	Australian Capital Territory
AORA	Australian Organics Recycling Association
APCO	Australian Packaging Covenant Organisation
bagasse	fibrous waste remaining when sugarcane stalks are crushed to extract juice
biosolids	solid, semi-solid or slurry material produced by the treatment of urban sewage
bottom ash	ash produced by burning coal or other materials that remains in the furnace or incinerator
CAGR	compound annual growth rate
capita	person
C&D	construction and demolition
C&I	commercial and industrial
CDS	container deposit scheme
COAG	the former Council of Australian Governments
commercial and industrial waste	waste produced by institutions and businesses; includes waste from schools, restaurants, offices, retail and wholesale businesses, and industries including manufacturing
construction and demolition waste	waste produced by building and demolition activities, including road and rail construction and maintenance and excavation of land associated with construction activities
core waste	waste generally managed by the waste and resource recovery sector, comprising solid non-hazardous waste and hazardous waste including liquids, and generated in the municipal, construction and demolition, and commercial and industrial sectors generally excluding primary production and including biosolids
cullet	recycled broken or waste glass used in glass-making
Department	Department of Agriculture, Water and the Environment
disposal	the deposit of solid waste in a landfill or incinerator, net of waste allocated to energy recovery
EfW	energy-from-waste
EPA	Environment(al) Protection Authority (name varies with jurisdiction)
EPS	expanded polystyrene
energy recovery	the process of recovering energy that is embodied in solid waste (the amount of solid waste recovered is net of any residuals disposed)
e-waste	electrical or electronic waste
FOGO	food organics and garden organics
GDP	gross domestic product
GL	gigalitres
GO	garden organics
gross domestic product	the total market value of goods and services produced in Australia within a given period after deducting the cost of goods and services used up in the process of production but before deducting allowances for the consumption of fixed capital
gross state product	the total market value of goods and services produced in an Australian state or territory within a given period after deducting the cost of goods and services used up in the process of production but before deducting allowances for the consumption of fixed capital

hazardous waste	waste that, by its characteristics, poses a threat or risk to public health, safety or to the environment and comprising, in this report, waste that cannot be imported to or exported from Australia without a permit under the *Hazardous Waste (Regulation of Exports and Imports) Act 1989*, or waste that a jurisdiction regulates as requiring particularly high levels of control
HDPE	high-density polyethylene
kg	kilograms
kt	kilotonnes (thousands of tonnes)
LDPE	low-density polyethylene
management method	the infrastructure used to manage waste – landfill, compost facility, alternative waste treatment facility, etc.
MBT	mechanical biological treatment
mechanical biological treatment	a waste processing facility that sorts residual waste, mostly from households, and processes the remaining organics-rich fraction through composting or anaerobic digestion
MFA	material flow analysis
MRF	materials recovery facility
MSW	municipal solid waste
municipal solid waste	waste produced primarily by households and council operations
Mt	megatonnes (millions of tonnes)
NGER	National Greenhouse and Energy Reporting
NPI	National Pollutant Inventory
NSW	New South Wales
NT	Northern Territory
NWRIC	National Waste and Recycling Industry Council
OECD	Organisation for Economic Co-operation and Development
per capita	per person
PET	polyethylene terephthalate
PFAS	per- and poly-fluoroalkyl substances
PP	polypropylene
product stewardship	a policy approach recognising that manufacturers, importers, governments and consumers have a shared responsibility for the environmental impacts of a product throughout its full life cycle
PS	polystyrene
PrSt Act	*Product Stewardship Act 2011*
PVC	polyvinyl chloride
Qld	Queensland
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)
recycling rate	the proportion of generated waste that is recycled
residual waste	waste left over after removal of material for recycling or energy recovery (garbage)
resource recovery	for data collation purposes, this is the sum of materials sent to recycling and energy recovery net of contaminants and residual wastes sent to disposal
resource recovery rate	the proportion calculated by dividing resource recovery by waste generation (also referred to as the 'recovery rate')

reuse	reallocation of products or materials to a new owner or purpose without reprocessing or remanufacture, but potentially with some repair (e.g. resale of second-hand cars or clothing re-sold via opportunity shops or the repair of wooden transport pallets for resale)
SA	South Australia
solid waste	waste that can have an angle of repose of greater than 5 degrees above horizontal, or does not become free-flowing at or below 60 degrees Celsius or when it is transported, or is generally capable of being picked up by a spade or shovel
t	tonne(s)
Tas	Tasmania
treatment (of hazardous wastes)	the removal, reduction or immobilisation of hazardous characteristics to enable the waste to be sent to its final fate or further treatment
UK	United Kingdom of Great Britain and Northern Ireland
US	United States of America
Vic	Victoria
WA	Western Australia
waste	materials or products that are unwanted or have been discarded, rejected or abandoned, including materials or products that are recycled, converted to energy, or disposed
waste-derived products	used to refer to exports of waste materials that have been sorted and sometimes additionally processed, and sold for recycling or energy recovery
waste fate	what happens to a waste i.e. recycling, energy recovery or disposal
waste generation	for data collation purposes, this is the sum of all waste fates
waste intensity	the tonnes of waste generated per million dollars of value added
waste reuse	reuse of a product or material that has entered a waste management facility (e.g. the sale of goods from a landfill or transfer station 'reuse shop')
WMRR	Waste Management and Resource Recovery Association of Australia

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We are grateful to the states and territories for sharing their data and perspectives for this report. We also thank the various industry bodies and associations for their contributions and data.

We particularly thank our project partners for their input:

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- Kyle O'Farrell (Envisage Works) for preparing material flow analyses and other data support
- Tim Woods (IndustryEdge) for data input to the material flow analyses.

At a glance

In 2018-19 Australia generated an estimated 74.1 million tonnes (Mt) of waste including 22.9 Mt of masonry materials, 14.3 Mt of organics, 12.5 Mt of ash, 7.8 Mt of hazardous waste (mainly contaminated soil), 5.9 Mt of paper and cardboard, 5.6 Mt of metals and 2.5 Mt of plastics. This is equivalent to 2.94 tonnes (t) per capita.

In 2018-19 there were about 61.5 Mt of 'core waste' (those wastes managed by the waste and resource recovery sector) generated, or 2.44 t per capita. This is up from 57.3 Mt in 2016-17. Figure 1 shows that the 2018-19 materials comprised:

- 12.6 Mt of municipal solid waste (MSW) from households and local government activities (500 kg per capita and 20% of the total)
- 21.9 Mt from the commercial and industrial (C&I) sector (36% of the total)
- 27.0 Mt from the construction and demolition (C&D) sector (44% of the total).

In 2016-17 these values were: MSW 12.6 Mt; core C&I waste 21.3 Mt; and C&D waste 23.4 Mt.

Over the 13-year period for which data is available, total waste generation increased by 11.3 Mt (18%). Assessed on a per capita basis, waste declined by 3.3% over this timeframe. MSW generation fell by 20% per capita and C&I waste by 15% per capita, while C&D waste grew by 32% per capita.

Headline numbers[1]

Millions of tonnes	2016-17	2017-18	2018-19
Waste generated	69	73	74
Waste recycled	40	42	43
Waste to energy	2.1	2.2	2.1
Waste disposal	27	27	27
Resource recovery rate	61%	62%	63%
Recycling rate	58%	59%	60%

Figure 1 Waste generation by material category and stream, Australia 2018-19 (core waste + ash)

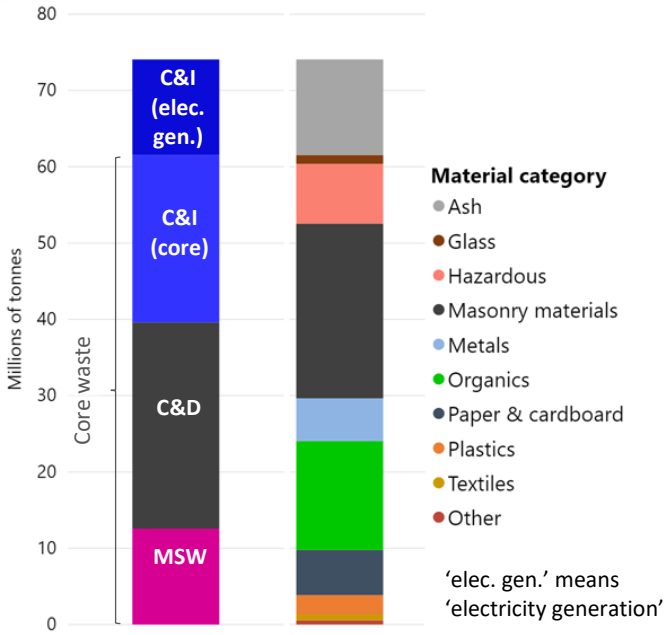
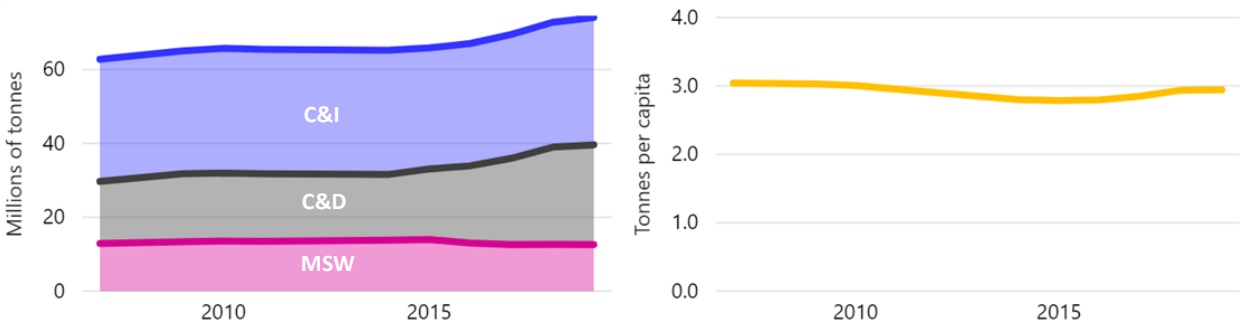


Figure 2 Trends in the generation of core waste plus ash by stream in total (left) and per capita (right), Australia 2006-07 to 2018-19

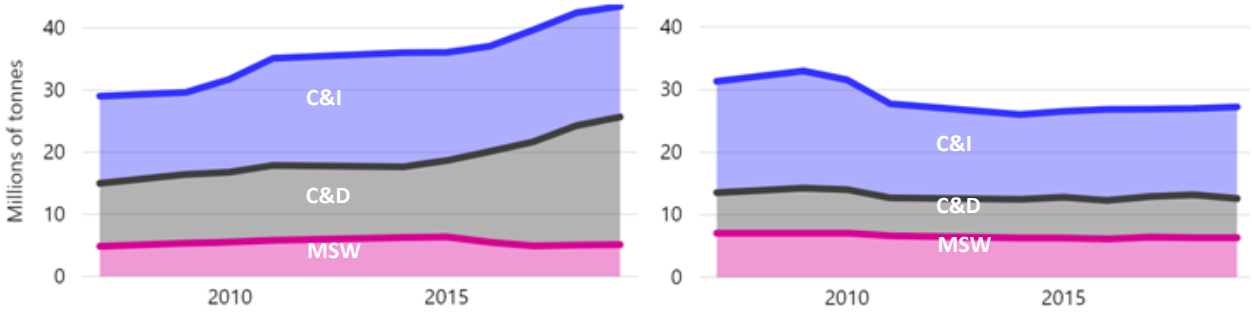


[1] The authors recommend that data extracted from this report is presented to two significant figures. See Section 1.3 for details.

Figure 3 shows that the quantities of waste recycled have continued to increase since 2006-07, reaching about 43.5 Mt in 2018-19 (the 2016-17 value was 39.6 Mt). Recycling of C&D waste doubled to 20.5 Mt over the 13-year period. Recycling of C&I waste rose until 2014-15 then levelled off, suggesting the easiest-to-recycle materials are dealt with and future gains in recovery will be harder to win. MSW recycling rose slightly over the data period, declining on a per capita basis. This is consistent with lower sales of newsprint, declining quantities of glass and lighter weight packaging. A sharp decline from 2014-15 to 2016-17 may be associated with changes to the NSW system for collecting waste data.

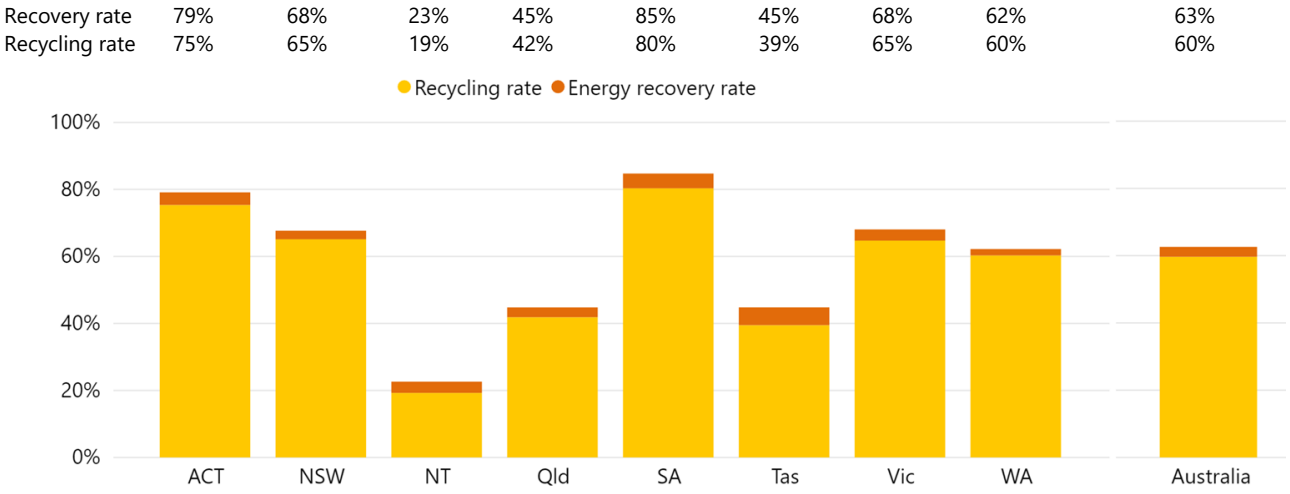
Despite rising population, waste disposal fell over the 13-year data period. In recent years waste disposal has climbed but at a rate lower than population growth. In 2018-19, 27.2 Mt of waste were disposed of, representing 37% of waste generated. In 2016-17, 26.9 Mt was disposed of.

Figure 3 Trends in the recycling (left) and disposal (right) of core waste plus ash by stream, Australia 2006-07 to 2018-19



In 2018-19, the Australian resource recovery rate (including both recycling and energy recovery) was 63% and the recycling rate was 60%. SA was the highest ranked jurisdiction, with a resource recovery rate of 85% and a recycling rate of 80%. Following, in order and with recovery rates in brackets, were the ACT (79%), NSW and Vic (68%), WA (62%), Qld and Tas (45%), and NT (23%). The trends in recovery and recycling rates are upwards. The Australian resource recovery rate was 50%[2] in 2006-07 and 61% in 2016-17.

Figure 4 Resource recovery and recycling rates by jurisdiction, 2018-19



[2] The larger value presented in the *National Waste Report 2018* excluded ash.

Exports of waste-derived products for recycling are falling, due largely to the restrictions imposed by many of the destination countries in South-East Asia (see Figure 5).

Figure 5 Trend in Australian exports of waste-derived products by core material category, 2006-07 to 2019-20

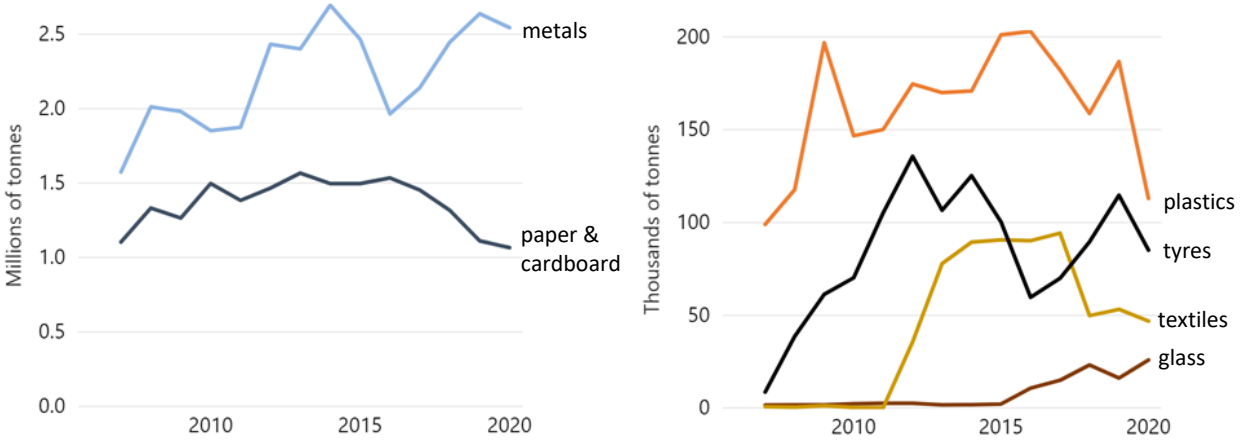


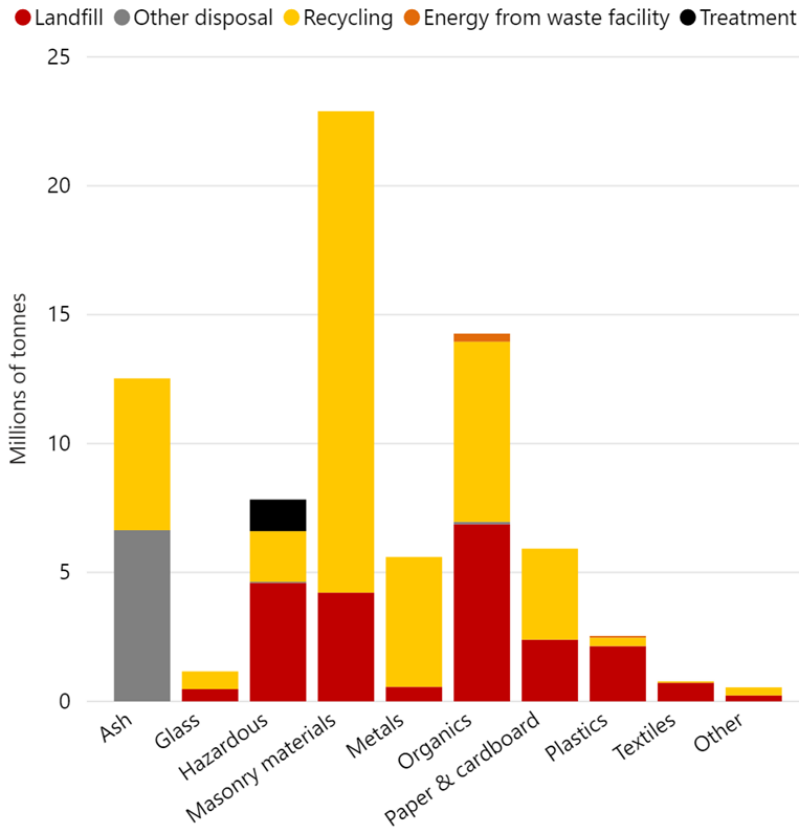
Figure 6 shows waste generation and management by material category.

The estimated recovery rates are highest for metals (90%), then masonry materials (82%), paper and cardboard (66%), organics (60%), glass (59%), ash (47%) and hazardous waste (30% [3]). At just 15%, plastics had the lowest recovery rate.

Figure 7 is a 'Sankey' diagram of Australian core waste flows in 2018-19. The arrows are proportional to the flow size measured in tonnes. The diagram provides an overview of the major material flows including source stream, waste management and destinations of recycled product.

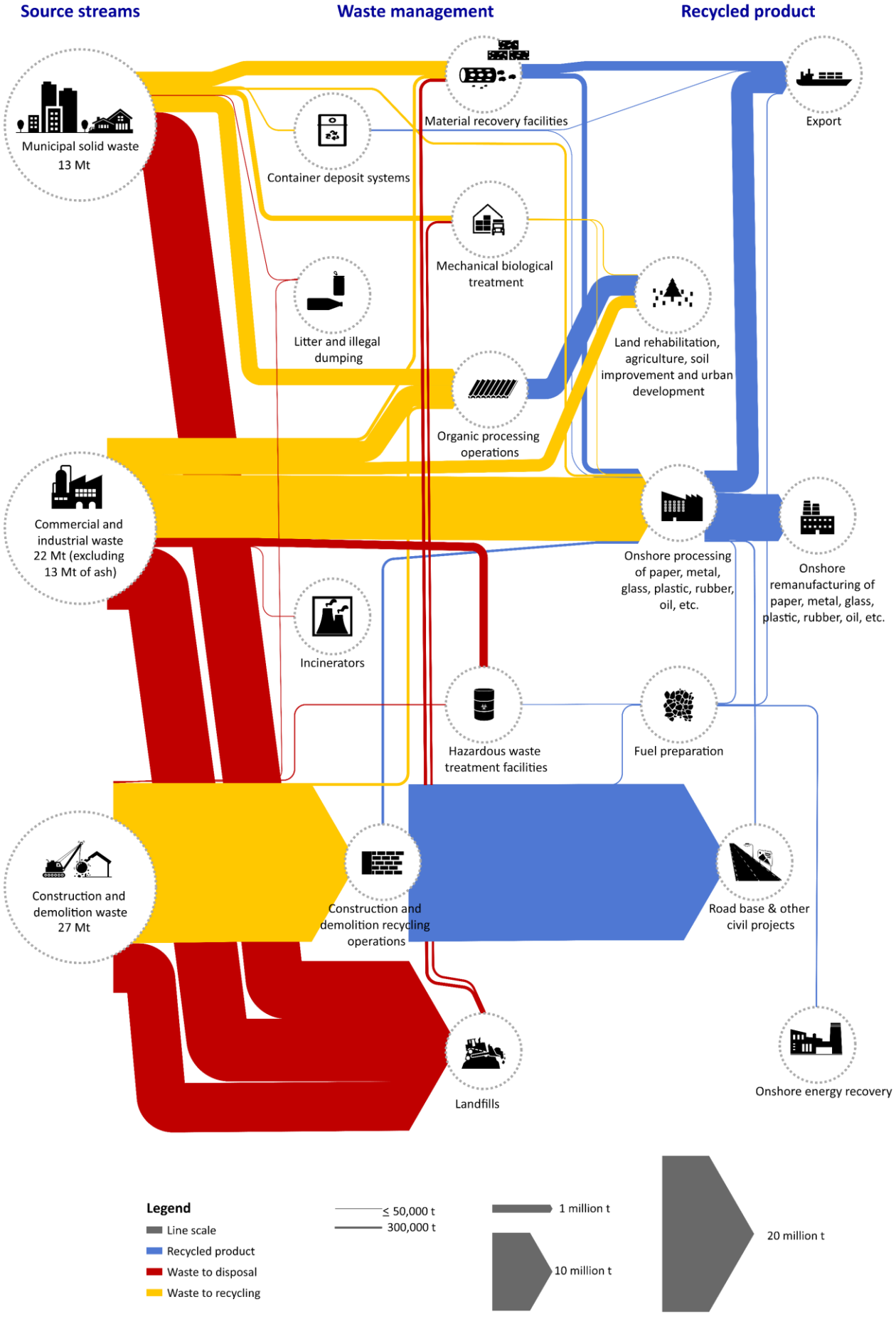
Figure 6 Generation and management method of core waste material categories and ash, Australia 2018-19

Recovery rate	47%	59%	30%	82%	90%	60%	66%	15%	22%	58%
Recycling rate	47%	59%	30%	82%	90%	49%	60%	13%	7%	58%



[3] Excludes hazardous waste sent to treatment as its fate cannot be readily classified as recovered or disposed of.

Figure 7 'Core' waste flows in Australia, 2018-19 (arrow thickness is proportional to flow size)



1. Introduction

This report was prepared on commission to the Australian Government Department of Agriculture, Water and the Environment (the Department), which has committed to producing a national waste report every two years. The report provides a summary of the status of waste in Australia in 2018-19, including data on waste generation, source streams, materials and fates. Trend data is included back to 2006-07. The report is released together with:

- National Waste Reporting Tools for 2017-18 and 2018-19, containing most of the 'raw' data reported for those two years
- the National Waste Database 2020, containing collated data for all available years in a format that allows users to readily undertake their own data analysis.

1.1 Scope

Wastes included

The report covers waste generated in Australia. Most of the report focuses on 'core waste' – materials generally managed by the waste and resource recovery sector, comprising solid non-hazardous waste materials, hazardous waste[4] including liquids, and biosolids from wastewater treatment. Core waste material categories and types are listed in Table 1. Many of the trend charts shown in the report also include ash from power generation. Some data on waste from mining, minerals processing, agriculture and fishing is included in parts of the report, but is not comprehensive. A separate section addresses liquid waste. The report excludes data on forestry residues, pre-consumer waste that is recycled as part of a production process and uncontaminated soil (clean fill).

Table 1 Categories and types in the core waste data set

Waste categories	Waste types included in this category
Glass	Glass
Hazardous	Acids; alkalis; inorganic chemicals; reactive chemicals; paints, resins, inks and organic sludges; organic solvents; pesticides; oils; food-derived organic wastes (K100, K110 and K200); other putrescible or organic waste (K140 and K190); organic chemicals; contaminated soils; asbestos contaminated materials; other soil/sludges; clinical and pharmaceutical; tyres; other miscellaneous; unclassified hazardous wastes
Masonry materials	Asphalt, bricks, concrete, rubble (including non-hazardous foundry sands), plasterboard and cement sheeting
Metals	Steel, aluminium, other non-ferrous metals
Organics	Food, garden organics, timber, other organics and biosolids. Excludes: • paper, cardboard, leather, textiles and rubber (included in separate categories) • except where specified, hazardous organic wastes (these are included in the 'hazardous' category)
Paper and cardboard	Cardboard, liquid paperboard, newsprint and magazines, office paper
Plastics[5]	PET (1), HDPE (2), PVC (3), LDPE (4), PP (5), PS (6), other (7)
Textiles, leather and rubber	Textiles; leather and rubber (excluding tyres)
Other	Other unclassified materials

[4] The report series *Hazardous Waste in Australia* addresses hazardous waste in detail. A new version will be released in 2021.

[5] The full chemical names of these types of plastic are given in the glossary.

The period covered

The *National Waste Report 2020* focuses on waste generated and managed during the financial year (July to June) 2018-19. For the main data set, trend data is presented covering the period 2006-07 to 2018-19. National data covering 2007-08, 2011-12 and 2012-13 was not collected. Trends are interpolated across those years. Some more recent information is presented where available, particularly in relation to exports of waste-derived products.

The geographic area covered

The report covers waste generated in Australia, including exports of waste and waste-derived products. Small amounts of imported waste are likely to be included. The report covers the Australian states and territories: Australian Capital Territory (ACT); New South Wales (NSW); Northern Territory (NT); Queensland (Qld); South Australia (SA); Tasmania (Tas); Victoria (Vic); and Western Australia (WA).

Waste sources

In the core data set, waste sources are considered within three source streams: municipal solid waste (MSW) from households and council operations; commercial and industrial (C&I) waste; and construction and demolition (C&D) waste. The report also includes 2018-19 data on 'non-core' C&I wastes from Australia's mining and minerals processing sectors and limited data on organic agriculture and fisheries wastes. A separate section quantifies and considers waste collected by local governments. These local government collected wastes are not additional to the core data set, but form part of it.

Waste management

Waste management processes are considered to be of two types:

1. pathways, which comprise interim steps on the way to the end destination of the material and include short-term storage[6], stockpiling[6], treatment, sorting, processing and export
2. waste fates or end destinations, which are categorised into disposal, recycling, energy recovery and long-term storage[6].

The term 'resource recovery' is used to encompass both recycling and energy recovery.

The term 'management' is used to describe the type of infrastructure applied (landfill, materials recovery facility, etc.).

Most waste managed at a landfill is considered to have the fate 'disposal'. However, many large landfills capture methane-rich landfill gas and extract its energy value, typically through combustion, to generate electricity that is sold to the grid. The tonnage of waste generating this energy is back-calculated in the National Waste Reporting Tool 2018-19 by applying formulas from the National Greenhouse and Energy Reporting (NGER) system, and then allocated to the fate 'energy recovery'.

Large amounts of hazardous waste are managed in facilities that treat the waste to reduce its hazard. The fate of this waste includes disposal (to sewer and landfill) and some recycling. The quantities with these different fates are not known. Rates for recycling, recovery and disposal are calculated excluding waste that has an unknown fate. So, for example, the recycling rate (RR) for C&I waste in 2018-19 is calculated using the following formula (where 't' means tonnes):

$$RR_{C\&I,\ 2018\text{-}19} = t\ C\&I\ waste\ recycled_{2018\text{-}19} / (t\ C\&I\ waste\ generated_{2018\text{-}19} - t\ C\&I\ waste\ to\ treatment_{2018\text{-}19})$$

[6] Reporting of short-term storage, stockpiling and long-term are limited due to data unavailability.

Waste avoidance, reduction and reuse

Waste avoidance, reduction and reuse are briefly discussed in Chapter 4.

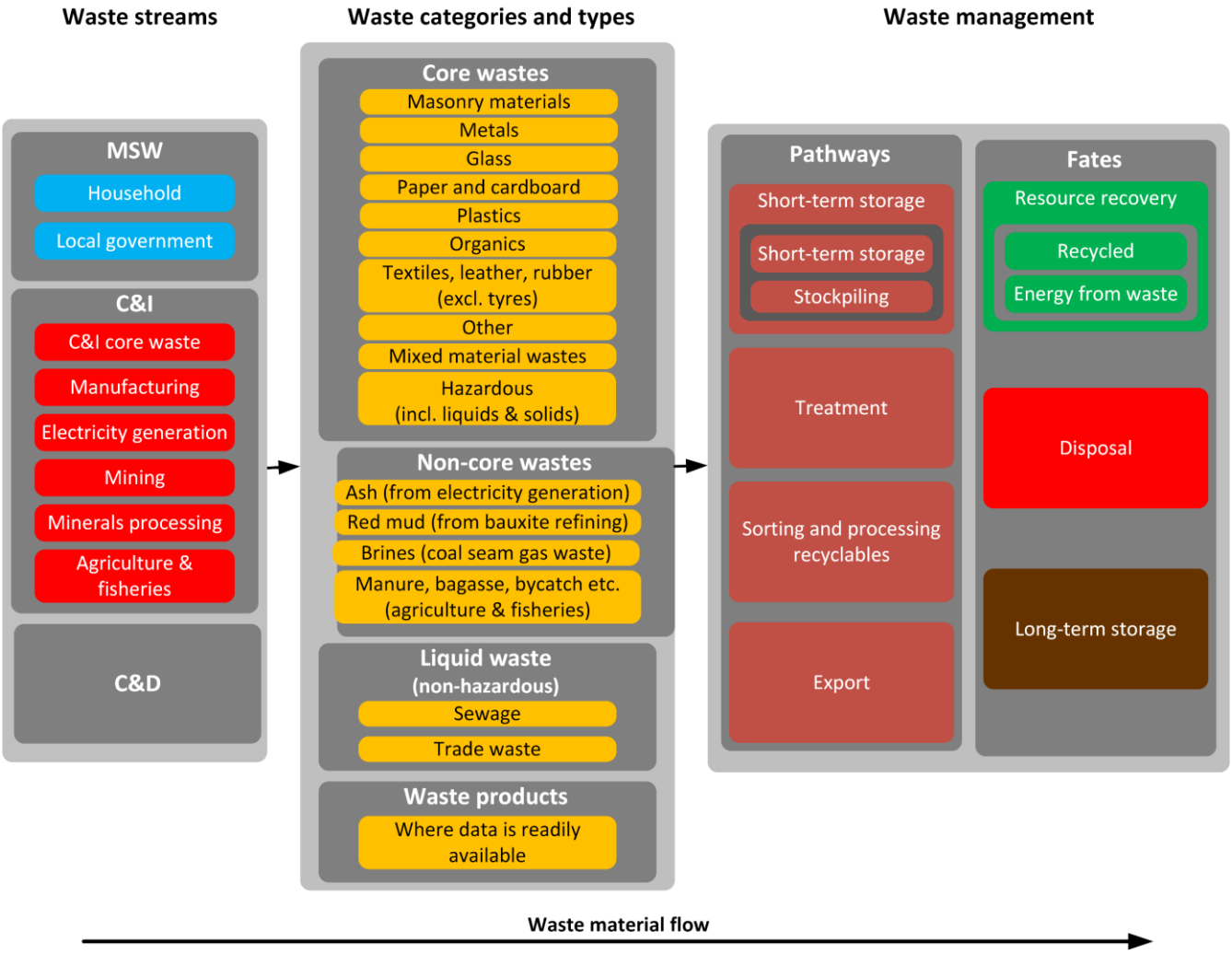
Material flow analyses

For select materials – glass, paper and cardboard, plastic and tyres – this report pilots 'whole of life' material flow data including use of primary materials and consumption. Over time, it is hoped this pilot approach can be expanded for other materials.

Summary

Figure 8 provides a summary of the scope of reporting for this report.

Figure 8 Summary of the scope of the National Waste Report 2020



1.2 Data

Units

Quantitative data is presented by weight, either in kilograms (kg), tonnes (t), thousands of tonnes (kilotonnes or kt) or millions of tonnes (megatonnes or Mt).

Data sources

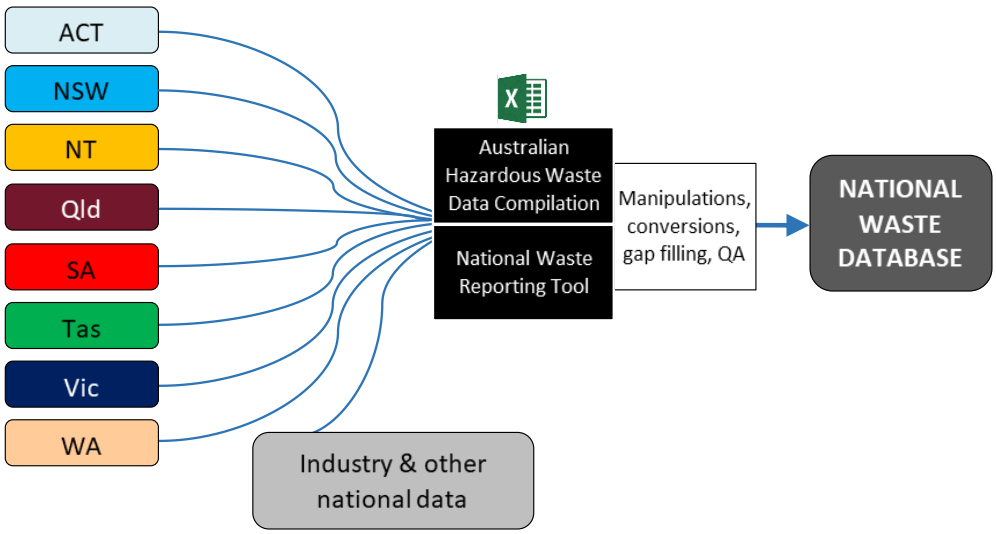
Much of the data included in this report was obtained from state and territory governments, which collect it for their own monitoring and reporting. This data comprises mainly tonnes of waste sent to landfill and various forms of recycling. State and territory data is supplemented, and sometimes replaced, by national industry data or other national estimates. These include industry data on plastics recycling, ash and biosolids. Data sources are listed in the bibliography and in the National Waste Reporting Tool 2018-19.

Data collation methods

To derive a national picture on waste, a common set of assumptions and categories must be applied to the collected data. This requires some manipulation of state and territory data, including re-categorisation, applying assumed compositional splits and adjusting for cross-border transport.

To facilitate these manipulations, two Microsoft Excel workbooks were established that transform state and territory data into a coherent national database using a set of manipulation steps endorsed by the states and territories. These are the National Waste Reporting Tool and the Australian Hazardous Waste Data Compilation. The National Waste Reporting Tool 2018-19 is to be published online together with this report. The outputs of this tool and previous versions of it are combined into a National Waste Database 2020, going back to 2006-07. It is understood that the Department will prepare a mechanism for exploring this dataset online. An illustration of the data inputs to and outputs from the tool is given in Figure 9.

Figure 9 Waste data flows and the National Waste Database



Data quality

Significant effort has been made to ensure that the data presented in this report is reliable. In general, the quality and quantity of Australian data on waste tonnages, source streams and materials are improving. Various adjustments to historical data, undertaken in consultation with the states and

territories, have improved the trend analysis. It is not possible to calculate margins of error because data arises from multiple sources and is aggregated in different ways by different organisations. Overall, the authors believe the data reliably supports the key messages presented here.

Data quality problems can arise due to difficulties and costs in collecting the data and the fact that state and territory data systems have evolved largely independently. Issues include the following:

1. Some data may be based on incomplete surveys or estimates converted through volumetric measures or truck counts.
2. Reporting or calculation errors can occur (see Table 28).
3. Data is not always available to encompass the full scope of geography, waste categories, source streams and management methods needed. In these cases, a best estimate is made, sometimes using data from other states and territories.
4. Data is sometimes categorised in different ways by states and territories, requiring assumptions for conversion to a common measure. Calculations performed to establish a common dataset are included in the National Waste Reporting Tool 2018-19.
5. State and territory data systems focus on material managed in their jurisdiction and are often weak in identifying material imported from or exported to other jurisdictions. This creates risks of double-counting and incorrect estimates of recovery rates.
6. The composition of waste to landfill is estimated from periodic audits at a few landfills. These snapshots will not be perfectly representative. In particular, they may miss waste types that are deposited infrequently or seasonally.
7. Waste streams are not fully separate. Municipal collections often include some businesses, and commercial collections often include some high-rise residential buildings. Recycling operators cannot always report the sources of all their materials. Consequently, source stream data is not perfectly accurate.

Several significant data gaps and quality issues, and how they were addressed in the report, are described in the 'Method' chapter in Section 18.5.

Indicators of higher underlying quality in the reported data include:

- reporting via compulsory, rather than voluntary, programs
- measurement via a weighbridge, rather than via volumetric measures or truck counts
- recycling collected via a comprehensive industry survey rather than partial or ad-hoc surveys
- for hazardous waste, tracking systems that require reporting of waste movements.

Table 2 shows the characteristics of the data from each state and territory against these indicators.

Data in this report may differ from state and territory data

The methods used by the Australian Government for categorising and analysing waste data are not always the same as those used by individual states and territories. Consequently, data presented here may differ from corresponding data presented in state and territory reports. Some methodological approaches likely to cause differences are described below.

- Some waste is generated in one state but transferred to another. For example, in recent years large amounts of waste were transported from NSW to Qld. States and territories typically report only waste that is recovered or disposed within their boundaries but in this report, where data is available, transfers are reassigned to the jurisdiction where the waste was generated.
- This report covers waste that is sometimes excluded from state and territory reports, such as biosolids from sewage treatment plants, ash from power stations and hazardous waste.

Table 2 Indicators of data quality in the core 2018-19 state and territory data in this report

	RECYCLING DATA			LANDFILL DATA		HAZARDOUS WASTE DATA
	Compulsory facility reporting?	% tonnes measured via weighbridge	Comprehensive recycling survey?	Compulsory facility reporting?	% tonnes measured via weighbridge	Tracking system?
ACT	Partly [1]	Unknown	✓	✓	100%	×
NSW (regulated area) [2]	✓	Unknown	✓	✓	80%	✓
NSW (other)	×	Unknown	×	✓		
NT	×	Most	×	Most	80%	×
Qld	✓	Unknown	✓	✓	95%	✓ [3]
SA	×	77%	✓	✓	99%	✓
Tas	×	46%	×	×	83%	×
Vic	×	Unknown	✓	✓	97%	✓
WA (metro Perth) [4]	× [5]	30%	✓	✓	70%	✓
WA (regional)				×		

Notes 1 Will become compulsory over the coming few years.
2 The regulated area covers about 86% of the NSW population comprising Sydney, Illawarra and Hunter regions, central and north coast local government areas and three other local government areas.
3 Qld has a tracking system but 2018-19 data was not available in time for inclusion in this report.
4 The Perth metropolitan region represents about three quarters of the WA population.
5 Compulsory from 2019-20.

- This report uses national instead of state and territory data for some waste and some jurisdictions, including for plastics and biosolids.
- The states and territories do not distinguish between 'management method' and 'fate' of waste, and do not count any waste to landfill as being used for energy recovery.

Historical and trend data have been updated

This report incorporates data back to 2006-07. Some of the historical data has been updated from previously reported figures due to receipt of new or amended data, and changes to assumptions or calculations. Major changes to the data are listed in Table 29 (in Appendix A). They include use of actual, rather than estimated, data for NSW recycling in 2015-16 and 2016-17, correction of reporting errors and revision to some historical hazardous waste data. Some data presented here differs from equivalent data presented in the *National Waste Report 2018.* The information presented here supersedes previously reported information.

1.3 Data and report layout

The main data presentations are in chapters 3 to 8. The primary focus is financial year 2018-19 but more recent data is included where known and relevant. Data for 2018-19 is shown mainly in static bar charts, often with absolute tonnages split in several ways. Trend data back to 2006-07 is presented mainly in area charts, showing absolute tonnages and, where applicable, tonnes per capita.

National targets for waste reduction and management have been established under the *National Waste Policy Action Plan* with 2016-17 as the baseline year (see Section 2). Accordingly, 2016-17 data values are emphasised in many parts of the report.

Technical terms and abbreviations are explained in the glossary starting on page vii. Abbreviations are introduced in capital letters.

The data presentations are generated using Microsoft Power BI and are subject to that program's limitations. Chart labels by calendar year refer to financial year, so '2019' means '2018-19' and so on. The data set will be made available via the Department's website so users can do their own analyses.

Three data appendices are presented:

- Appendix B contains data corresponding to the charts
- Appendix C compares data for 2016-17 (the baseline year for the National Waste Policy Action Plan) and 2018-19
- Appendix D presents data on waste deposited in landfill.

Data is rounded to different levels of significance for the benefit of different users, as shown in Table 3.

Table 3 Levels of significance of data presentations

Report elements	Level of significance
• Headline numbers box on first page of 'At a glance' • Charts • Percentage values • Values in 'At a glance' and chapters 2 to 8, 14 and 15 that are <10 and part of a group in which most values are >10	Two significant figures
• Most other text in 'At a glance' and chapters 2 to 8, 14 and 15	Three significant figures
• Appendices B, C and D	Largest value in any table given to four significant figures. Other data rounded to same number of decimal places as that figure.
• Other chapters	Ad-hoc, based on source data

Blue Environment recommends that users of the data reported in this document:

1. express data to two significant figures only to appropriately reflect the uncertainty in the data values
2. undertake calculations using data in the National Waste Database 2020 (which expresses the data to the nearest tonne) or, alternatively, using the data in the appendices.

Due to rounding, some data may not appear to add up perfectly and percentages may sum to more or less than 100%.

1.4 A note on the pandemic

Like almost all industries and social functions, waste management has been significantly affected by the COVID-19 pandemic. While the focus of this report is 2018-19, which precedes the pandemic, some data and observations are included in Section 16.1 in the 'Current and emerging challenges' chapter.

2. Progress against the national waste targets

In 2018 the Australian Government, state and territory governments and the Australian Local Government Association established the updated *National Waste Policy.* The policy aims to help Australia move closer to a more circular economy that eliminates waste and improves economic, social and environmental outcomes. The following year, the *National Waste Policy Action Plan* established targets and actions to implement the policy and noted that the National Waste Report will provide both baseline and ongoing performance data for the seven national targets. Table 4 reports on progress[7].

Table 4 Progress against the targets in the National Waste Policy Action Plan

Target	Progress report				
1 **Ban the export of waste plastic, paper, glass and tyres, commencing in the second half of 2020**	A March 2020 response strategy produced by the former Council of Australian Governments agreed to the following program[8] for implementing the bans. At the time of writing, legislation to implement the bans is under development.				
	From	**Material to be banned from export**			
	1 Jan 2021	Unprocessed glass, in a whole or broken state. Both formed packaging and flat sheet glass.			
	1 July 2021	Mixed plastics that are not of a single resin/polymer type and/or further sorting, cleaning and processing is required before use in re manufacturing.			
	1 Dec 2021	All whole used tyres including baled tyres, but not including bus, truck and aviation tyres exported for re-treading to a verified re-treading facility.			
	1 July 2022	Single resin/polymer plastics that have not been re-processed (e.g. cleaned and baled PET bottles).			
	1 July 2024	Mixed and unsorted paper and cardboard.			
2 **Reduce total waste generated in Australia by 10% per person by 2030**	Estimated core waste + ash per capita, Australia	**2016-17**	**2017-18**	**2018-19**	
		2.85 t	2.94 t	2.94 t	Estimated increase of 3% since 2016-17
3 **80% average resource recovery rate from all waste streams following the waste hierarchy by 2030**	Estimated resource recovery rate, Australia	**2016-17**	**2017-18**	**2018-19**	
		60.8%	62.3%	62.6%	Estimated increase of 1.8 percentage points since 2016-17
4 **Significantly increase the use of recycled content by governments and industry**	Material recycled and not exported	**2016-17**	**2017-18**	**2018-19**	
		35.7 Mt	38.3 Mt	39.3 Mt	Estimated increase of 10% since 2016-17

[7] Methods of measurement and baselines are still being developed for some targets. Initial approaches here (such as for uptake of recycled content) may be superseded by the next report.
[8] The program was subsequently amended to delay the ban for glass due to the COVID-19 pandemic.

<table>
<tr><th>Target</th><th>Progress report</th></tr>
<tr><td>5 Phase out problematic and unnecessary plastics by 2025</td><td>The Australian Packaging Covenant Organisation (APCO) is leading a project to identify and eliminate single-use, problematic and unnecessary plastic packaging (APCO 2019a). Identified priority materials are expanded polystyrene (EPS) food and beverage service containers, EPS packaging fill, fragmentable plastics and light weight bags. APCO will work with industry in 2020 to develop action plans for these materials and its annual report for 2020 will include quantitative data on them.

All states and territories except NSW have banned single-use plastic bags. ACT, Qld and SA are introducing legislation that will phase out certain single-use plastics with bans set to commence in 2021. NSW and WA have released public discussion papers that propose similar bans.</td></tr>
<tr><td>6 Halve the amount of organic waste sent to landfill by 2030</td><td>Estimated organic waste disposed of in landfill [9], Australia
2016-17: 5.73 Mt
2017-18: 5.59 Mt
2018-19: 5.60 Mt
Estimated 2% reduction since 2016-17</td></tr>
<tr><td>7 Make comprehensive, economy-wide and timely data publicly available to support better consumer, investment and policy decisions</td><td>In addition to this report, the Department has commissioned the following for completion by the end of 2021:
an updated national waste database
projections of future waste quantities
a database of national waste infrastructure, and an assessment of its adequacy
Hazardous Waste in Australia 2021.
The Australian Government recently announced $24.6m of funding on a national waste data visualisation platform, to be developed over four years.

The Australian Bureau of Statistics (ABS) is preparing an update to the Waste Account to be released this year.</td></tr>
</table>

[9] Data is presented excluding waste that generates methane that is captured at the landfill and used for energy recovery – see Section 18.4.

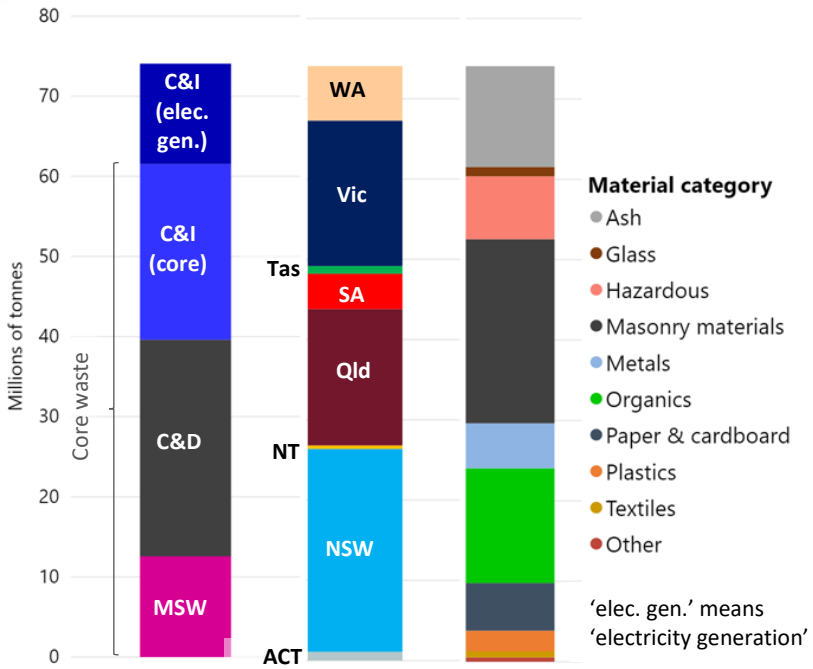
3. Waste generation

This chapter reports on waste generated in Australia in 2018-19 and the trends since 2006-07.

3.1 Waste generation in 2018-19

Waste generation in 2018-19 is illustrated in Figure 10[10]. The left column of the figure shows the waste by material category, encompassing core waste and ash. In total, an estimated 74.1 Mt of waste was generated, including 22.9 Mt of masonry materials, 14.3 Mt of organics, 12.5 Mt of ash, 7.8 Mt of hazardous waste (mainly contaminated soil), 5.9 Mt of paper and cardboard, 5.6 Mt of metals and 2.5 Mt of plastics. This is equivalent to 2.94 t per capita. Of the 74.1 Mt generated, 11% is classified as hazardous.

Figure 10 Waste generation (core waste and ash) by material and stream, Australia 2018-19



There were about 61.5 Mt of core waste (2.44 t per capita). This is up from 57.3 Mt in 2016-17. The 2018-19 core waste comprised 12.6 Mt of MSW (500 kg per capita and 20% of the total), 21.9 Mt of C&I waste (36% of the total) and 27.0 Mt of C&D waste (44% of the total).

In 2016-17 there was 12.6 Mt of MSW, 21.3 Mt of core C&I waste, 23.4 Mt of C&D waste and 12.2 Mt of ash, summing to overall waste generation of 69.5 Mt.

Some waste is absent from this data, including unknown quantities of illegally disposed waste not subsequently collected by government agencies. This quantity is likely to be relatively small.

3.2 Primary and secondary production waste

The core waste data set excludes many industry wastes that are managed on-site or are generated upstream in the production system. The main sources of these materials are primary production activities such as mining, agriculture and forestry, and secondary production such as mineral processing. Data on these waste materials is often poor.

Figure 11 presents data on some 'non-core' industry wastes generated in 2018-19 including selected agricultural organic residues, fisheries by-catch, some mineral processing wastes and, for the first time in this report series, a close to comprehensive estimate of mining waste generated in Australia. Mining and mineral processing wastes are discussed below. Agricultural organics are addressed in Section 8.8.

[10] Full data for all charts is given in Appendix B.

Mining wastes

The main method used for estimating quantities of mining wastes was by combining data reported via the National Pollutant Inventory (NPI) with public annual audit compliance reports from mine sites in WA. The NPI is a database of emissions and transfers of 93 toxic substances, including those found in mine tailings. These were matched by mining sector against the waste quantities stated in the audit compliance reports to derive an average 'factor' that could be applied to national NPI data to scale up the NPI substance transfers to total waste[11].

Total mining waste in 2018-19 is estimated at 502 Mt dry weight, almost seven times the quantity of core waste and ash, and 40 times the quantity of municipal waste. Typically, mining waste is a slurry of pulverised rock and water. An estimated 83% of mining waste was deposited in a tailings dam, which is generally intended to facilitate separation of the solid and water fractions[12]. Most of the remainder was used to fill mining voids. Mines may recycle some more valuable materials and may run an on-site landfill, but the quantities of material to both are relatively minor.

Figure 12 presents estimated waste quantities by mining sector. Gold mining produces the most waste, followed by iron ore and oil and gas extraction.

Mineral processing wastes

The two main mineral processing wastes identified and quantified are:

- an estimated 25.8 Mt of red mud, an alkaline by-product of bauxite refining that was deposited at sites in WA and Qld (about 850 Mt of red mud has been deposited in Australia over the last 50 years)
- an estimated 2.4 Mt of coal-seam gas brine, a residue of the desalination of extraction waters that were deposited in much higher volumes in ponds mainly in south-east Qld.

Figure 11 Waste generation (all measured materials) by stream, Australia 2018-19

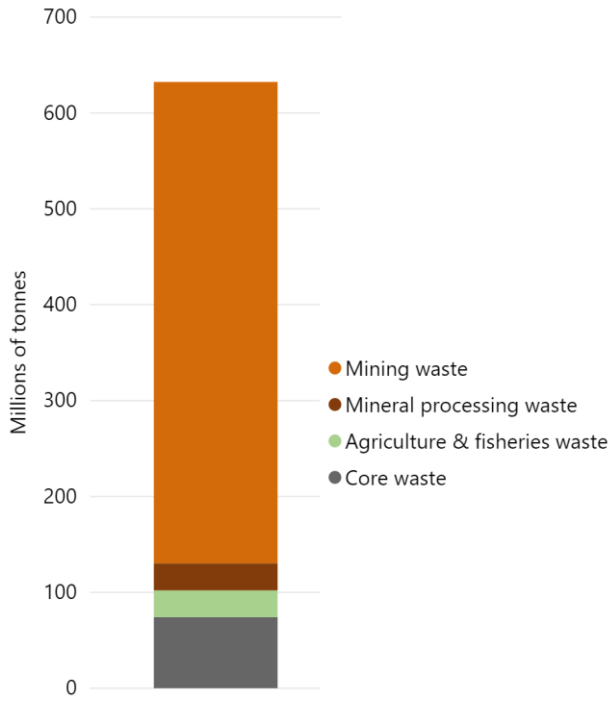
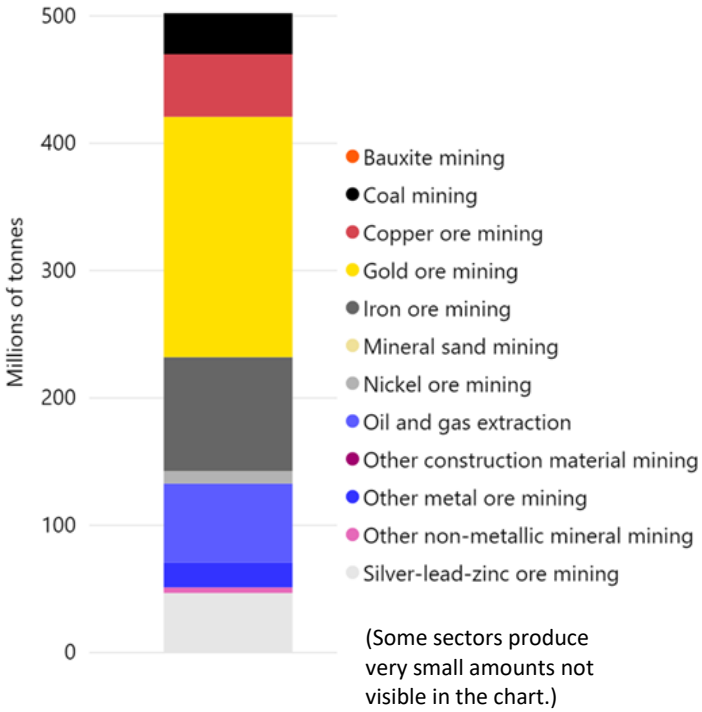


Figure 12 Estimated mining waste by sector, Australia 2018-19



(Some sectors produce very small amounts not visible in the chart.)

[11] Blue Environment thanks Cara Francis and the WA Department of Water and Environmental Regulation for help with this process. The estimates supersede the data in the *National Waste Report 2018*, which included only NPI substances.

[12] The tailings estimated was in 'dry tonnes', so excludes the water component.

3.3 Trends in waste generation

Figure 13 shows the trend in the generation of core waste plus ash between 2006-07 and 2018-19 by source stream. The charts on the left are total tonnes and those on the right are tonnes per capita. Over the 13-year data period, waste generation increased by 11.3 Mt (18%) or by 13.1 Mt (27%) when ash is excluded. By stream, MSW shrank by 0.31 Mt (-2.4%), C&I waste including ash grew by 1.4 Mt (4.2%), C&I waste excluding ash grew by 3.2 Mt (17%) and C&D waste grew by 10.2 Mt (61%). Full data is given in Appendix B.

Table 5 presents the 13-year changes on a per capita basis by waste stream, and shows that both MSW and C&I waste per capita fell. The phenomenon of declining waste per capita has been observed in other developed nations, including Japan (MoE 2014), Singapore (NEAS 2020), Germany (FMENCN 2018) and the USA (US EPA 2020). The concept of 'peak waste' has been formulated from this observation. Probable causes include reduced printed material due to digitisation and advances in material science and technology making products smaller, lighter and more resource efficient (Hoornweg *et al.* 2013). It may also reflect relative increases in the marginal cost of extracting mineral resources (Badia *et al.* 2014). Note that declining weights do not necessarily correspond to declining volumes.

For C&D waste, Table 5 shows a very different trend – this stream grew by 32% per capita over the 13-year period, with most growth occurring in the last five years. The cause is unprecedented levels of development, particularly in the major cities.

Feature 1 Imports of waste into Australia

This report focuses on waste generated in Australia. Imported waste from other countries was excluded, to the extent it could be identified.

Based on Australian Bureau of Statistics (ABS) data, in 2018-19 Australia imported about:

- 70,700 t of non-hazardous scrap materials, comprising 50% metals, 17% plastics, 12% glass, 10% paper and cardboard, 8% tyres and 4% textiles
- 72 t of municipal waste (likely to be from Antarctica)
- 1,020,000 t of granulated slag sand from the manufacture of iron or steel, which is used primarily in cement manufacture, reducing energy requirements and greenhouse gas emissions in the production process
- 149,000 t of other slag materials
- 22,500 t of other hazardous materials for industrial use or treatment, including lyes, catalysts and oils
- 1,210,000 t of agricultural organics potentially classifiable as wastes.

Table 5 Changes in the quantity of waste generated per capita, Australia 2006-07 to 2018-19

	Core waste plus ash	Core waste	MSW	C&I incl. ash	C&I excl. ash	C&D
13-year change	- 3.3%	+ 4.2%	- 20%	- 15%	- 4.1%	+ 32%

Figure 14 (p.14) shows the generation trend by jurisdiction, this time focusing only on core waste. Increases are recorded for all jurisdictions except the NT and WA, where there may be data issues (see Section 18.5). The biggest increase was in Victoria, and is attributable to its development boom.

Figure 13 Trends in the generation of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2018-19

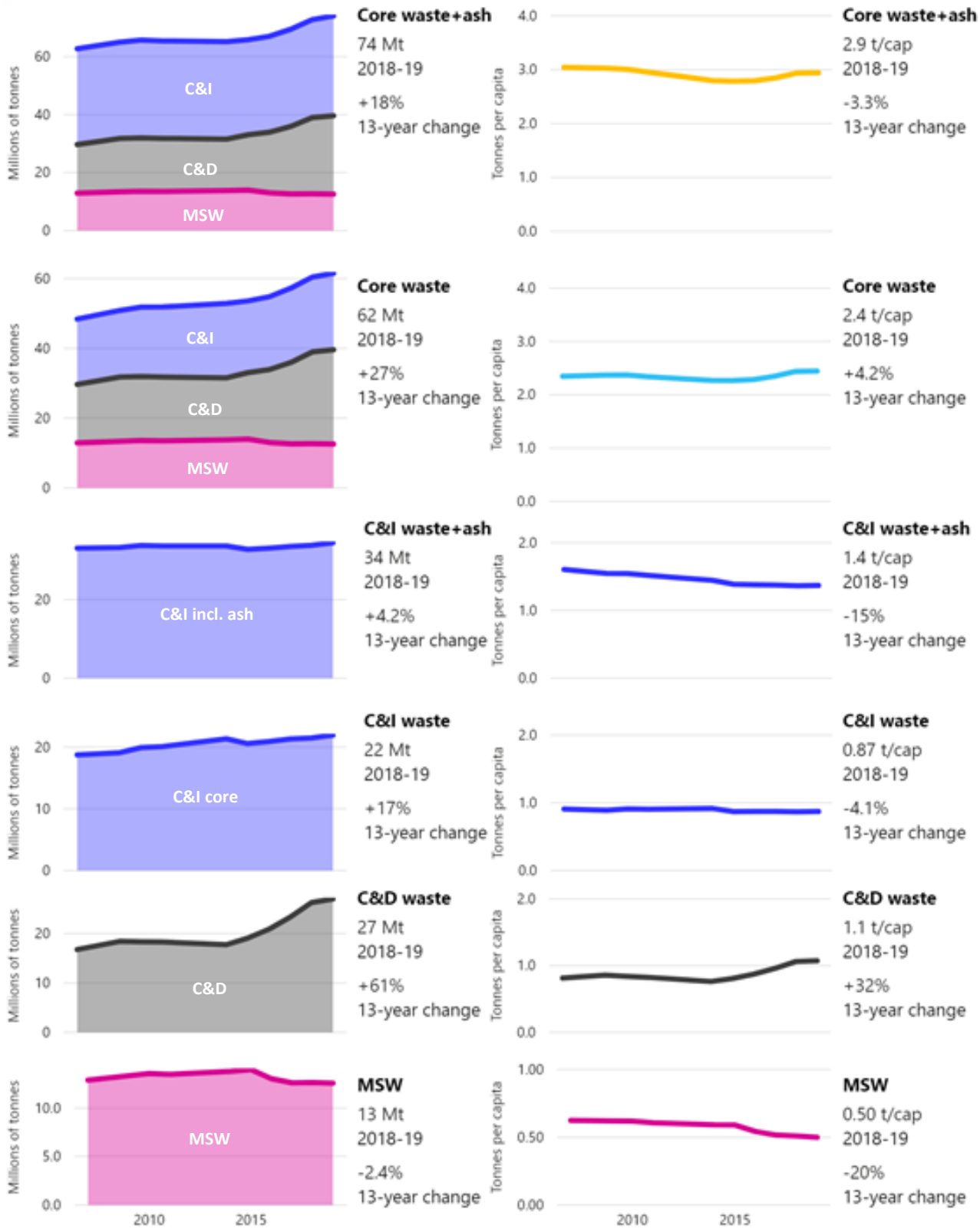
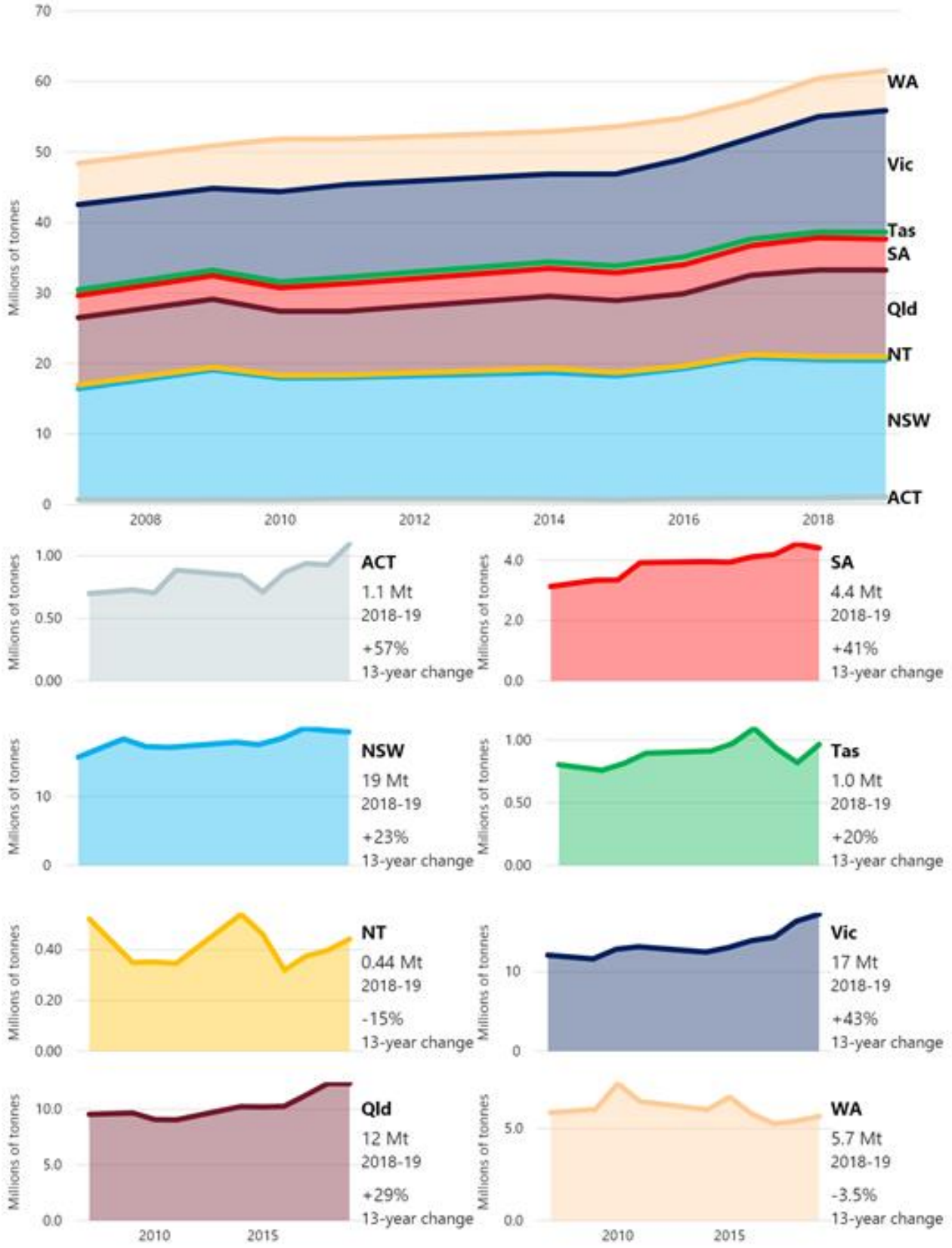


Figure 14 Trends in the generation of core waste by jurisdiction, Australia 2006-07 to 2018-19



4. Recycling

This chapter reports on the quantities of waste materials processed for recycling in Australia in 2018-19 and the trends since 2006-07. It discusses sorting of mixed recyclables and exports of sorted materials. Information on the recycling of particular waste materials is given in Chapter 8. Full data for all charts is given in Appendix B.

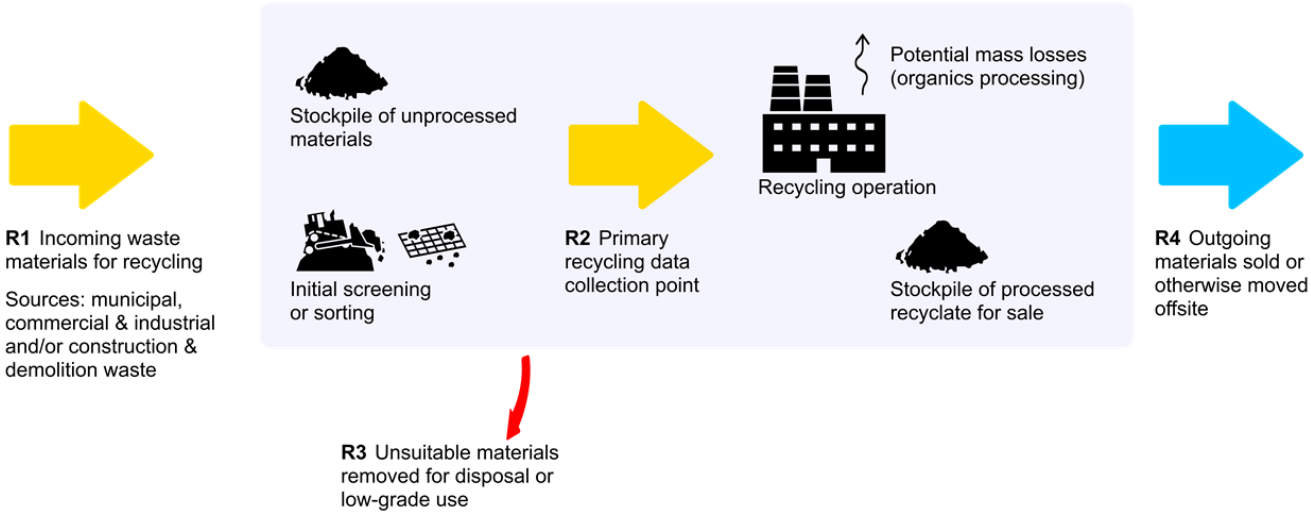
4.1 What the data covers

Figure 15 illustrates material flows at a generic recycling facility. Material flows can be measured at different points, illustrated as R1 to R4. The measurement points used vary by waste type and jurisdiction. Most ACT, NT, SA, Tas and Vic waste is measured at point R1. This risks exaggerating recycling because stockpiles of processed or unprocessed material would be included. It also risks double-counting since some material (R3) may be rejected and counted again at the landfill. NSW and most WA data is reported at R2, and Qld at R4. It is to be hoped that standardisation over time will allow convergence to a single measurement point to provide reliable data and allow reasonable comparisons.

This section reports data on materials received or processed by recycling facilities, including materials exported for recycling overseas. This somewhat overstates the recycling rates since some exported material was contamination, or 'off-spec', and likely to have been disposed of or used as a fuel.

The measures reported here are indicators of recycling. In reality, recycling does not occur until the processed material is used in new products, buildings or infrastructure. However, the vast majority of material processed for recycling is so used.

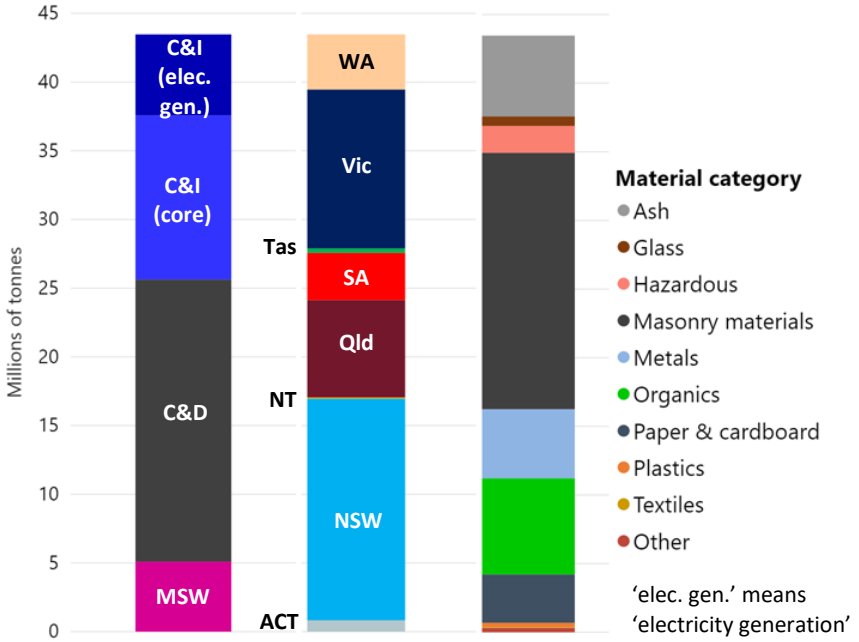
Figure 15 A generic recycling process, illustrating what is included in the data presented in this section



4.2 Recycling in 2018-19

The quantities of core wastes and ash recycled in Australia in 2018-19 are illustrated in Figure 16. About 43.5 Mt of materials were received or processed for recycling, up from 39.6 Mt in 2016-17. The four largest fractions, making up more than 80% of the total, were masonry materials (18.7 Mt), organics (7.0 Mt), ash (5.9 Mt), and metals (5.0 Mt). C&D materials represented the largest source stream (47%) followed by C&I materials including ash (41%) and MSW (12%). The equivalent values in 2016-17 were 42%, 45% and 12% respectively.

Figure 16 Recycling of core waste and ash by category, jurisdiction and stream, Australia 2018-19



4.3 Sorting

The data presented above covers materials delivered to or processed by recycling operations. Depending on the source and material, materials often need to be sorted before delivery to these facilities. At depots specialising in homogenous, commercially-sourced material streams such as cardboard or glass, sorting is often a simple manual process. Mixed material streams need sophisticated sorting.

The most complex sorting processes are at material recovery facilities (MRFs) receiving mixed domestic materials. MRFs received about 2.3 Mt of materials in 2018-19, over 80% of which was from households. About 1.9 Mt was subsequently forwarded for reprocessing, and the estimated 20% remainder went to landfill. MRFs typically operate a range of automated sorting methods – including trommels, air separators, magnets, eddy currents and optical sorting devices – that target particular materials and separate them. They tend to produce some high value products such as baled aluminium cans, and some low value materials such as mixed paper or plastics.

For most of the 2006-07 to 2018-19 period covered in this report, demand for low-grade mixed products was high, mainly from Chinese buyers. This tended to promote high speed and low cost MRF operation to produce large quantities of low-grade product. From late 2017, import restrictions from China, followed by other Asian countries, disrupted this approach across the globe. This is evident in the commodity prices shown in Table 6. All the listed prices have fallen, but those for mixed materials dropped the most. Section 4.4 provides more detail on the changes in the recycling market and the waste export bans.

Photo 1 Re.Group's Townsville MRF processes about 15,000 tonnes of domestic recyclables per year

Photo kindly provided by Re.Group

Table 6 Indicative scrap commodity prices ($ per tonne, product leaving a material recovery facility)

Commodity	June 2017	June 2019	June 2020
Green glass	not available	$30	$30
Green glass from container deposit schemes	not available	$100	$75
Mixed glass from material recovery facilities	$0	-$30	-$30
Steel	$216	$150	$97
Aluminium	$1,249	$1,100	$931
Mixed paper and cardboard	$124	$0	$0
Newsprint and magazines	not available	$187	$95
Old corrugated cardboard	$205	$196	$105
PET plastic (code 1)	$575	$400	$296
HDPE plastic (code 2)	$575	$500	$345
Mixed plastics (codes 1-7)	$325	$65	$47

Source: Envisage Works analysis based on various sources

4.4 Exports of waste-derived products for recovery

Export to Asia has been a primary market for some waste-derived products, especially sorted domestic recyclables. This can be seen in Figure 17, which shows trends in exports of core waste materials for recovery[13] based on ABS data[14].

Exports of these materials stood at 2.79 Mt in 2006-07, climbed to a peak of 4.58 Mt in 2013-14, then fell back to 3.88 Mt in 2019-20.

The material category exported in the largest volume is metals, which, despite volatility, remains on a long-term upward trajectory. Exports in 2019-20 were 2.54 Mt, or two-thirds of the listed materials.

[13] Most materials are exported for recycling, but some plastics and nearly all tyres are used for energy recovery.

[14] These figures differ from those presented in the Department's monthly and annual reports on exports of waste-derived products and waste, which report a total of 4.2 Mt of waste-derived products and waste in 2019-20. Those reports have a broader scope covering all wastes and probable wastes, whereas Figure 17 includes only core waste commodities exported for recovery. They exclude hazardous wastes, agricultural organics and a few other minor categories.

Scrap paper and cardboard had a contrary trend, falling 27% (386 kt) since 2016-17, mainly due to import restrictions in Asia. Exports in 2019-20 were 1.07 Mt.

Until 2019-20, tonnages of scrap plastics exports remained buoyant despite falling prices, but last year they fell sharply to 113 kt.

Exports of end-of-life tyres barely featured in 2007 then expanded strongly until 2011-12 and have been volatile since then[15]. Exports in 2019-20 were 85.1 kt.

Similarly, the export market for scrap textiles grew from very little in 2010-11 to about 90 kt by 2013-14, before falling back to 46.8 kt in 2019-20.

Scrap glass is a minor export but has grown from a very low base since 2014-15, reaching 25.9 kt in 2019-20.

Figure 17 Trends in Australian exports of waste-derived products by core material category, 2006-07 to 2019-20

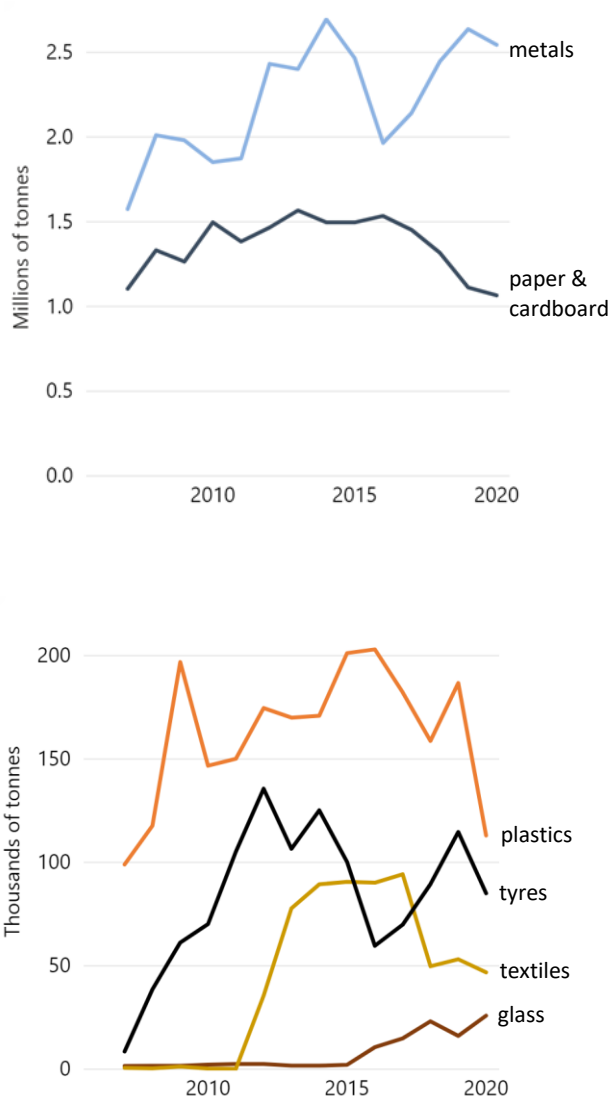


Photo 2 In 2019-20 Australia exported 3.88 Mt of core waste for recovery overseas

High levels of imported goods into Australia mean space on ships leaving the country is relatively cheap.

Photo from Public Domain Pictures 14, via canva.com

Figure 18 shows that the quantities of waste-derived products exported for recovery are small compared with the total quantities recovered. For some materials, however, the exported proportion was substantial, as shown in Table 7.

With the Asian restrictions and Australian waste export bans (see Section 16.2), Australia faces a major challenge in finding new markets for recycled materials, especially paper and cardboard, plastics and tyres. Announcements in 2020 from industry and governments should help address these challenges. For example, Asahi Beverages, the PACT Group and Cleanaway are building a new plastics recycling facility at Albury-Wodonga to increase use of recycled PET by about 20 kt per year. The Australian Government's $190 million Recycling Modernisation Fund is expected to leverage $600 million in investments to improve Australia's recycling infrastructure, further supported by commitments made in the National Waste Policy Action Plan, such as to improve public and private sector purchasing of recycled content in goods, buildings and infrastructure.

[15] Review of other data sources suggests the ABS data on exports of waste tyres may not be comprehensive. This is probably because exporters do not always use export codes correctly.

Figure 18 Comparison of core waste exported and recovered by material category, Australia, 2018-19

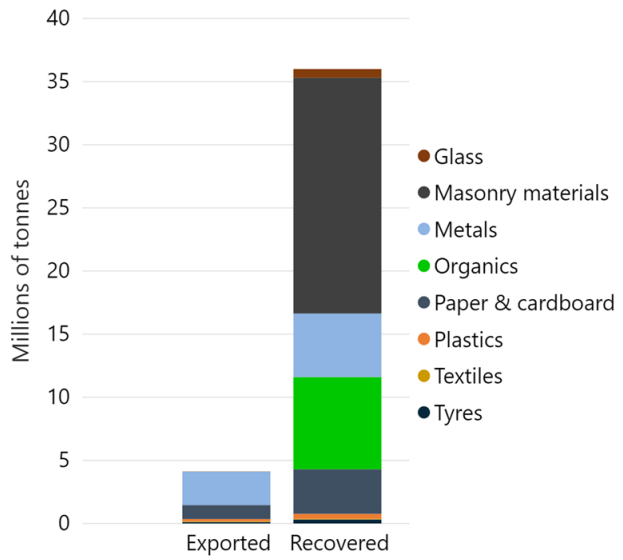


Table 7 Exports compared to total recovered materials by category, Australia 2018-19

Scrap material	Exported (kt)	Recovered[16] (kt)	Estimated proportion exported
Glass	16	688	2%
Metals	2,640	5,040	52%
Paper	1,110	3,530	32%
Plastic	187	393	48%
Textiles[17]	53	58	92%
Tyres	115	316	36%

Feature 2 Waste avoidance, reduction and reuse

The waste hierarchy (Figure 19) establishes a preferential order of waste management options based on environmental impact. The activities at the top of the hierarchy – avoidance, reduction and reuse – tend to have the lowest impact on the environment.

Australia has committed to reducing waste generation by 10% per person by 2030.

The most preferred approach is to not create waste in the first place, which can be facilitated by good product design, repair, sharing and thoughtful consumption.

Community-led repair initiatives have been established across Australia such as 'Repair Cafes' and 'Men's Shed' workshops. The European Union recently passed legislation entailing a 'right to repair', obliging manufacturers of electronic devices to better facilitate product repair (Lowrey 2019). The Australian Government intends to review and report on options to improve consumers' right to repair by 2021.

Sharing of products (e.g. cars and power tools) has gained popularity in recent years, using modern platforms that reduce transactional costs and risks.

The second most preferred option in the waste hierarchy is reuse, which avoids the energy and resource costs of recycling. Significant examples include:

- Soils – a strong market exists for reusing excavated material on sites requiring fill. SA has established an Adelaide facility for storing low level contaminated soil for suitable reuse projects.
- Reuse shops (see Photo 3) help reduce landfill and provide cheap goods to the community and often employment to the disabled. The Qld Government reports that its 104 reuse shops sold about 17,000 tonnes of material in 2018-19.
- Food share – several not-for-profit charities collect quality excess food from commercial outlets, supermarkets, farmers, cafes, bakeries, etc. In 2018-19, about 64,000 tonnes were charitably distributed.
- Excess non-food goods – Good360 Australia collects excess products from major retailers for charitable distribution. It reports distributing 1,202 tonnes of goods in 2019-20 worth about $50 million.
- Charity shops have a major role in Australia's reuse economy. The National Association of Charitable Recycling Organisations reports about 2,500 charity shops across Australia. Over a million tonnes of unwanted goods are donated to these shops each year, diverting nearly 600,000 tonnes from landfill

[16] Comprises the tonnages allocated to the fates recycling and energy recovery excluding via landfill gas.

[17] Data on textiles recycling is not well collected. Some domestic recycling may be absent from the data.

Dumping of goods at charity storefronts costs charities about $13 million per year (NACRO 2018). State governments often provide some financial relief through landfill levy exemptions.

- Demolition salvage – in advanced form, buildings can be purposefully deconstructed to maximise reuse and recycling (DECCW NSW 2010).

The adoption of the 'circular economy' concept at the heart of waste policy should result in an increased focus on avoidance, reduction and reuse.

Figure 19 The waste hierarchy expresses a preferential order to managing waste, and is embedded in state and territory policy frameworks

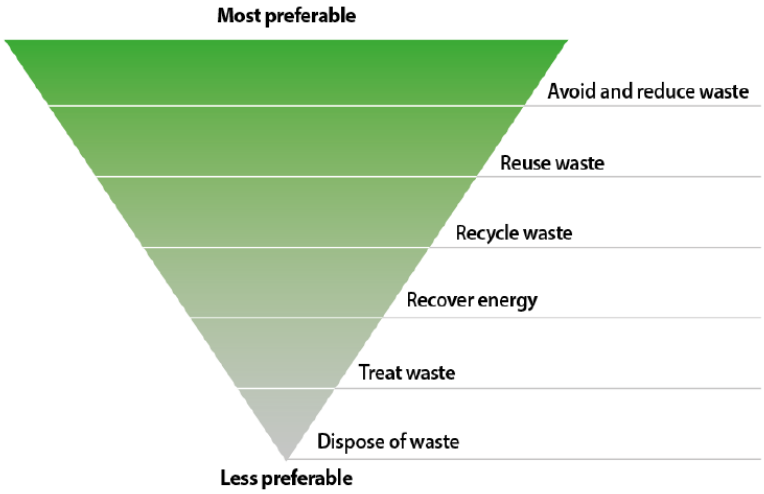


Photo 3 Reuse shops rescue products and materials from landfill disposal for repair and sale

Rescued sports equipment for sale at the Resource Work Cooperative in Hobart, which is run as a workers' cooperative.

Photo kindly provided by Resource Work Cooperative

4.5 Trends in recycling

Figure 20 shows the trends in recycling by source stream, in absolute tonnes on the left and per capita on the right. Overall recycling increased strongly during the 13-year timeframe, rising by about 50% on a tonnage basis and by about 23% on a per capita basis. In the early part of the time series, rates rose in all three streams (MSW, C&I waste and C&D waste) but from about 2014-15, differing trends are apparent.

C&D waste recycling rose markedly from 2014-15, partly due to larger amounts of material generated but also better recovery. These materials tend to be homogenous and their management is sensitive to landfill prices. Demolition waste recycling is a success story in most jurisdictions, providing an alternative source of materials for road base and construction aggregates (see Section 8.6).

C&I waste recycling levelled off and declined slightly on a per capita basis. This suggests the easiest-to-recycle materials are dealt with and future gains in recovery may be harder to win.

MSW recycling, from 2014-15, dropped sharply before rising again in the last two years. This trend is worth close examination as it is counter-intuitive and inconsistent with the trend shown in the *National Waste Report 2018*. Close examination of the data suggests it is caused by two phenomena:

- Falling weight of domestic recyclables due to lower sales of newsprint, declining quantities of glass and lighter weight packaging.
- Changes to NSW data. NSW reports that its new and more rigorous data system found lower quantities of organics and metals than previously reported. With organics, this was because the previous voluntary system double-counted an unexpectedly large amount of material transfers between facilities. With metals, it was because the industry did not respond to the voluntary surveys so the data was estimated. NSW corrected recent historical data but not older data, which therefore may contain some double-counts. This is a cautionary tale for jurisdictions that still use voluntary surveys to collect recycling data.

Figure 21 (on p.23) shows trends in the quantities of core waste to recycling by jurisdiction[18]. Recycling increased in all jurisdictions. The steep rises towards the end of the Qld and Vic data series were mainly associated with C&D waste. NSW quantities fell towards the end of the series, linked to the methodological changes discussed above. In the smaller jurisdictions, the quantities recycled per year are sometimes highly variable. This is associated with particular large-scale projects and potentially data measurement issues.

Photo 4 Product awaiting shipment from Re.Group's Townsville MRF

In the stacks from left to right are coloured HDPE plastic, aluminium cans and PET plastic.
Photo kindly provided by Re.Group

[18] Ash is not included in this chart as ash recycling rates by jurisdiction are estimates only and not relevant to ACT, NT, SA or Tas.

Figure 20 Trends in the recycling of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2018-19

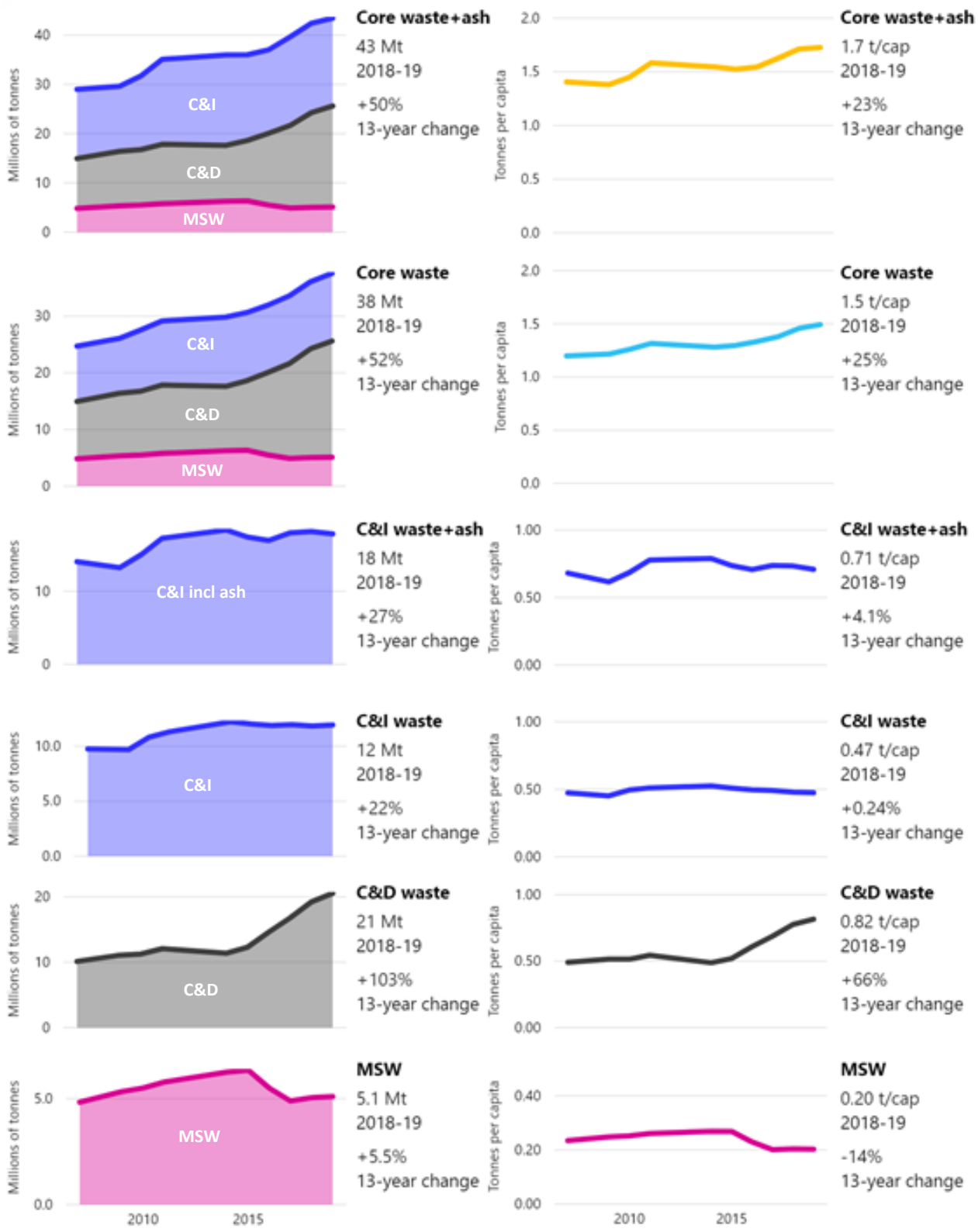
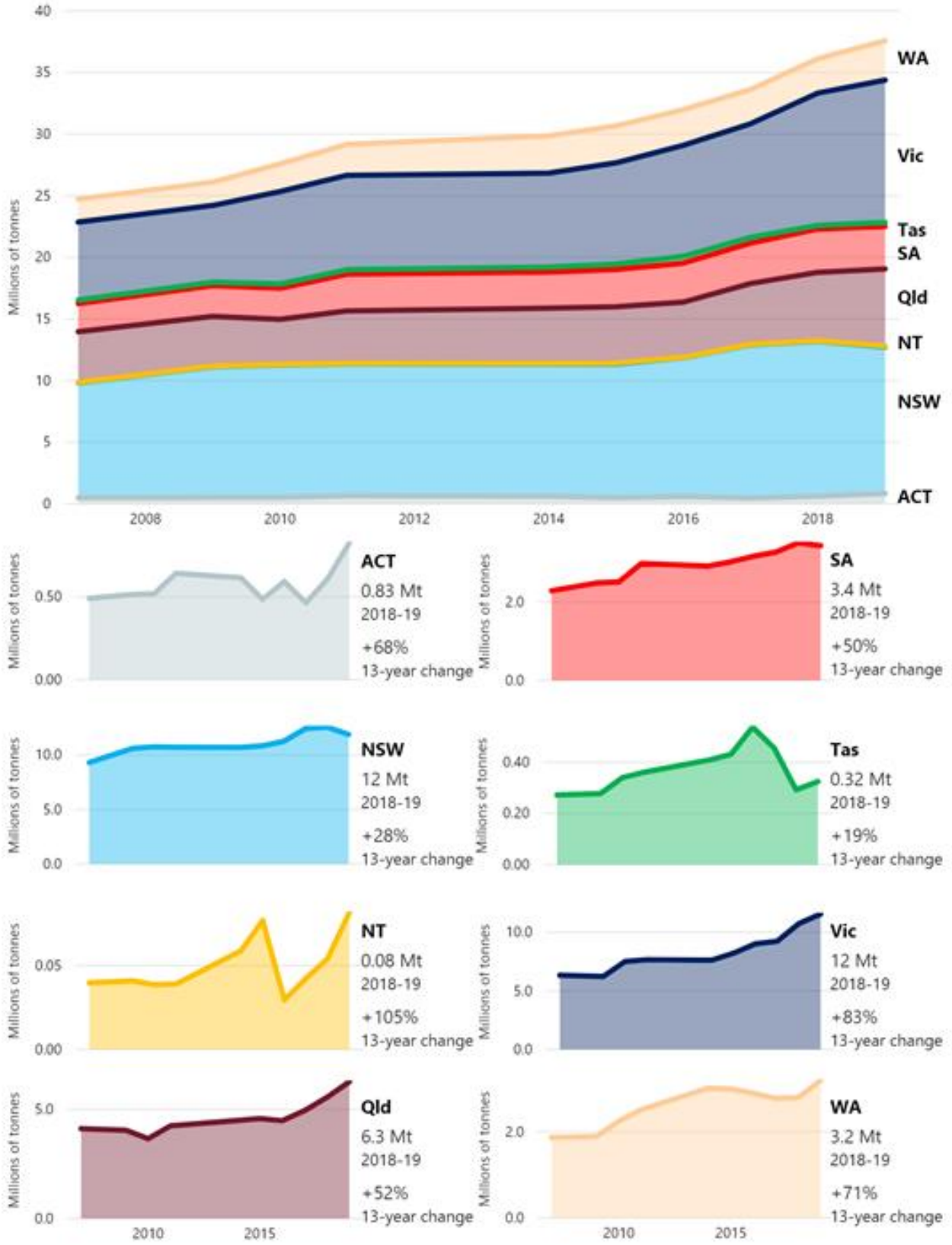


Figure 21 Trends in the recycling of core waste by jurisdiction, Australia 2006-07 to 2018-19



5. Energy recovery

This chapter reports on core waste materials[19] used for their energy value in Australia in 2018-19.

5.1 Types of energy recovery

The main ways waste was or could be used for energy are described below, in order of significance.

Table 8 Types of energy recovery from Australian solid waste

Method	Description	Use in 2018-19
Landfill gas	Methane-rich gas is generated from anaerobic decay of organic wastes in landfills. At larger sites, including those accepting 75% of MSW, this is collected and combusted for its energy value, usually by generating electricity for sale into the grid.	An estimated 42% of landfill gas generated was used for its energy value.
Waste derived fuels	Waste derived fuels are of different types: • 'solid recovered fuels' (sometimes called 'process engineered fuels') are made to a specification, including a calorific value, mainly from C&D and C&I waste timber, plastics, paper, cardboard and/or textiles • 'refuse derived fuels' are generally residual timber or garden organics • whole tyres exported for pyrolysis • high calorific value liquid hazardous wastes (solvents and paints).	Waste-derived fuels from NSW, Qld, SA and Vic were sold for export or domestic use in cement kilns or industrial furnaces
Anaerobic digestion	Anaerobic digestion is similar to composting in large, oxygen-deprived tanks. This generates methane that can be used for generating electricity. Although a common component of wastewater treatment, anaerobic digestion is not widely used for solid waste in Australia due to its cost.	Digesters in NSW, Vic (2) and WA process commercially-derived food wastes[20]
Energy-from-waste facilities	No significant energy-from-waste facilities operate in Australia. One is under construction in Kwinana, Perth, and due to start operating in late 2021. Several others are planned.	None

Photo 5 Incinerators in Pilsen (Czech Republic; left) and Copenhagen (Denmark; right)

Modern energy-from-waste facilities often highlight architectural features. The grassed area on the facility shown to the right is a ski slope.

Photos from Kletr (left) and Oliver Foerstner (right), via Shutterstock.com

[19] Excludes agricultural and forestry biomass (e.g. sugarcane bagasse and mill sawdust) and energy recovery from wastewater.

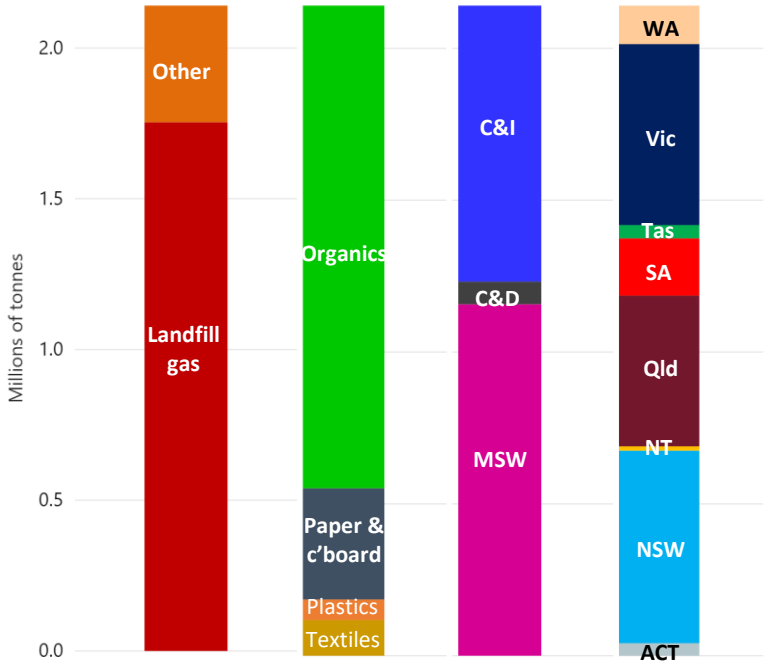
[20] Partially overlooked in the main data set due to inclusion in recycling or treatment data.

5.2 Energy recovery in 2018-19

Figure 22 shows recorded energy recovery from core waste by management method, material, stream and jurisdiction. About 2.1 Mt of waste was used for energy recovery, unchanged from 2016-17. The 2018-19 data comprised about:

- 1,750 kt (82%) of recovery through landfill gas collection
- 311 kt (15%) of recovery as fuels, the biggest portion of which was solid recovered fuels (see Table 8)
- 75 kt (4%) of anaerobic digestion of food-derived waste.

Figure 22 Energy recovery from core waste by management method, material category, stream and jurisdiction, Australia 2018-19



Landfill gas energy recovery occurs in all states and territories. Of the six states, the highest rates of gas recovery for energy generation are in Vic and the lowest are in SA and WA.

5.3 Trends in energy recovery

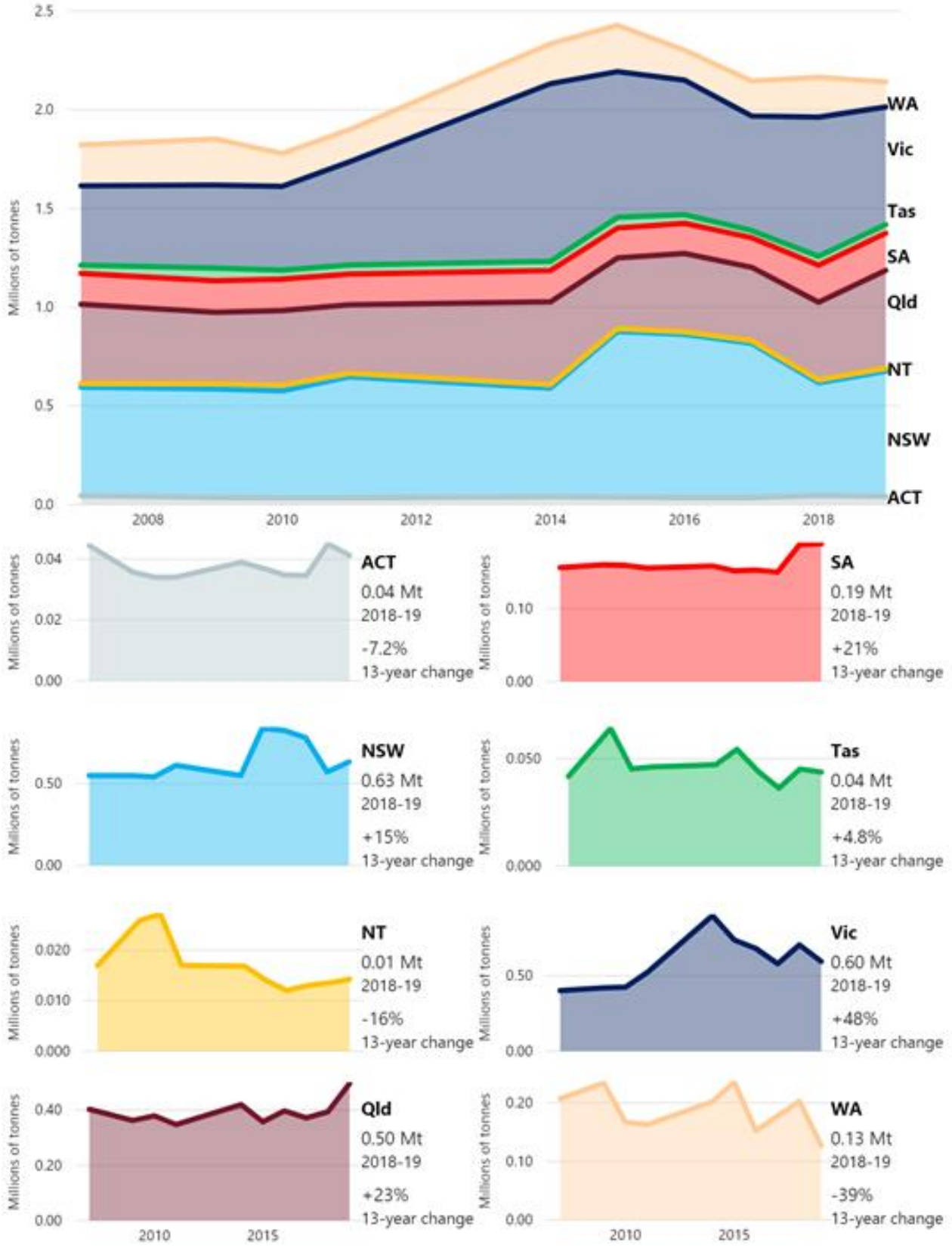
Figure 23 shows trends in energy recovery from waste. Use of waste for energy generation peaked in 2014-15 and has since fallen by more than 10%. This is due to declining use of landfill gas energy, particularly in NSW, Tas, Vic and WA. Factors that could be contributing to these falls include:

1. reduced quantities of organics sent to landfill
2. lower rainfall reducing waste degradation rates
3. a switch in operator focus from energy generation to flaring[21]
4. reduced landfill operator interest in collecting landfill gas
5. reduced local government reporting under the National Greenhouse and Energy Reporting system[22].

[21] At landfills that are small or far from the grid, landfill methane is sometimes collected and flared. When this occurs, it is usually because it was required by the regulator to reduce odour or to generate credits under the Emissions Reduction Fund.

[22] Reporting requirements for local governments changed from compulsory to voluntary when the *Clean Energy Act 2011* was repealed.

Figure 23 Trends in energy recovery from core waste by jurisdiction, Australia 2006-07 to 2018-19



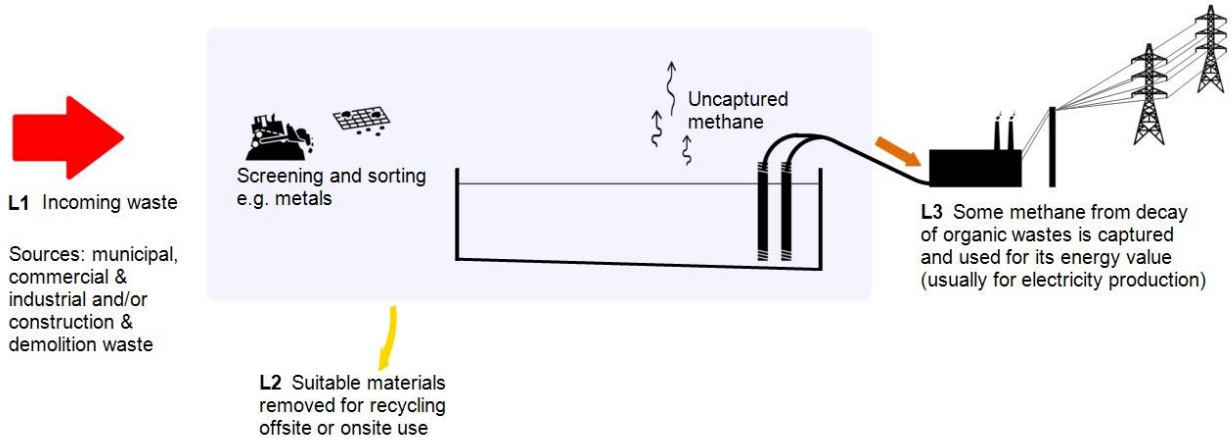
6. Disposal

This chapter reports on the quantities of core waste and ash materials disposed of in Australia in 2018-19. Disposal means allocation to a fate in which no use is made of the waste. More than three-quarters of disposed material was sent to landfill. The remainder comprises ash deposited in ash dams and relatively small quantities of medical and other waste sent for thermal destruction.

6.1 What the data covers

In this report, not all waste taken to landfill is considered 'disposal'. Waste to landfill used for generating electricity is counted under 'energy recovery' and material sold from the landfill or used on-site is counted under 'recycling'. This is illustrated in Figure 24, which shows material flows at a generic landfill facility. Waste to landfill is equal to L1 minus L2; waste to disposal is equal to L1 minus L2 minus L3.

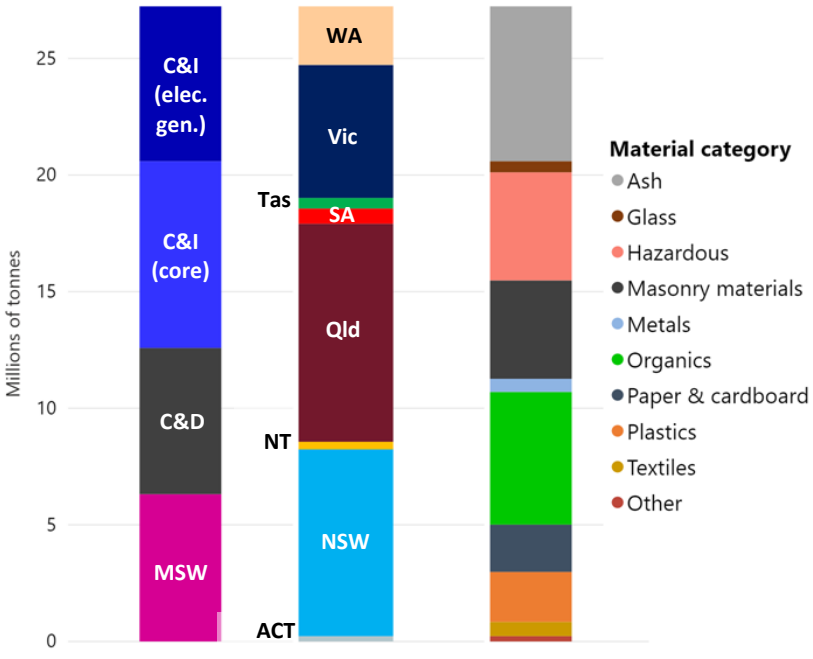
Figure 24 A generic landfill process, illustrating the data presented in this section



6.2 Waste disposal in 2018-19

Figure 25 shows disposal of core waste and ash by material, stream and jurisdiction. About 27.2 Mt of waste were disposed of, some 37% of the 74.1 Mt generated. Disposal tonnages were 26.9 Mt in 2016-17. The biggest material fractions disposed of were ash, organics, hazardous waste (mainly soils contaminated with hydrocarbons, heavy metals or asbestos) and masonry materials. Organics are problematic in landfills as they give rise to leachate, gas and odours. The proportions of the disposal stream were: C&I core 29%; MSW 23%; C&D 23%; ash 24%. In 2016-17 these values were 29%, 24%, 24% and 23% respectively.

Figure 25 Disposal of core waste and ash by material, stream and jurisdiction, Australia 2018-19



Supplementing the disposal data, Table 9 shows, for each state and territory, the quantity of waste sent to landfill (L1 minus L2 in Figure 24). A total of 22 Mt of core waste was deposited in landfill, comprising 36% of the 62 Mt of core waste generated. More detail on waste to landfill is given in Appendix D.

Table 9 Core waste to landfill by jurisdiction, Australia 2018-19 (kt) and changes since 2006-07

	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Aust.
MSW	104	2,200	139	1,780	362	149	1,690	992	7,410
C&I waste	115	2,720	56	2,060	171	287	2,160	932	8,500
C&D waste	51	1,910	143	2,080	210	61	1,490	362	6,310
Total	**270**	**6,820**	**337**	**5,920**	**742**	**497**	**5,340**	**2,290**	**22,200**
Change since 2006-07	31%	10%	-29%	17%	-7%	4%	0%	-42%	-1%

Photo 6 The Hanson landfill at Wollert in Melbourne

The Wollert landfill accepts several hundred thousand tonnes of waste per year. In the foreground is new liner, a composite of 500 mm clay and synthetic layers. Before use, this will be topped by a layer of aggregate then a filter textile to drain and capture leachate for treatment and disposal. In the centre is the active cell. Waste is being deposited to the left. In the background are filled areas, with progressively advanced rehabilitation with distance. At the top of the picture, where the left-hand access road ends, is a 7 MW power station fuelled by landfill gas.

Photo kindly provided by Hanson Landfill Services (2017)

6.3 Trends in waste disposal

Figure 26 shows trends in the disposal of core waste and ash by source stream over the 13-year data set. Waste to disposal has declined by about 13% including ash and 3% excluding ash. The quantities of core C&I and C&D waste have remained fairly steady, but MSW dropped by about 10% over the 13 years. When ash is included, C&I rates have fallen by 18%. On a per capita basis, disposal quantities have declined across all streams, due to increased recycling and stable or falling waste generation rates.

Figure 27 shows disposal trends by jurisdiction. Total disposal quantities have fallen slightly despite strong population growth, but disposal trends in individual jurisdictions differ. The variability across years, including the spikes in the ACT and NT and the recent significant growth in Vic, are associated with particular large projects. The strong fall in WA disposal is associated with a C&D waste data issue discussed in Section 18.5.

Figure 26 Trends in the disposal of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2018-19

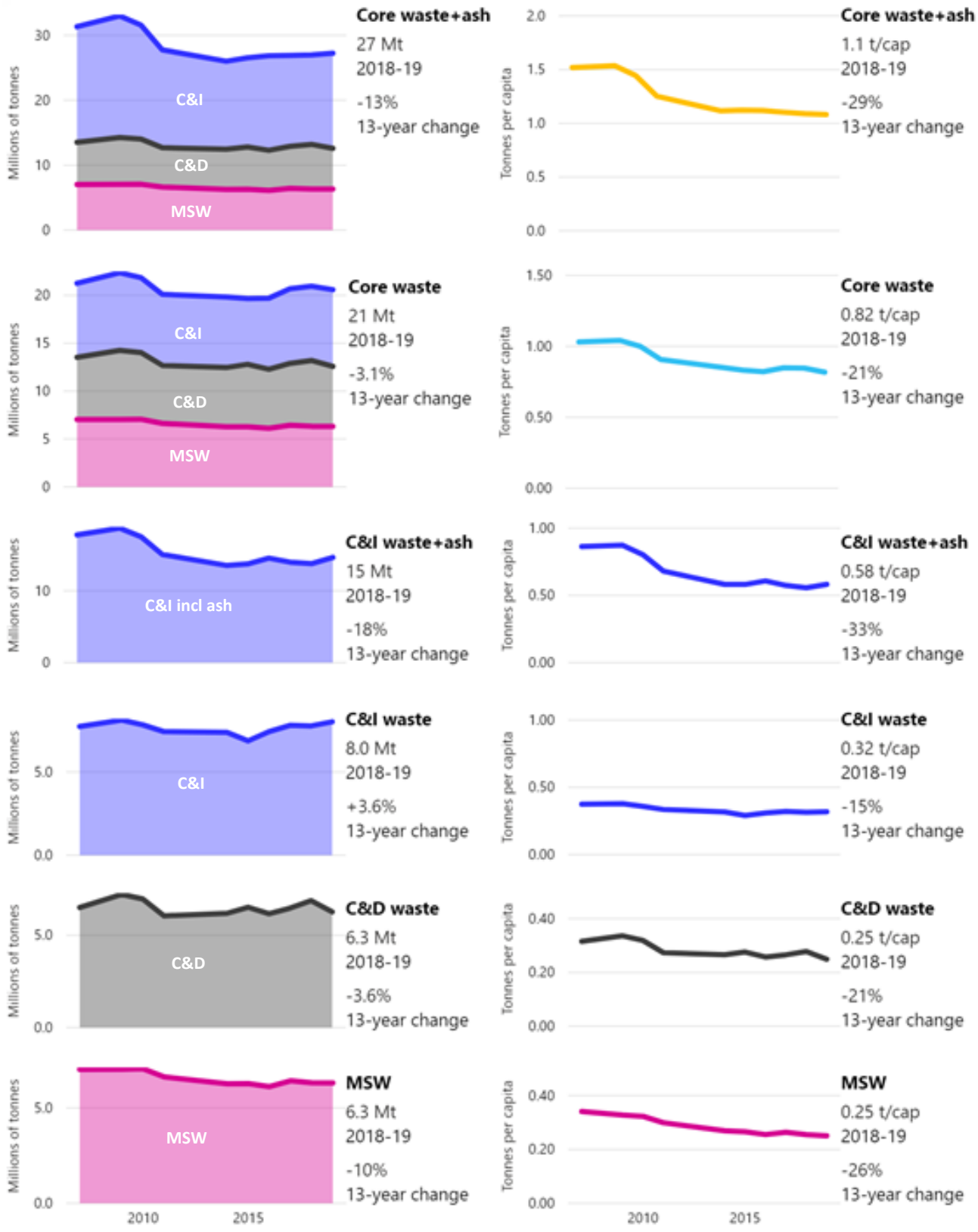
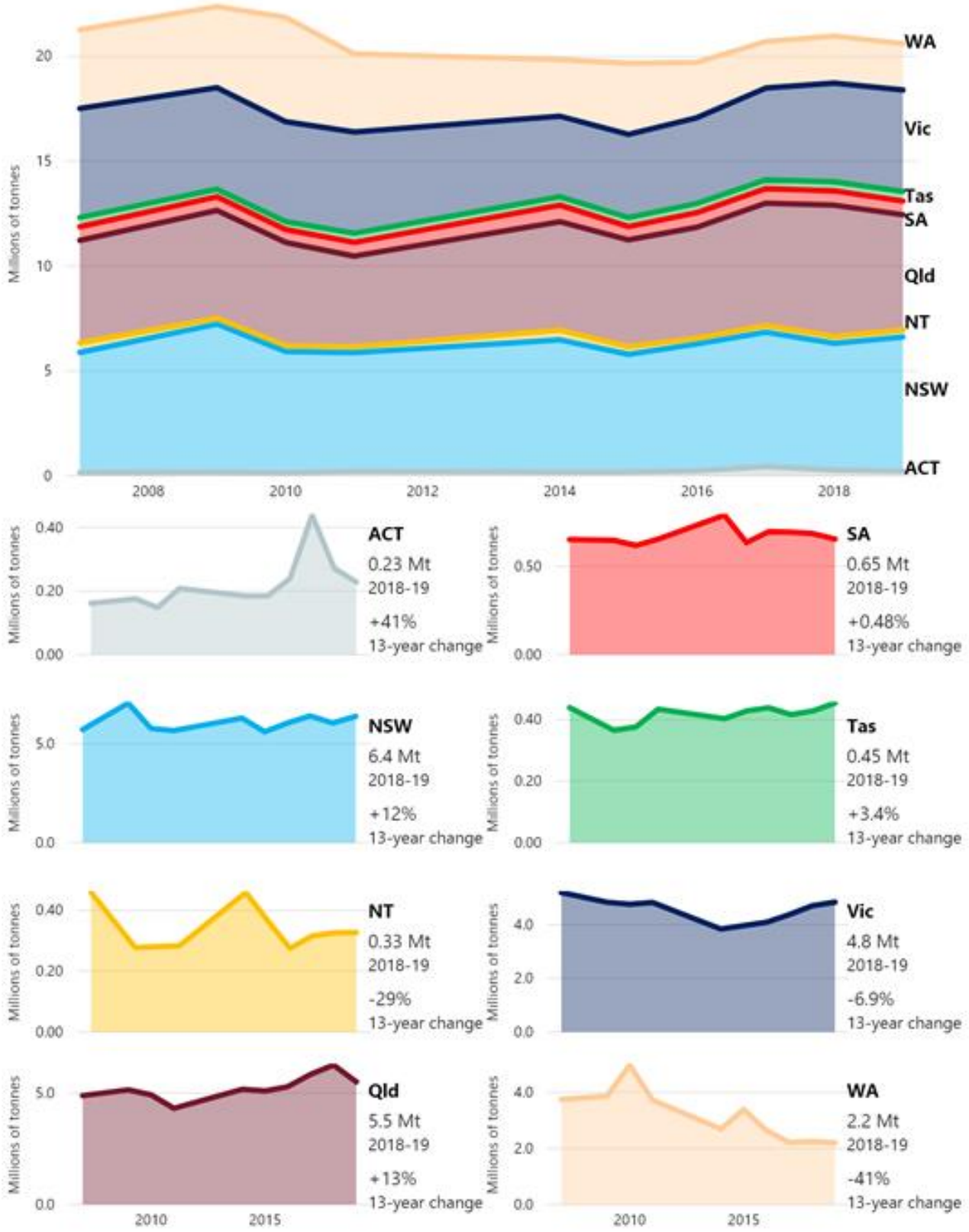


Figure 27 Trends in the disposal of core waste by jurisdiction, Australia 2006-07 to 2018-19



7. Resource recovery and recycling rates

This chapter assesses and compares resource recovery and recycling rates. It looks at these measures for the states and territories and for the three main waste streams. For clarity:

- the resource recovery rate is the proportion of generated waste that is processed for recycling or used for energy recovery
- the recycling rate is the proportion of generated waste that is processed for recycling.

For both measures, the value for generated waste includes only wastes with a known fate. The 1.23 Mt of hazardous waste sent for treatment cannot be accurately allocated to recycling, energy recovery or disposal so is excluded.

7.1 Resource recovery and recycling rates, 2018-19

The national resource recovery rate in 2018-19 was 63% and the recycling rate was 60%. These headline values are calculated including ash. In 2016-17 these rates were 61% and 58% respectively.

Figure 28 shows the estimated resource recovery and recycling rates for each state and territory, again including ash. The rankings on both measures are similar. SA was the highest ranked jurisdiction, with a resource recovery rate of 85% and a recycling rate of 80%. Following, in order of recovery rate, were ACT, NSW and Vic, WA, Qld and Tas, and NT.

Figure 28 Resource recovery and recycling rates of core waste plus ash by jurisdiction, 2018-19

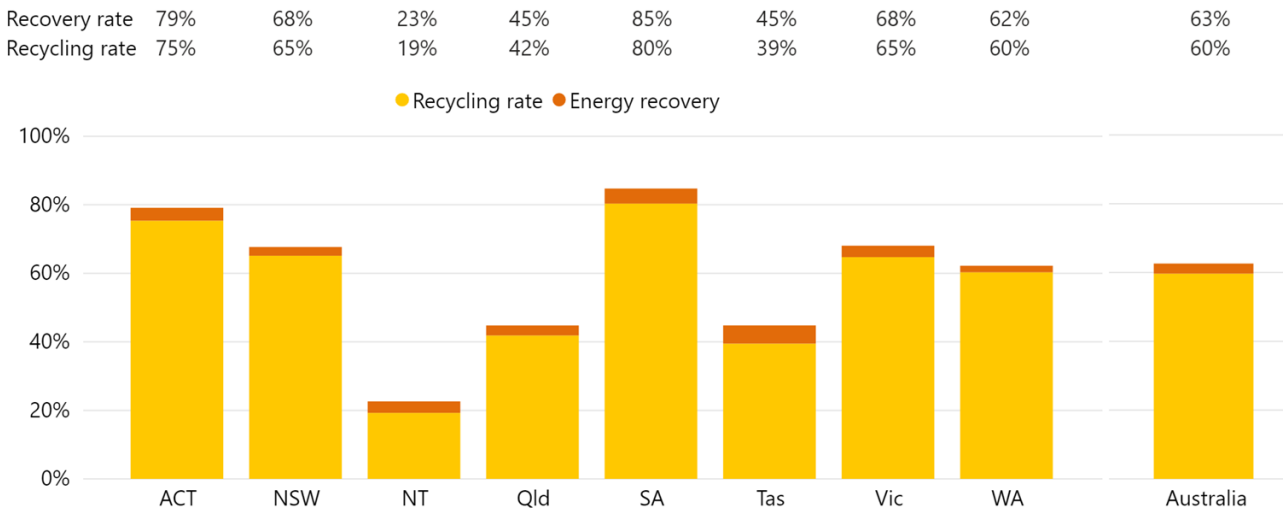
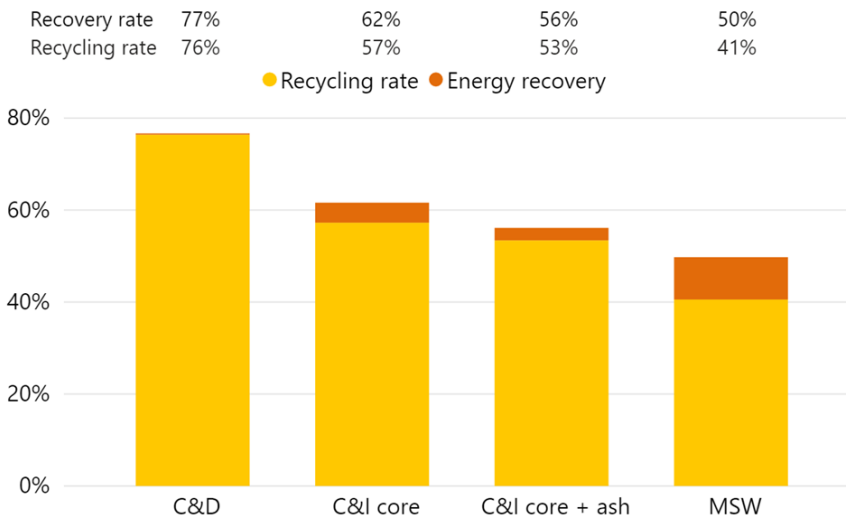


Figure 29 shows resource recovery and recycling rates by source stream in the reference year. Recovery from the C&D waste stream was highest, followed by C&I waste (shown separately with and without ash included), and lastly MSW. Slightly less than half of MSW is recycled.

Figure 29 Resource recovery and recycling rates by source stream, Australia 2018-19



7.2 Trends in resource recovery rates

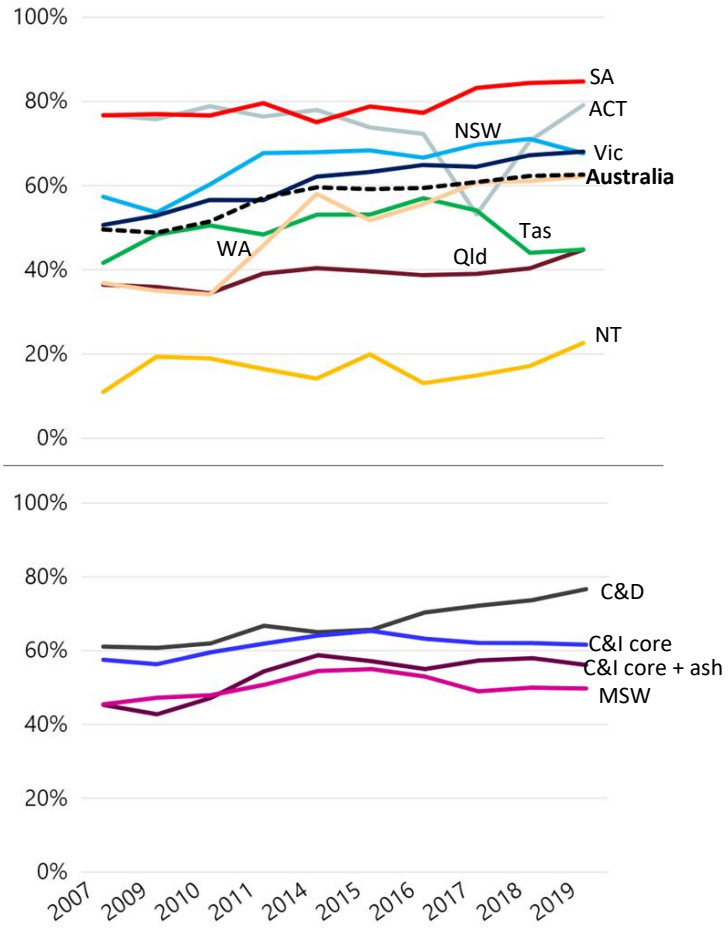
Figure 30 shows the trends in resource recovery rates by jurisdiction and by source stream over the 13 years from 2006-07 to 2018-19. The analysis includes core waste and ash.

In general, and across Australia altogether, the trend is for rising recovery rates. The exception is Tasmania, for which the recorded recovery rate has dropped substantially since 2015-16 for reasons not clear to the authors. The ACT recovery rate dipped sharply in 2016-17 because of a 1,000+ house demolition program due to asbestos-based insulation. NSW recently reformed its system for collecting and collating waste data, and believes the new data are incompatible with data prior to 2015-16.

Australia's resource recovery rate rose from about 50% in 2006-07 to 61% in 2016-17 then to 63% in 2018-19.

Examined by source (shown in the lower part of Figure 30), recovery rates for all three streams have increased, but MSW recovery rates have dropped by more than 5% since 2014-15. The reasons are discussed in Section 4.5. They appear to be a mixture of lighter weight packaging, reduced quantities of printed material, and changes to the NSW data system.

Figure 30 Resource recovery rate trends of core waste and ash by jurisdiction (top) and stream (bottom), Australia 2006-07 to 2018-19



8. Waste materials analysis

This chapter reports on the status and trends of particular waste materials, focusing mainly on core waste. It opens with an overview comparing waste generation, management, recovery rate and trends by material category. The second section introduces material flow analysis (MFA), which is applied to five of the materials addressed in this section. Following the overview and MFA introduction, the status and trends in generation and management of key waste categories are examined in turn. The discussion on the organics category is more detailed and covers a broad scope of organic materials.

8.1 Waste materials analysis overview

Figure 31 shows the generation and management methods of the core waste categories and ash generated in Australia in 2018-19. The categories arising in the largest tonnages were masonry materials, organics, ash and hazardous waste. Figure 32 shows the resource recovery and recycling rates. Metals (90%) and masonry materials (82%) were highest and second highest on both measures. The recovery rate for plastics was the lowest. At 15%, it was about half the estimated rate for hazardous wastes. The recycling rate for textiles was the lowest at an estimated 7%.

Figure 31 Generation and management method by material category, 2018-19

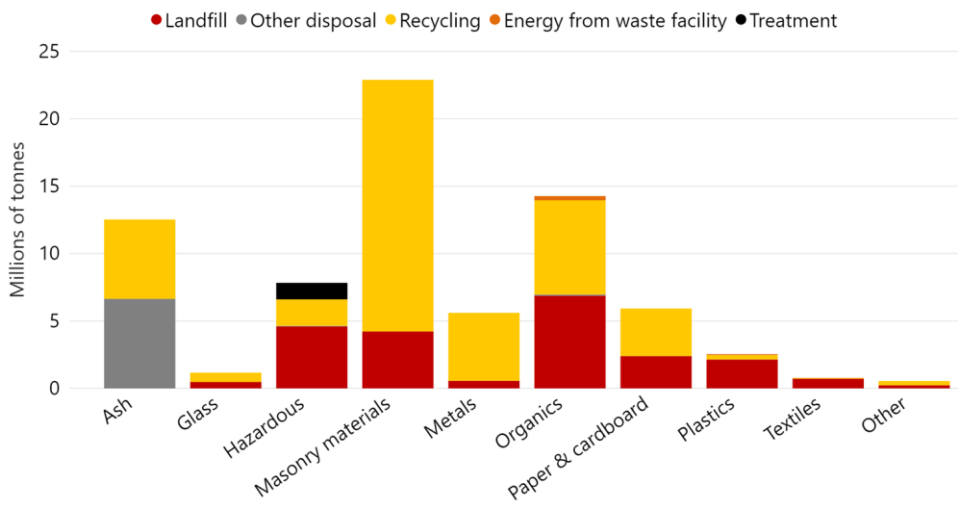


Figure 32 Resource recovery and recycling rates by material category, 2018-19

	Ash	Glass	Hazardous	Masonry materials	Metals	Organics	Paper & cardboard	Plastics	Textiles	Other
Recovery rate	47%	59%	30%	82%	90%	60%	66%	15%	22%	58%
Recycling rate	47%	59%	30%	82%	90%	49%	60%	13%	7%	58%

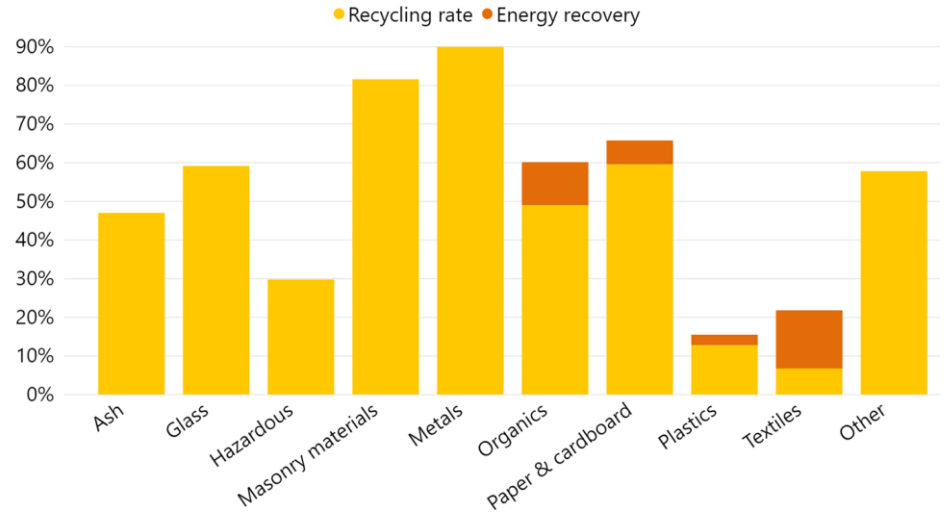
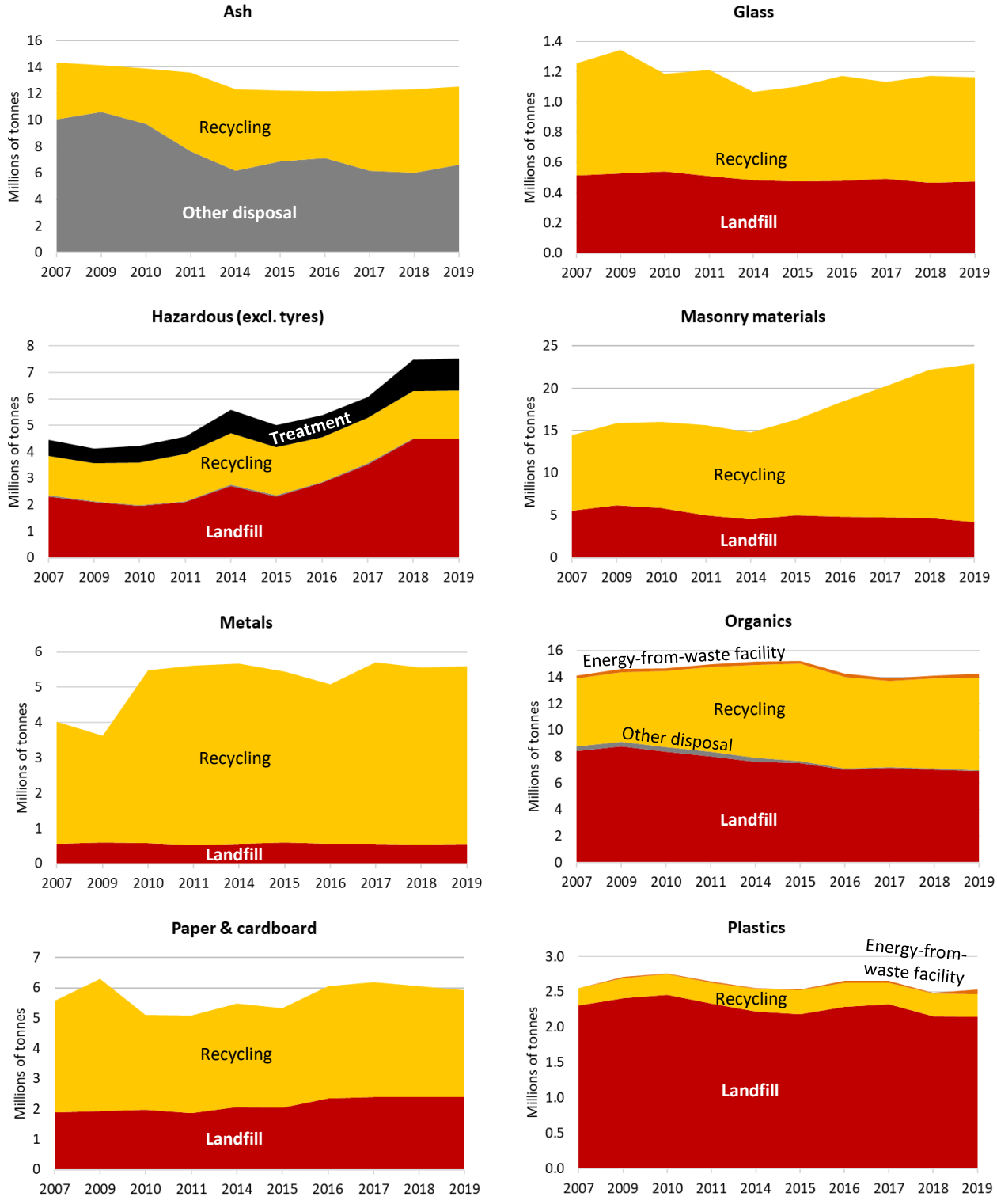


Figure 33 shows the trends in generation and management for some important material categories. These are addressed in the sections following. End-of-life tyres are generally included in the 'hazardous waste' category because of fire risk, but in this chapter they are addressed separately (Section 8.12) so are excluded from hazardous waste.

Figure 33 Trends in the generation and management methods of key material categories, Australia 2006-07 to 2018-19



8.2 Introduction to material flow analysis

This report pilots MFA for five material categories – glass, metals, paper and cardboard, plastics and tyres. The United Nations Environment Programme (UNEP 2020) defines MFA as:

> *"… a group of methods to analyse the physical flows of materials into, through and out of a given system. It can be applied at different levels of scale, i.e. products, firms, sectors, regions, and whole economies. The analysis may be targeted to individual substance or material flows, or to aggregated flows, e.g. of resource groups (fossil fuels, metals, minerals)."*

The MFAs reported here are quantitative assessments of the state and change of flows and stocks of materials within Australia in 2018-19. They follow the principle of conservation of mass, tracing material flows by balancing inputs and outputs and drawing on the following concepts of:

- a *system* of processes, flows and stocks
- *processes* that transform, transport or store materials (e.g. a processing facility transforming tyres into marketable commodities)
- *flows* between connected processes (e.g. used tyres moved from tyre retailers to a reprocessor)
- *transfer coefficients* that apportion outgoing flows from a process to downstream processes
- *stocks* resulting from a portion of the flow remaining as an 'accumulation', going back 100 years (e.g. accumulated materials in use, stockpiling of wastes or landfill).

Details of the MFA method are given in Appendix E. MFA and the scientific field developing around it support the analysis of anthropogenic (and natural) material flows through manufacturing, use, disposal and recovery. This is useful for monitoring the transition to a circular economy, addressing waste and pollution problems, and improving environmental outcomes generally.

Table 10 sets out definitions of the MFA circular economy metrics and what they measure.

Table 10 Circular economy indicators developed through material flow analyses

Metric	Definition	What it measures
Recycled content	Secondary sourced material divided by consumption	Success in using recycled material
Collection efficiency	Discarded materials collected for recovery divided by total discarded materials entering the waste system	Diversion of waste to sorting
Sorting efficiency	Materials collected for sorting divided by materials sent to reprocessing	Sorting losses
Reprocessing efficiency	Materials recovered out of reprocessing divided by materials sent to reprocessing (excluding energy recovery)	Reprocessing losses
Recycling rate	Materials recovered back to local or overseas manufacturing divided by material entering the waste system	Success in recycling waste
Landfill rate	Materials sent to landfill divided by material entering the waste system	Material losses to landfill
Local material utilisation rate	Local secondary material into local manufacturing, divided by total material entering manufacturing	Success in on-shore remanufacturing

The status and trends of the material categories that were subjected to MFA are addressed in Sections 8.4 (glass), 8.7 (metals), 8.9 (paper and cardboard), 8.10 (plastics) and 8.12 (tyres).

Note that the waste flows quantified via MFA may differ from those presented elsewhere in this report because they draw on estimates of material consumption and lifespans. The MFAs do not consider energy recovery from landfills.

8.3 Ash

Coal-based power accounted for 56% of Australia's electricity in 2018-19 (DISER 2020) and generated about 12.5 Mt of ash (12.2 Mt in 2016-17), which is just under 500 kg per capita (ADAA 2018). This is about the same as all household waste landfilled and recycled. About 90% is 'fly ash' – the lightweight particles that rise up with flue gases before being captured. The remainder is coarser 'bottom ash' that settles to the combustion chamber floor.

About 47% of the generated ash (5.9 Mt) was recycled, down from 49% in 2016-17. Its primary use is as a substitute for material in the mining and construction industries. Non-recycled material was placed in on-site 'ash dams' within the coal mine void. Australia's 47% utilisation of coal ash is lower than the global average, and much lower than Japan (97%), China (70%) or the UK (70%). Opportunities exist to recycle more ash, provided contamination issues are appropriately managed.

Figure 33 (p.34) shows the trend in ash waste generation and management method from 2006-07 to 2018-19[23]. Ash generation fell 13% over the period, from 14.4 to 12.5 Mt, reflecting the decline in coal-fired power generation in Australia. Blue Environment projections suggest it will fall to about 10 Mt in 2030 and 4.4 Mt in 2040.

Coal ash contains trace heavy metals that, without proper management, can leach, overflow or spill from ash dams into surrounding environments. Reports suggest this may have occurred at Lake Macquarie in NSW, leading to elevated levels of toxic metals (Millington 2019). About 360 Mt of ash has been deposited into ash dams in Australia since around 1975.

Ash is produced by a host of other industrial operations but on a smaller scale. As energy-from-waste facilities become operational, there will be a need to recycle or dispose of their ash waste.

8.4 Glass

In 2018-19 about 1.16 Mt or 46 kg per capita of glass waste was generated, up from 1.13 Mt in 2016-17. The 2018-19 recycling rate was 59%, up from 57% in 2016-17. Figure 33 (p.34) shows the trend in generation and management method of glass from 2006-07 to 2018-19. Glass packaging has lost market share to plastic, resulting in declining quantities until about half-way through the data series. In recent years, quantities have increased slightly but at a lower rate than population growth.

Recycling rates have remained consistent and reasonably high given the relatively low commodity value of glass per tonne compared to plastic or cardboard, and the difficulty of recovery from mixed waste loads. Waste sorting tends to break glass into small pieces that contaminate paper and cardboard recycling and are not easily recoverable. Larger recycling facilities have technologies to deal with these small fractions.

Container deposit systems are generating cleaner, better sorted and higher value glass 'cullet'[24], which may be displacing markets for mixed glass from domestic recycling. However, the new owner of Australia's major glass manufacturer, Visy, has promised to greatly increase the recycled content of its

[23] Data estimated from calendar year reports.

[24] Recycled broken or waste glass used in glass-making.

product. There is also potential to expand the processing of lower grade glass into sand for use in civil construction projects.

Waste glass will be affected by the waste export bans (see Section 16.2) but the market impact is likely to be small as very little glass cullet is exported.

Glass material flow analysis

A pilot MFA was prepared to quantify the system processes and flows for glass. The results are illustrated in Figure 34.

Australian glass consumption in 2018-19 was estimated at 1.21 Mt, of which over 90% was used for packaging. The estimated recycled content of consumed glass was 27%, nearly all in packaging.

Stocks of glass in use were estimated at 2.87 Mt, of which two-thirds have accumulated in the built environment, vehicles and other longer-lived products.

Table 11 Circular economy indicators for glass, Australia 2018-19

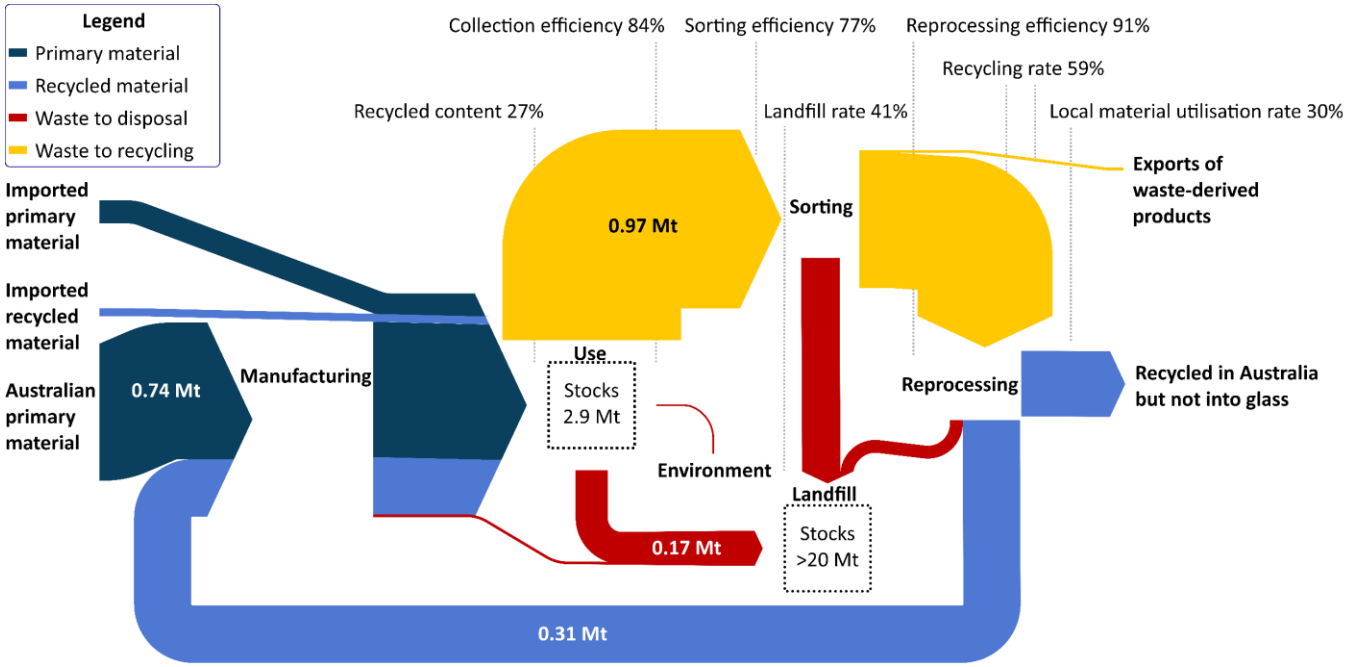
Indicator	Value
Recycled content	27%
Collection efficiency	84%
Sorting efficiency	77%
Reprocessing efficiency	90%
Recycling rate	59%
Landfill rate	41%
Local material utilisation	30%

The collection efficiency (diversion to sorting from landfill) is high at 84%, reflecting extensive collections systems for packaging glass. However, system losses during sorting and reprocessing are also high, totalling over 30% of collected glass in aggregate, and diversion of non-packaging glass from landfill is minimal.

Of the 59% of glass recycled, half was into products other than glass such as construction aggregates and sands.

An estimated 41% of glass leaving use was disposed to landfill. Accumulated stocks of waste glass in landfill are at least 20 Mt nationally.

Figure 34 Glass flows in Australia, 2018-19



8.5 Hazardous waste (excl. tyres)[25]

In 2018-19 Australia generated 7.54 Mt of hazardous waste excluding tyres, or 300 kg per capita, of which 24% was recycled, 59% landfilled and 16% sent to a treatment facility[26]. This is a big increase from 2016-17, when only 6.08 Mt were generated. The bulk of this category comprised contaminated soils and asbestos. Treatment options are available to remove the hazards from some contaminated soils, enabling reuse or recycling (see Photo 7).

Figure 33 (p.34) shows the trend in the generation and management of hazardous waste excluding tyres from 2006-07 to 2018-19. Quantities grew by 66% over the time series, mostly due to very high rates of increase in the last few years. The growth from 2014-15 to 2018-19 was mainly due to unprecedented levels of urban development causing increases in generation of about:

- 200% in contaminated soils in NSW, Qld and Vic, which rose to 2.38 Mt
- 430% in asbestos (including soil contaminated with asbestos) in NSW, which rose to 1.32 Mt.

Hazardous waste generation and management is examined in detail in the Department's *Hazardous Waste in Australia* report series, the next version of which will be produced in 2021.

Photo 7 The RePurpose It plant in Epping, Melbourne, which washes and recycles contaminated soils from development sites

Photo kindly provided by RePurpose It

8.6 Masonry materials

In 2018-19 about 22.9 Mt, or 909 kg per capita, of waste masonry materials were generated. This is a big increase from 20.2 Mt in 2016-17. The masonry materials category includes heavy waste types such as concrete, bricks and rubble and is mostly recorded in the C&D stream. Masonry materials are recovered from most large demolition projects but less so from smaller projects, which often generate mixed material loads that are sent directly to landfill.

Figure 33 (p.34) shows the trend in masonry waste generation and management methods from 2006-07 to 2018-19. Waste generation grew by about 58%, with three-quarters of this growth occurring since 2014-15. This is associated with very high rates of urban development, mainly in NSW and Vic.

The 2018-19 recycling rate for masonry materials was 82% (18.7 Mt), rising from 62% in 2006-07 and 76% in 2016-17. There are good markets for recycled concrete aggregate for use as road base,

[25] Throughout most of this report, tyres are included under hazardous waste. They are considered separately here because they are subject to the waste export bans. Including tyres, in 2018-19, 7.83 Mt of hazardous waste was generated and 30% recycled.

[26] Hazardous waste treatment facilities are complex and variable. Significant proportions of treated material are discharged to sewer or sent to landfill, but the overall fate proportions are not readily calculable.

aggregates and hardstand areas. Recycled concrete aggregate 'packs down' well and forms a harder and more stable hardstand than pure virgin aggregate. There are also good options for recycling bricks and asphalt. Asbestos contamination risks are generally well-recognised and managed.

8.7 Metals

In 2018-19 about 5.60 Mt, or 223 kg per capita, of metal waste was generated (down from 5.71 Mt in 2016-17). The recycling rate of 90% was higher than any other material category. Metal recycling is well-established in every state and territory but the industry has suffered from falling global prices in recent years. The scrap metals industry depends on export markets – domestic reprocessing of aluminium and tin-plated steel is no longer occurring. Some toxic (e.g. cadmium and cobalt) or precious (e.g. gold and palladium) metals are landfilled in composite material products such as electronic waste.

Figure 33 (p.34) shows the trend in metals waste generation and management method from 2006-07 to 2018-19. Waste generation increased by about 39% and the recycling rate increased slightly from 86% to 90% (3.46 Mt to 5.04 Mt).

Metals material flow analysis

A pilot MFA was prepared to quantify the system processes and flows for metals. The results are illustrated in Figure 35.

Australia consumed about 8.09 Mt of metals in 2018-19, of which 86% was steel, 8% aluminium, and 6% all other metals. The estimated recycled content of metals into use was 37%.

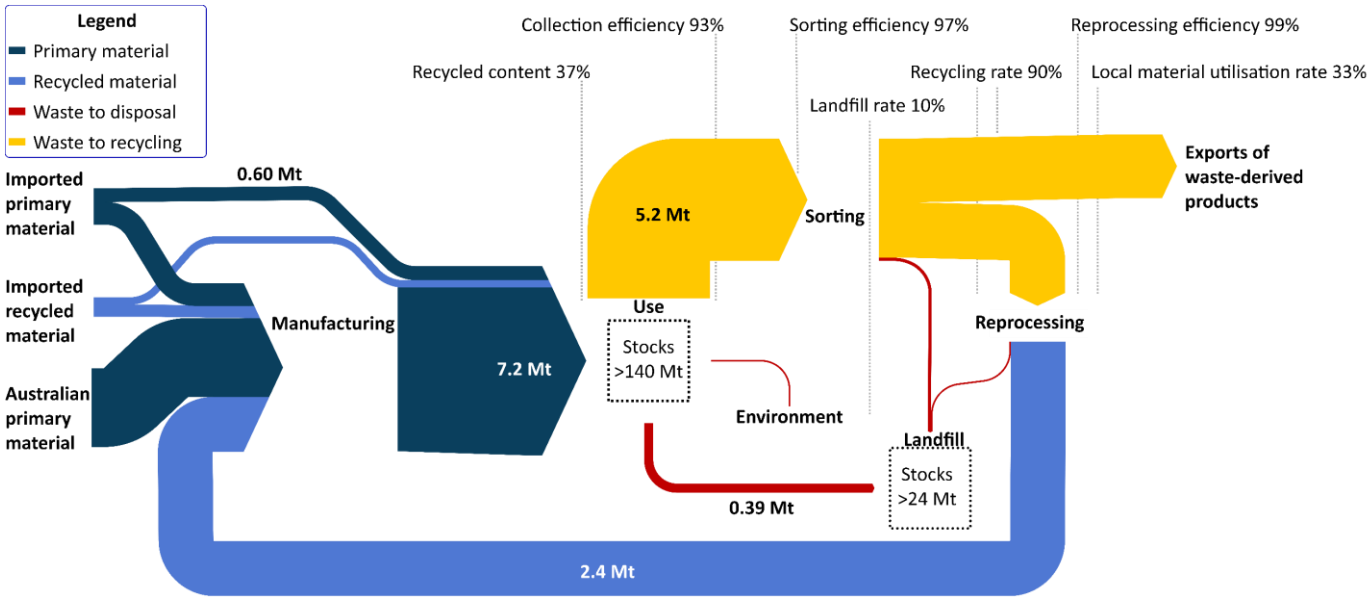
Stocks of metals in use were estimated at 143 Mt, of which 78% has accumulated in the built environment, 18% in transport, and the rest in other long-lived products.

Table 12 Circular economy indicators for metals, Australia 2018-19

Indicator	Value
Recycled content	37%
Collection efficiency	93%
Sorting efficiency	97%
Reprocessing efficiency	99%
Recycling rate	90%
Landfill rate	10%
Local material utilisation	33%

The collection efficiency (diversion to sorting from landfill) is high at 93%, reflecting extensive collection systems for steel, aluminium and copper. More than half this material is exported. System losses during sorting and reprocessing were low, at around 3% of collected metals in aggregate.

Figure 35 Metal flows in Australia, 2018-19



Of the 90% of metals recycled, all of it was sent back to smelters and so re-enters the pool of metals in use. No significant diversion of metals into non-metal products was identified.

About 10% of metals entering the waste stream were disposed to landfill. Accumulated stocks of waste metals in landfill are at least 24 Mt nationally.

8.8 Organics

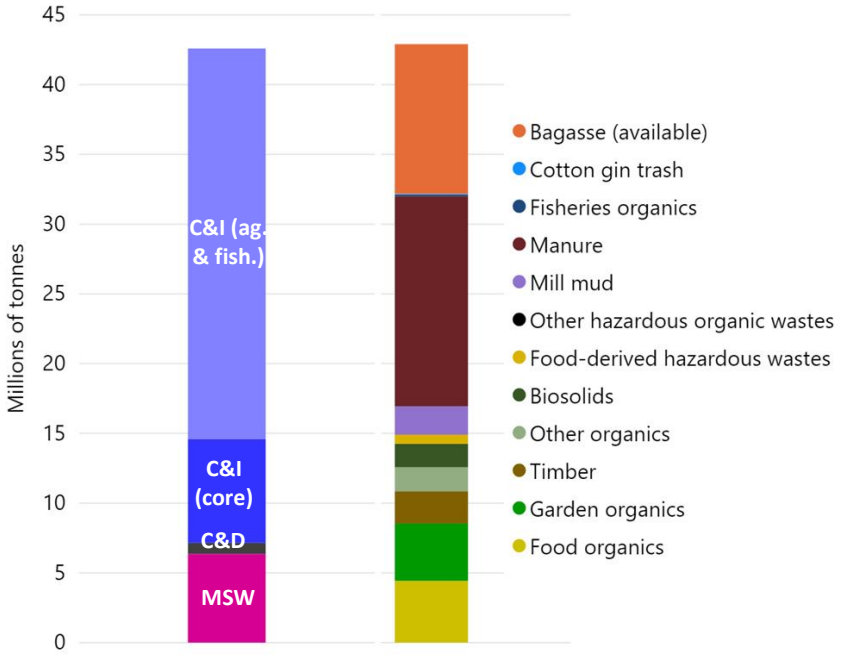
The trend in generation of organic waste (primarily food, garden organics, timber and biosolids) is shown in Figure 33 (p.34) from 2006-07 to 2018-19. Generation remained fairly stable over the 13-year period while Australia's population increased. Generation was 14.3 Mt in 2018-19. Overall, the data records a reduction per capita of about 17% over the 13-year time period. The reduction from 2014-15 is associated with the NSW data improvements discussed in Section 4.5.

The recycling rate for these materials increased from 37% to 49% (5.15 to 6.99 Mt). In 2018-19 about 6.87 Mt of organics were deposited in landfill[27]. Overall recovery in 2018-19 totalled 8.58 Mt (60%) comprising about 5.60 Mt of composting or mulching, 1.42 Mt of biosolids applied to land, 0.31 Mt incorporated into fuels or processed through anaerobic digestion and 1.28 Mt recovered through landfill gas energy generation.

Figure 36 shows the generation of organic wastes, this time extending the scope of the materials covered to include:

1. 0.67 Mt of organic wastes reported within the hazardous waste material category – mostly grease trap sludge and waste from abattoirs and tanneries, nearly all of which was composted
2. 28.0 Mt of non-core organic wastes from the agriculture and fisheries sectors, including manure, available sugarcane bagasse[28], mill mud (the residues of sugarcane juice clarification and filtering), cotton gin trash and fisheries waste.

Figure 36 Generation of organic waste by type and stream, Australia 2018-19



Organic materials from the MSW, C&I (core) and C&D sectors made up about 14.9 Mt (or 593 kg per capita) and non-core organics from agriculture and fisheries[29] made up the remainder of generation.

[27] Some of the deposited organics are allocated to the fate 'energy recovery' due to collection and use of landfill gas. After this allocation, the quantity of organics disposed of in landfill was 5.6 Mt.

[28] Includes only that portion of bagasse in excess of the amount estimated as required to power an efficiently operating sugar mill, based on calculations by the Queensland Government (2018a).

[29] The quantity of agricultural waste is much larger than was reported in the *National Waste Report 2018* due to changes in scope and improved data collection.

In total, 42.9 Mt of organic waste was generated, the most significant tonnages being livestock manure (35%), available bagasse (25%), food organics (10%), garden organics (10%), timber (5%), mill mud (5%), biosolids (4%), food-derived hazardous waste (2%), and other organics (4%).

Almost all organics can be recycled by composting, which generates products that improve soil productivity and health. In the past, urban landscaping absorbed most compost products but agriculture and horticulture are increasingly important outlets as awareness of the agronomic value of compost increases. Logistical costs are a barrier to expanding agricultural markets and they can be more price-sensitive than urban landscaping markets.

Significant opportunities remain to improve the recovery of organics. Reducing and managing contamination – chemical, plastic and glass – is the key issue for enabling higher rates of organics composting. Some organics, such as food waste, are suited to anaerobic digestion processes, which generate electricity and produce a useful 'digestate' product similar to compost.

Photo 8 Peats Soils and Garden Supplies compost operation in Brinkley, SA

Windrows of composting material can be seen in the foreground. They will be turned several times during the composting process. For correct pasteurisation, the temperature of the piles must maintain a temperature of 55°C for at least three days, based on Australian Standard AS4454-2012. Compost operations that lack the Brinkley site's large separation distances to neighbours are now often in enclosed buildings and may have shorter processing and maturation periods.

Photo kindly provided by Peats Soils and Garden Supplies

Food waste

In the following discussion, food waste refers to:

1. food waste from households and businesses that is typically discarded in general putrescible garbage or recovered, mainly for composting or bioenergy facilities
2. food-derived waste in the core 'hazardous waste' category – that is, grease trap sludge and wastes from abattoirs and tanneries.

Food waste generated on-farm and in many food processing operations is not included in this report. Data on this waste is not readily available.

Photo 9 Discarded watermelons left to rot – the data presented in this report excludes this kind of on-farm food waste

Photo by Neenawat Khenyothaa via Shutterstock.com

Figure 37 shows the generation and management methods of food waste. The column on the right shows all recorded food waste data as defined above. The column on the left excludes food-derived hazardous waste. In 2018-19, about 5.09 Mt of food waste was generated, of which 1.10 Mt, or 22%, was processed through composting or anaerobic digestion. About 4.43 Mt (87% of the total food organics) was classified as non-hazardous. Of this, about 3.76 Mt (85%) was deposited in landfill[30], 14% was composted and 2% processed by anaerobic digestion. Of the estimated 0.66 Mt of food-derived hazardous organics, three-quarters were recorded as recycled (composted) and it is likely that most of the 24% recorded as 'treated' were also composted.

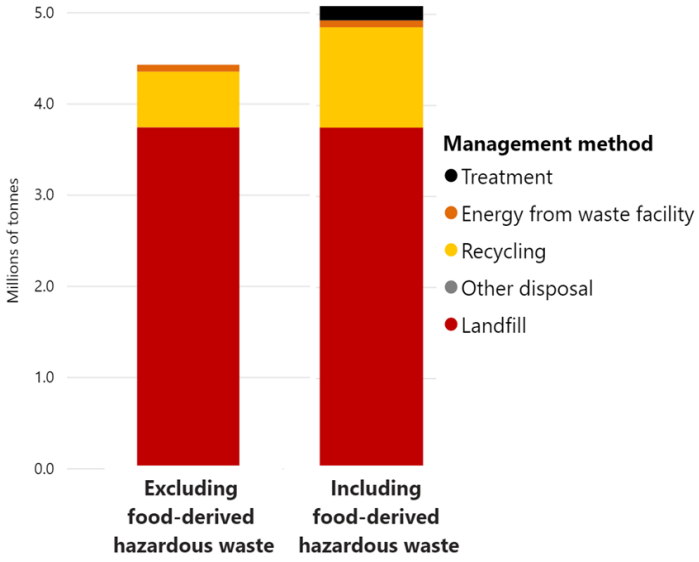
The main sources of reported non-hazardous food waste were:

- households – an estimated 3.11 Mt (71%)
- commercial and industrial sources – the remaining 1.32 Mt (29%).

The National Food Waste Strategy aims to halve food waste by 2030 (Australian Government 2017). Table 13 presents data on food waste generated, landfilled and disposed of since the strategy was established. It covers the broad scope of food waste presented to the right of Figure 37.

While it is early in the strategy implementation process, a continuation of the measured trends would not meet the target as applied to the three measures. These results should be taken as indicators only, as the data on food waste to landfill and food waste disposed of are estimates only.

Figure 37 Generation of food waste by management method, Australia 2018-19



[30] This is prior to allocation of some food waste to the fate 'energy recovery' through use of landfill gas.

Table 13 Progress in implementing the National Food Waste Strategy – estimated tonnes of food waste, Australia 2016-17 to 2018-19 (data in Mt)

	2016-17	2017-18	2018-19	Progress
Food waste generated	5.39	5.20	5.09	- 6%
Food waste to landfill	4.06	3.87	3.76	- 7%
Food waste disposed of [31]	2.95	2.77	2.78	- 6%

An increasing number of local governments are providing food organics recovery services to residents and some businesses (see Section 12.1). Commercial food organics recovery services are also available to food manufacturers, food retailers and hospitality and food preparation premises in many jurisdictions. Expanded food organics and garden organics (FOGO) collection services in NSW, Tas, Vic and WA, as well as a commitment by the SA Government to promote greater food organics recovery from residents that already have access to FOGO services, should increase food recovery over the next five years.

8.9 Paper and cardboard

About 5.92 Mt of scrap paper and cardboard was generated in 2018-19 (6.19 Mt in 2016-17), or 235 kg per capita. About 60% was recycled and nearly all the remainder was sent to landfill.

Figure 33 (p.34) shows the trend in generation and management method of paper and cardboard. Generation increased by about 6% between 2006-07 and 2018-19, which equates to a per capita decline of about 13%. This fall is linked to the digitisation of information – Australian consumption of newsprint fell by an average of 8.7% per year between 2017 and 2019 (IndustryEdge 2020).

The recycling rate fell from 66% (3.68 Mt) in 2006-07, to 61% (3.79 Mt) in 2016-17, then to 60% (3.53 Mt) in 2018-19. The market for scrap paper and cardboard products has been strongly impacted by the Asian restrictions on waste imports (see Section 4.4) and will be affected by the waste export bans (see Section 16.2). Australia faces a major challenge finding productive uses for waste paper and cardboard in a saturated domestic market.

Paper and cardboard material flow analysis

A pilot MFA quantified the system processes and flows for paper and cardboard. The results are shown in Table 14 and Figure 38.

Australian paper and cardboard consumption in 2018-19 was estimated at 5.91 Mt of which about 3.86 Mt was into packaging applications and the remainder into office paper, newsprint, tissue and other applications.

The recycled content of paper and cardboard into use was estimated at 52%. Cardboard, in particular, has high recycled content in both imported and local product.

Table 14 Circular economy indicators for paper & cardboard, Australia 2018-19

Indicator	Value
Recycled content	52%
Collection efficiency	64%
Sorting efficiency	94%
Reprocessing efficiency	95%
Recycling rate	59%[32]
Landfill rate	41%
Local material utilisation	51%

Stocks of paper and cardboard in use were estimated at 5.95 Mt. There is some accumulation of paper in longer lived products (e.g. published materials), but most products have lifespans of less than one year.

[31] Differs from food waste to landfill by subtracting 1.1 Mt of food waste that generated landfill gas used for its energy value.

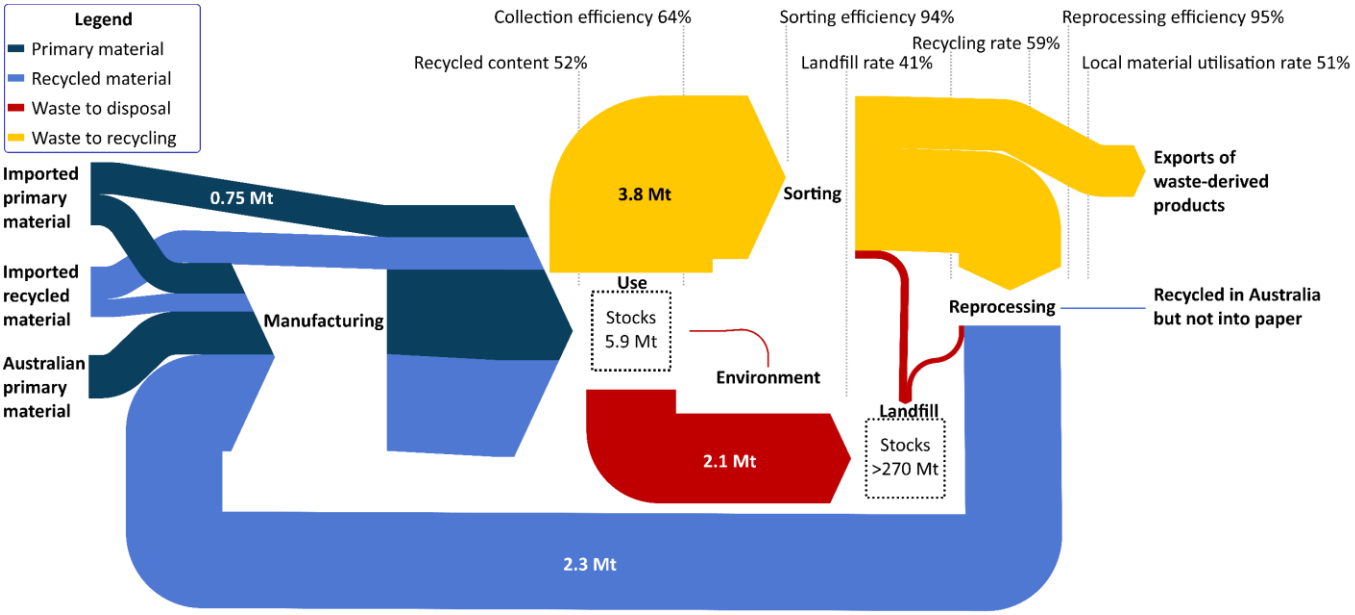
[32] This is slightly different from the estimate given above because the MFA uses a different method.

The collection efficiency (diversion to sorting from landfill) was high at 64%, underpinned by strong collection systems for C&I cardboard. System losses at sorting and reprocessing were about 11%.

Of the 59% recycled, less than 1% went into non-paper products such as pet litter.

About 41% of paper and cardboard leaving use was deposited in landfill, and there have now been at least 270 Mt of paper and cardboard landfilled nationally. Tissues to sewer are modelled to be incorporated into biosolids.

Figure 38 Paper and cardboard flows in Australia, 2018-19



8.10 Plastics

About 2.54 Mt or 101 kg per capita of plastic waste was generated in 2018-19, down from 2.66 Mt in 2016-17. A little less than 13% (in 2016-17 it was 12%) was recycled and a little less than 3% used for its energy value, mostly in solid recovered fuels for energy recovery. The remainder was deposited in landfill.

Figure 33 (p.34) shows the trend in generation and management method of plastics from 2006-07 to 2018-19. Generation was stable over the period which, with a growing population, equates to a per capita decrease of 17%. Light-weighting is the likely cause. The plastics recycling rate increased marginally. Diversion into fuels is a fairly new and growing market. Exports of waste plastics to Asian markets, either in products or as a contaminant of mixed paper and cardboard, led to some poor environmental outcomes such as being used as cheap fuel or unmanaged material release into the environment. This is coming to an end due to import restrictions from Asian countries and Australia's waste export bans (see Section 16.2). Australia faces a significant challenge finding uses for the displaced materials, and achieving the National Packaging Targets (see Feature 4 on page 87).

Plastics material flow analysis

A pilot MFA quantified the system processes and flows for plastics. The results are shown in Table 15 and Figure 39.

Australian plastics consumption in 2018-19 was estimated at 3.36 Mt. The recycled content of consumed plastics is estimated at 4%. There are low levels of recycled content in both imported and locally manufactured plastic products.

Stocks of plastics in use were estimated at 29.1 Mt. There is significant accumulation of plastics in the built environment and many longer-lived consumer products. However, about a third of plastics go into applications with lifespans of less than one year (e.g. packaging).

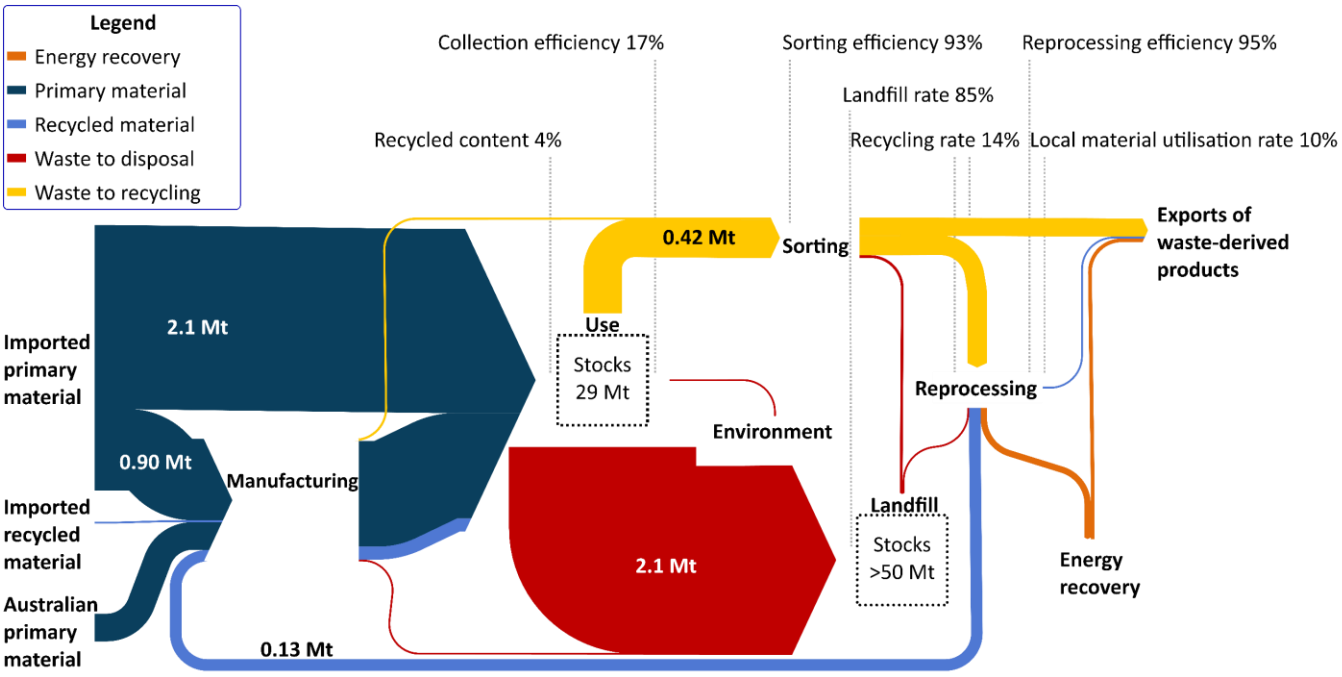
The collection efficiency (diversion to sorting from landfill) is low at 17%, and mostly from plastic packaging collections. Sorting and reprocessing losses were about 12% of collected plastics in aggregate.

Table 15 Circular economy indicators for plastics, Australia 2018-19

Indicator	Value
Recycled content	4%
Collection efficiency	17%
Sorting efficiency	93%
Reprocessing efficiency	95%
Recycling rate	14%[33]
Landfill rate	85%
Local material utilisation	9%

About 85% of discarded plastics were sent to landfills, which now contain at least 50 Mt of plastics.

Figure 39 Plastics flows in Australia, 2018-19



8.11 Textiles

'Textiles' is used here as shorthand for textiles, leather and rubber (excluding tyres), and would include discarded clothing, carpets, furniture coverings, rags, bags, tarpaulins and similar. The data on these materials is likely to be deficient due to the diffuse ways they are recycled and reused.

In 2018-19 an estimated 780 kt, or 31 kg per capita, of textile waste were generated, up from about 779 kt in 2016-17. The recycling rate is estimated at only 7%, most of which is exports. The recovery rate is a much higher 22% because of collection and use of landfill gas generated from decaying textile wastes. Trends are not included here as the historical data is not considered sufficiently reliable.

[33] This is slightly different from the estimate given above because the MFA uses a different method.

8.12 Tyres

In 2018-19 about 449 kt, or 18 kg per capita, of end-of-life tyres were generated, up from 412 kt in 2016-17. The resource recovery rate was about 70%, split evenly between recycling and energy recovery. Nearly all of the energy recovery was in export markets and was of two types: solid recovered fuels (see Section 5.1) sold to cement kilns and whole tyres used in usually low-technology pyrolysis[34] machines, largely in India. Most whole end-of-life tyres will be subject to the waste export bans (see Section 16.2). Trends in tyre flows are not included here as the historical data is not considered sufficiently reliable[35].

Tyres material flow analysis

A pilot MFA quantified the system processes and flows for tyres. The results are shown in Table 16 and Figure 40.

Australian consumption of tyres in 2018-19 was about 542 kt. The recycled content of tyres into use was about 5%, based entirely on truck re-treads entering the market – for technical, logistical and liability reasons, negligible recycled material is used in new tyres. Tyres have not been manufactured at scale in Australia since 2010.

Stocks of tyres in use were a relatively low 642 kt, reflecting a short average lifespan of tyres of two to three years.

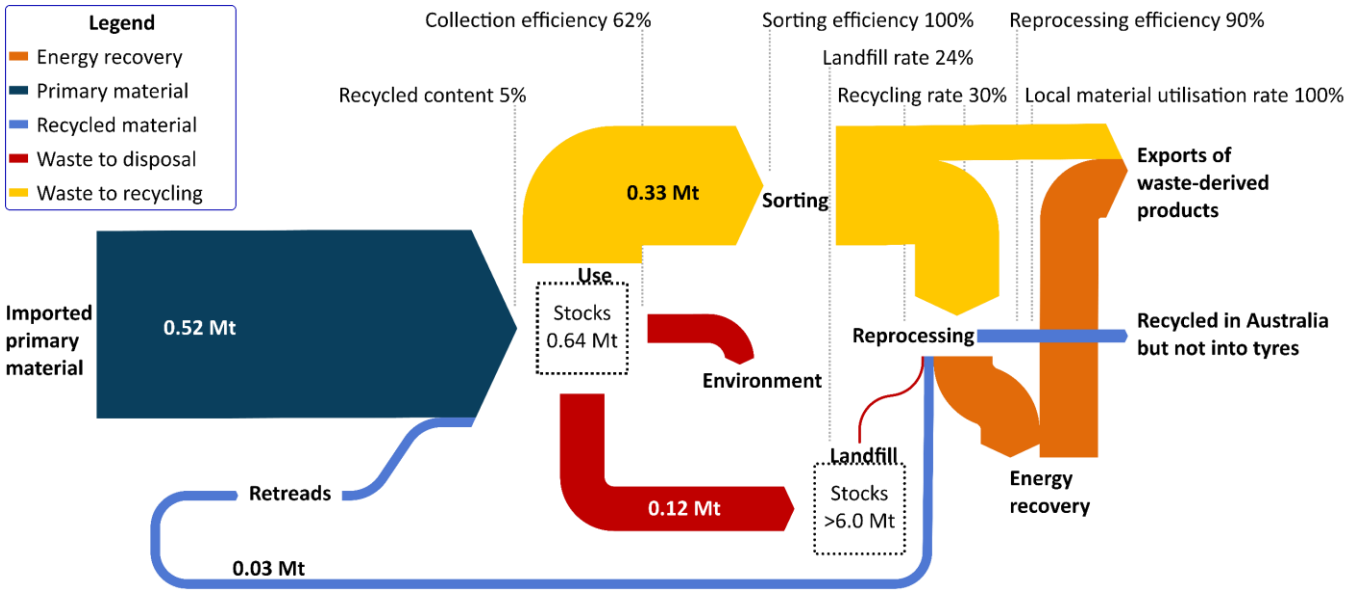
Table 16 Circular economy indicators for tyres, Australia 2018-19

Indicator	Value
Recycled content	5%
Collection efficiency	62%
Sorting efficiency	100%
Reprocessing efficiency	90%
Recycling rate	30%
Landfill rate	24%
Local material utilisation	100%

About 80 kt of tyre wear dust was left on our roads. Much of this would be washed into the ocean.

The collection efficiency (diversion to sorting from landfill) was a reasonably high 62%. Sorting and reprocessing losses were about 10%. In 2018-19 about 24% of the mass of end-of-life tyres was buried, mostly at mine sites and other remote locations. At least 10 Mt of tyres have now been buried or landfilled nationally.

Figure 40 Tyre flows in Australia, 2018-19



[34] A technology in which materials are heated in the absence of oxygen, generating a gaseous, liquid or solid fuel.

[35] Data on waste tyres has previously been reported within hazardous waste, as they are a fire hazard and listed as a 'controlled waste' in the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure*.

9. Waste economics

9.1 The ABS waste account 2018-19

The Australian and state and territory governments agreed in 2018 to implement environmental economic accounting. As part of this program, the ABS (2020a) developed the Waste Account 2018-19, drawing on the data presented in this report and other sources. Following the structure set in the United Nations System of Environmental-Economic Accounting, it presents data on:

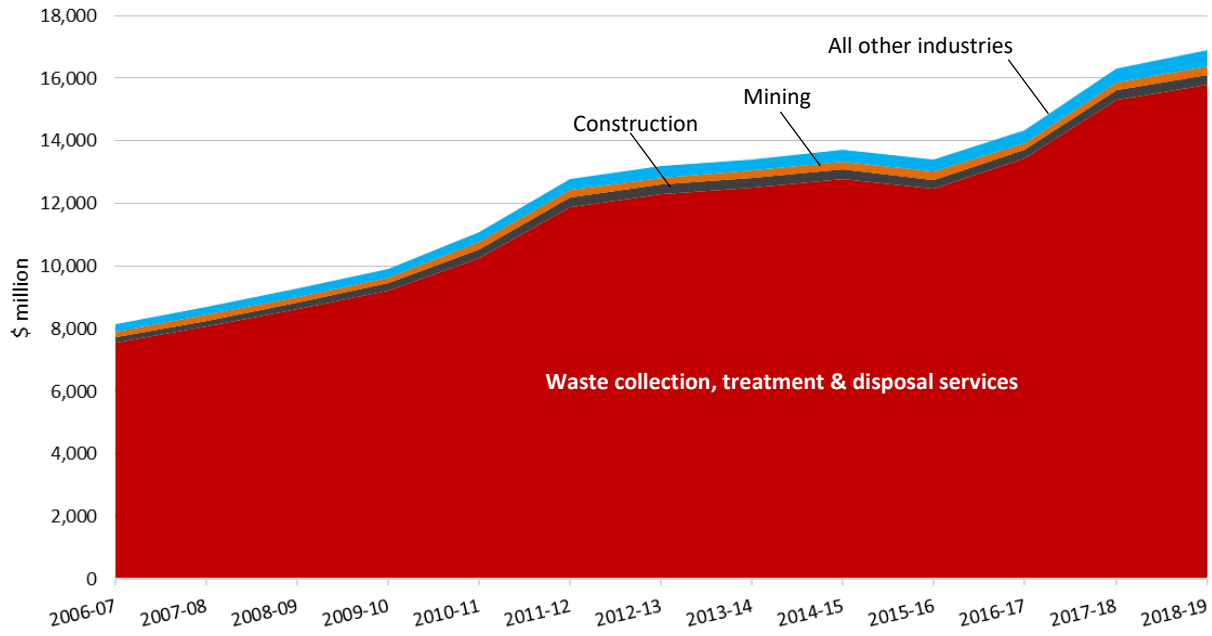
- the generation ('supply') and management ('use') of all waste materials and of electronic waste (e-waste) materials, by industry division, in 2018-19 (tonnes)
- the supply and use of waste services from 2002-03 to 2018-19 (dollars)
- a summary of waste generation, value added and waste intensity[36] by industry division, 2018-19
- waste sector employment, wages, gross operating surplus and value added, 2007-08 to 2018-19.

Information on generation and management of waste materials is covered in this report in detail. The Waste Account's information on the waste sector is reported in Chapter 13. The following section presents Waste Account data on the supply and use of waste services, and waste intensity.

9.2 Supply of waste services

The supply of waste services, as presented in the Waste Account 2018-19, is illustrated in Figure 41. The chart indicates that waste management in 2018-19 was a $17.0 billion task, and 93% of this was undertaken by the waste collection, treatment and disposal services sector.

Figure 41 Trends in the supply of waste services at basic prices, 2006-07 to 2018-19 ($ millions)



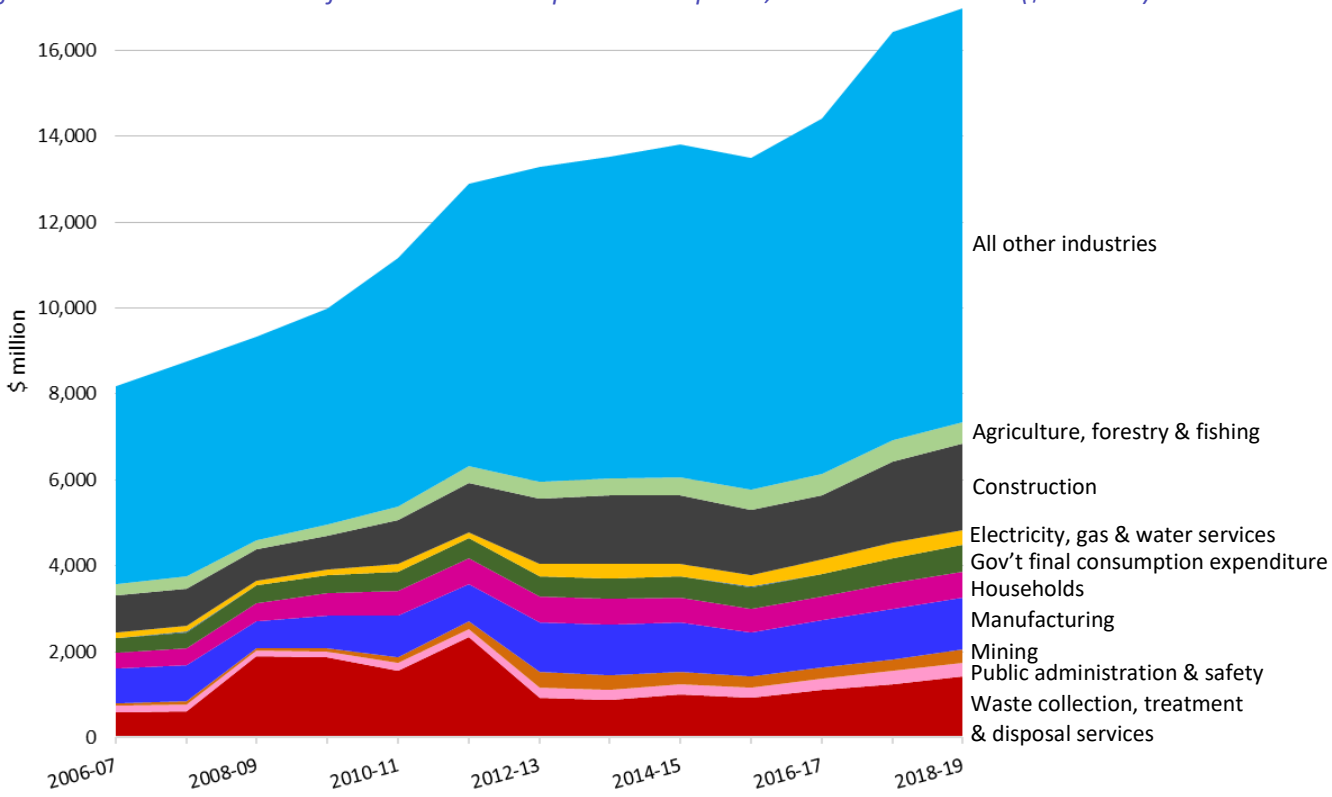
Source: ABS (2020a)

[36] The tonnes of waste generated per million dollars of value added.

9.3 Use of waste services

The use of waste services, as presented in the Waste Account 2018-19, is illustrated in Figure 42. The chart shows that waste generation, and the associated demand for waste services, is widely spread across industry sectors. The small size of expenditure allocated to households reflects the relative efficiency of the communal system of municipal collections through local governments, and also possibly some cross-subsidisation of the financial costs of municipal waste services within the ABS data set.

Figure 42 Trends in the use of waste services at purchasers' prices, 2006-07 to 2018-19 ($ millions)



Source: ABS (2020a)

9.4 Waste intensity

The estimated waste intensity of different industry divisions is shown in Table 17. The waste intensity of the electricity, gas, water and waste services division is the highest. This includes the waste sector itself, which produces much waste as treatment by-products. Second is the construction industry, which produces large quantities of demolition waste and contaminated soils. Manufacturing is third most significant. The 'all other industries' has a low intensity even though Figure 42 shows it is the largest user of waste services. This is explained by the large value added by this group of industry divisions.

Table 17 Waste intensity by industry division, Australia 2018-19

Industry division	Waste intensity (t/$m)	Industry division	Waste intensity (t/$m)
Agriculture, forestry and fishing	23	Mining	11
Construction	87	Public administration & safety	6
Electricity, gas, water & waste services	253	All other industries	16
Manufacturing	116		

10. International comparisons

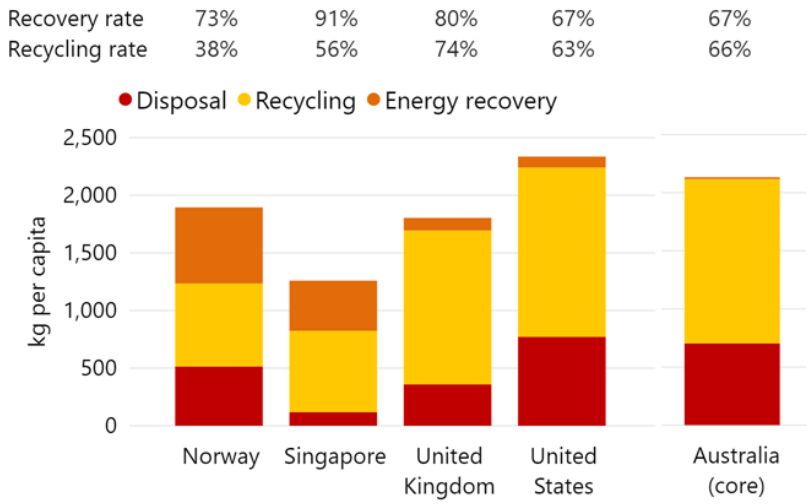
This chapter compares Australia's rates of waste generation, recycling and fate with various countries. It does this firstly for most core waste, and secondly for MSW only. The countries used in the comparison were selected based on the availability of recent data that was readily comparable with Australia.

10.1 Overall waste generation and fate

Figure 43 compares Australia's rates of waste generation, disposal, recycling and resource recovery with selected other countries. To ensure a consistent comparison, the Australian data excludes hazardous waste, ash and energy recovery from landfill gas.

Table 18 describes the wastes included in each of the totals shown. Consistency has been sought across these definitions but there is no international standard on how to report data, and some differences remain.

Figure 43 Comparison of annual waste generation and fate per capita, Australia and selected countries (excluding hazardous waste, ash and landfill gas energy recovery)



Figures are indicative only. Data is compiled for different years (2016 to 2019) and sources due to limitations on data availability. Data sources:

1 This project
2 2018 data from Statistics Norway (2020)
3 2019 data from National Environment Agency, Singapore (2020)
4 2016 data from Department for Environment Food & Rural Affairs (2020) official statistics tables
5 Based on 2017 data from US EPA (2020).

Table 18 Descriptions of the waste sources included in the data compared in Figure 43

Country	Description of waste sources included
Australia	Total solid waste includes MSW, C&I and C&D waste. Excludes ash from coal fired power generation, hazardous waste and energy recovery from landfill gas recovery (not applied by other countries).
Norway	Includes non-hazardous waste from construction, households, manufacturing, service industries and other or unspecified sources. Includes wet organic waste, park and gardening waste, wood waste, paper and cardboard, glass, e-waste, concrete and bricks, cinders, dust, ash, plastics, rubber, textiles, discarded vehicles, mixed waste and other. Excludes polluted soil, sludges, hazardous waste or radioactive waste.
Singapore	Total solid waste includes C&D waste, ferrous metal, paper and cardboard, plastics, food, wood, horticultural waste, textile and leather, non-ferrous metal, glass, scrap tyres. It excludes slag, and ashes and sludge.
United Kingdom (UK)	Includes non-hazardous waste from MSW, C&I and C&D sources. Includes metallic waste, glass, paper & cardboard, rubber, plastics, wood, textiles, discarded equipment (e-waste), discarded vehicles, batteries & accumulators, animal & mixed food waste, vegetal waste, animal faeces, urine & manure, household & similar wastes, mixed & undifferentiated materials, sorting residues and C&D mineral waste. Excludes acid, alkaline or saline waste, chemical waste, combustion waste, common sludges, dredging spoils, health care & biological waste, industrial effluent sludges, mineral waste from waste treatment, stabilised waste, other mineral waste, sludges & liquid waste from waste treatment, soils, spent solvents, used oils, waste containing polychlorinated biphenyls.
United States (US)	Includes household, commercial, business and institutional and C&D waste.

Singapore had the lowest per capita waste generation rate at 1.26 t. The UK and Norway had similar generation of 1.80 and 1.90 t, respectively. Australia was second highest at 2.13 t per capita, while the US had the most at 2.34 t per capita.

Disposal rates varied widely. Singapore disposed 119 kg per capita, reflecting the lack of landfill space available in this region. The UK and Norway fell in the middle of the range with 360 and 514 kg per capita, respectively. Australia was next highest at 704 kg per capita, and the US was highest with 771 kg per capita.

Energy recovery rates were correspondingly highly variable. Norway and Singapore recovered energy from 660 and 435 kg of waste per capita respectively, due to high levels of thermal energy-from-waste. The US and the UK were similar, treating 95 and 110 kg per capita of waste through energy recovery, respectively. Australia was much lower, recovering energy from just 15 kg of waste per capita. There are currently no large-scale energy-from-waste facilities dedicated to core wastes in Australia, but some are under development or planned (see Section 5.1).

Recycling across the selected countries ranged from around 706 kg per capita in Singapore and Norway, to 1,470 kg per capita in the US. The UK had the highest recycling rate of the five countries at 74% followed by Australia at 66%. The next highest was the US at 63% and Singapore at 56%. The National Environment Agency Singapore (2020) noted that its recycling industry relied heavily on exports, and has been strongly affected by the waste import bans recently implemented in several South-East Asian nations. Norway had the lowest recycling rate of 38%, linked to its high rates of energy recovery.

Recovery rates (recycling and energy recovery combined) were by far the highest in Singapore at 91%. The UK and Norway followed at 80% and 73% respectively. Australia and the US both had recovery rates

of 67%, remembering that this presentation excludes hazardous waste, ash and energy recovery from landfill gas.

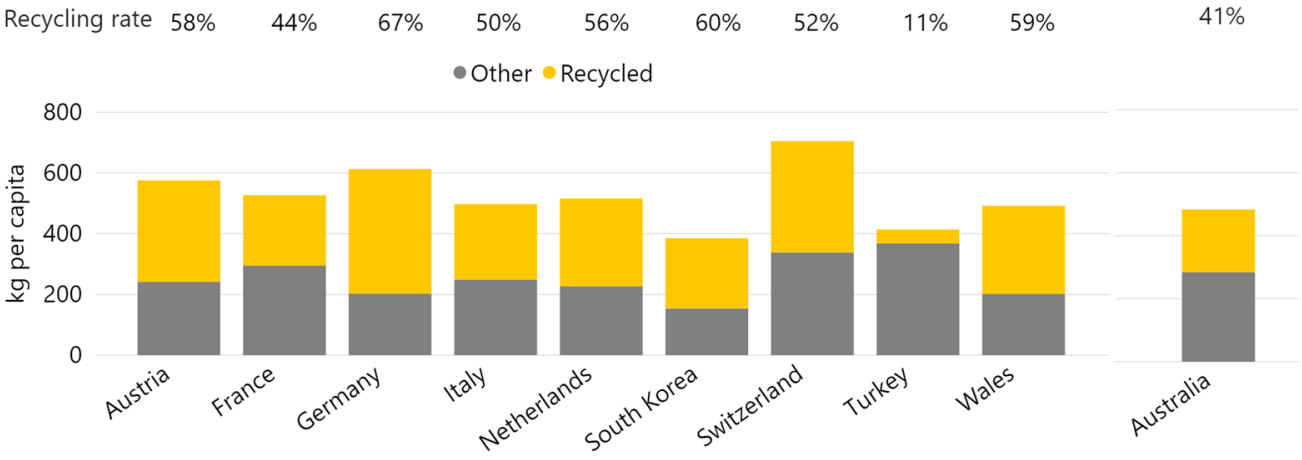
10.2 Municipal waste generation and fate

This section compares 2018-19 MSW generation and fate in Australia with selected countries. The data presented for most jurisdictions is sourced from Organisation for Economic Co-operation and Development data (OECD 2020). It defines the recycling rate as the percentage of materials recycled, composted and digested divided by the MSW generated.

Australia's 2018-19 MSW data, as reported elsewhere in this document, was adjusted to be as consistent as possible with the OECD data. This included removing all masonry materials from the MSW stream.

Figure 44 compares the adjusted per capita MSW generation in Australia with other nations as published in OECD (2020).

Figure 44 Comparison of MSW generation and recycling rates in selected countries



The average MSW waste generation across the reported countries was 521 kg per capita. Australia's adjusted MSW waste generation was about 483 kg per capita or 7% lower than the average.

The average MSW recycling rate was 51%. Australia's adjusted MSW recycling rate was about 41%. The highest recycling rates were mainly from European nations especially Germany (67%), Wales (59%), Austria (58%) and the Netherlands 56%. South Korea also reported a high recycling rate of 60%. The lowest recycling rate was from Turkey, indicating a lack of waste infrastructure available in that country.

Australia's MSW generation and recycling rates are not far from the average of the countries compared.

11. The role of the states and territories

State and territory governments have primary responsibility for managing waste through legislation, policy, regulation, strategy and planning, as well as permitting and licensing waste transport, storage, treatment and disposal operations. The policy frameworks in each state and territory differ but there are common themes and some coordination, including through the Australian Government. Common themes include ensuring waste is safely managed and that the waste hierarchy (see Figure 19 on p.20) is implemented. There is an increasing focus on promoting a 'circular economy' (see Section 16.7).

Table 19 summarises selected elements of jurisdictional policy frameworks, considering:

- Landfill levies – most jurisdictions require landfills to pay some amount to their state government for each tonne of waste deposited in landfill. The additional fee pushes up the cost of landfill, increasing the attractiveness of recycling. Often some of the collected funds are used to fund recycling infrastructure, programs or governance organisations. The table specifies levy rates operational at the time of writing.
- Strategy – most states and territories have a strategy that guides government organisations and industries in improving waste management over the strategy period. In many cases, strategies set targets for resource recovery or other waste performance indicators. Table 19 specifies the strategy document and any targets within it.
- The status in each state and territory of various important or topical waste-related programs –
  - does the jurisdiction require a deposit to be paid on drink containers to discourage littering?
  - has the jurisdiction implemented bans on disposing of any wastes in landfill (apart from liquid and hazardous waste)?
  - has the jurisdiction implemented a ban on any single-use plastics?
  - does the jurisdiction operate an intra-jurisdictional tracking system requiring producers, transporters and receivers of hazardous waste to inform the environmental regulator of each movement of hazardous waste?
  - does the jurisdiction provide a system for householders to dispose of waste chemicals locally?

State and territory perspectives

States and territories were invited to contribute their perspectives on:

- data trends and their drivers
- major wins or initiatives (especially unique initiatives that other jurisdictions may seek to follow)
- policy developments
- current challenges and opportunities and significant events.

Their responses are given after Table 19.

Table 19 Summary of state and territory waste policy settings

	Landfill levy (2019-20)	Strategy document (including targets)	Other policy settings		
ACT	MSW $98.45/t C&I $170.55/t Mixed C&I with >50% recyclable material $232.70/t (The dollar figures are prices rather than levy amounts, as ACT owns the landfill & sets fees)	*ACT Waste Management Strategy: Towards a sustainable Canberra 2011-2025*. Waste generation grows less than population. Expand reuse of goods. Waste sector is carbon neutral by 2020. Double energy generated from waste & recover waste resources for carbon sequestration. Recovery rate increases to over: • 85% by 2020 • 90% by 2025.	Container deposit scheme	✔	Introduced Jun 2018
			Landfill bans	✔	TVs & computers
			Single-use plastics ban	✔	Bags ban since 2011; cutlery, stirrers & polystyrene containers ban proposed
			Internal hazwaste tracking	✘	
			Household chemical collections	✔	Free drop-off at two facilities
NSW	Metro area: • Waste $143.60/t • Virgin excavated natural material $129.20/t • Shredder floc $71.80/t Regional area: • Waste $81.30/t • Virgin excavated natural material $73.17/t • Shredder floc $41.35/t Coal washery rejects $15.00/t	*NSW Waste Avoidance and Resource Recovery Strategy 2014-21*. By 2021–22: • reduce waste generation per capita • increase recycling rates for: – MSW from 52% (in 2010-11) to 70% – C&I waste from 57% to 70% – C&D waste from 75% to 80% • increase landfill waste diversion from 63% (in 2010-11) to 75% • establish or upgrade 86 drop-off facilities or services for household problem wastes • continue to reduce litter items. NSW Circular Economy Policy Statement: *Too Good To Waste* outlines steps to incorporate circular economy principles into its 20-year waste strategy.	Container deposit scheme	✔	Introduced Dec 2017
			Landfill bans	✘	
			Single-use plastics ban	✘	Bans on bags & others proposed
			Internal hazwaste tracking	✔	
			Household chemical collections	✔	CleanOut events and Community Recycling Centres

	Landfill levy (2019-20)	Strategy document (including targets)	Other		
NT	No landfill levy	*Waste Management Strategy for the Northern Territory 2015-2022* No specific targets are included in the strategy.	Container deposit scheme	✓	Introduced Jan 2012
			Landfill bans	✗	
			Single-use plastics ban	✓	Bags ban since 2011
			Internal hazwaste tracking	✗	
			Household chemical collections	✗	
Qld	General waste: MSW, C&I, C&D $75/t Regulated waste: • Category 1 $155/t • Category 2 $105/t	*Waste Management and Resource Recovery Strategy 2019* By 2025: • reduce MSW per capita by 10% • increase state average MSW recycling rate to 55% (from 32% in 2018) • increase C&I recycling rate to 65% (from 47%) • increase C&D recycling rate to 75% (from 51%) • reduce waste to landfill by 10% Targets are also set for 2030, 2040 & 2050.	Container deposit scheme	✓	Introduced 1 Nov 2018
			Landfill bans	✗	
			Single-use plastics ban	✓	Bags ban since 2018; straws, stirrers, plates & cutlery from July 2021
			Internal hazwaste tracking	✓	
			Household chemical collections	✓	Drop-off availability subject to arrangements by individual councils
SA	Metro Adelaide: • Solid waste $110 - $140/t • Shredder floc $62/t Non-metro Adelaide: • Solid waste $55/t • Shredder floc $31/t	*South Australia's Waste Strategy 2015-2020* By 2020: • 35% reduction in landfill disposal from 2002-03 level • 5% reduction in waste generation per capita (from 2015 baseline) • landfill diversion targets in the metro area are: – 70% for MSW – 80% for C&I – 90% for C&D maximise diversion in non-metro area.	Container deposit scheme	✓	Introduced 1977
			Landfill bans	✓	Ban on some hazardous, problematic and recyclable materials, including most e-waste
			Single-use plastics ban	✓	Bags ban since 2009; straws, cutlery, stirrers & EPS containers proposed
			Internal hazwaste tracking	✓	
			Household chemical collections	✓	Statewide household chemical drop-off

	Landfill levy (2019-20)	Strategy document (including targets)	Other		
Tas	Voluntary levy adopted by regional waste groups at levels of $0 to $7.50/t	*Draft Waste Action Plan (2019)* (subject to change before finalisation) • introduce a waste levy by 2021 • introduce CDS by the end of 2022 • have the lowest littering incident rate in Australia by 2023 By 2025: • 100% of packaging is reusable, recyclable or compostable • 5% reduction in waste generation per person • 40% average recovery rate for all waste • 25% reduction in volume of organics waste sent to landfill By 2030: • 10% reduction in waste generation per person • 80% average recovery rate for all waste • 50% reduction in volume of organics waste sent to landfill • phase out unnecessary plastics.	Container deposit scheme	✗	Proposed from 2022
			Landfill bans	✗	-
			Single-use plastics ban	✓	Bags ban since 2013
			Internal hazwaste tracking	✗	Framework in place but not operational
			Household chemical collections	✓	Selected regional programs

	Landfill levy (2019-20)	Strategy document (including targets)	Other		
Vic	Metro & regional: • MSW $65.90/t • C&I and C&D $65.90/t Rural: • MSW $33.03/t • C&I and C&D $57.76/t Prescribed industrial (hazardous) waste: • Category B $250/t • Category C $70/t • Asbestos $30/t	*Recycling Victoria: A new economy (2020)* • 100% of households to have access to separate glass services by 2027 • introduce CDS by 2023 By 2025: • 72% waste diversion from landfill • 50% reduction in volume of organics waste sent to landfill By 2030: • 15% reduction in waste generation per capita • 80% waste diversion from landfill • 50% reduction in volume of organics waste sent to landfill • 100% of households have access to food and garden organics services or local composting.	Container deposit scheme	✗	Proposed from 2023
			Landfill bans	✓	'Category A' hazardous waste, paint, industrial transformers, grease trap waste, oil filters, whole tyres, large containers, e-waste ban
			Single-use plastics ban	✓	Bags ban since 2019
			Internal hazwaste tracking	✓	
			Household chemical collections	✓	Statewide program
WA	Putrescible $70/t Inert $105/m^3 $70/t approx.	*Waste Avoidance and Resource Recovery Strategy 2030* From 2020, recover energy only from residual waste By 2025: • 10% reduction in waste generation per capita • increase material recovery to 70% By 2030: • less than 15% of waste generated in metro regions is landfilled • all waste is managed &/or disposed to better practice facilities • 20% reduction in waste generation per capita • increase material recovery to 75%.	Container deposit scheme	✓	To be introduced Oct 2020
			Landfill bans	✗	
			Single-use plastics ban	✓	Bags ban since 2018
			Internal hazwaste tracking	✓	
			Household chemical collections	✓	Eight metropolitan and five regional, permanent household chemical drop-off points

11.1 ACT perspective

The ACT Government is committed to ensuring that Canberra becomes a fully sustainable city and region and that future development is environmentally sensitive, both to maintain and protect natural assets and to respond to the challenges of climate change. The Territory's resource recovery rate has plateaued at just over 70%[37] in the past few years. The ACT Waste Feasibility Study completed in 2018 identified pathways to achieve the goals outlined in the ACT Waste Management Strategy 2011-2025, including the targets of seeing 90% of waste diverted from landfill by 2025 and a carbon-neutral waste sector by 2020.

The Roadmap implementation approach was highlighted around four key themes:

- promoting waste avoidance through education
- diverting organics from landfill
- industry development and support
- waste-to-energy.

Key waste management initiatives delivered in 2019-20 in the ACT are outlined below.

- Preparation work has been completed in 2019-20 to ensure the delivery of the free kerbside Bulk Waste Collection service for Gungahlin and Tuggeranong residents commencing 1 July 2020. There will be a two-pass system to separate the collection of reusable items and recyclables such as metals and e-waste including an education campaign to support households to use the service correctly.
- Approximately 65,000[37] tonnes of organics from households, businesses and public organisations go to landfill each year in the ACT, predominantly in the form of food organics. Initial scoping work has commenced on the food waste avoidance campaign pilot with the opportunity to implement a kerbside FOGO collection service and co-designing a collection system for businesses to encourage organic source separation.
- Planning for future waste infrastructure in line with the ACT Waste Feasibility Study. Investigations into upgrading the ACT Hume MRF has been conducted including potentials for an increase in recyclable products/new and emerging technologies and consideration of market pressures.
- Operations commenced at the new landfill site Mugga 2 Quarry in June 2020. Mugga 2 Quarry replaces the West Belconnen Resource Management Centre and has an estimated volume of 2,800,000 m^3 with an approximate life of 20-30 years of filling operations.
- The ACT Government is also committed towards improving data governance, collection and analysis relating to waste management. 2019-20 saw significant developments in a new Waste Services Management System and Waste Regulation Management System. The introduction of these new systems will significantly improve the quality of data captured in relation to waste services, waste facilities and waste transporters.

The ACT is committed to the *National Waste Policy* and *National Waste Policy Action Plan*. In August 2019, the former Council of Australian Governments announced its decision to ban the export of waste plastic, paper, glass and tyres, while building domestic capacity to produce high

[37] Data given here may not be consistent with the data presented in other parts of the report due to difference in measurement method and scope.

value recycled commodities and associated demand. The ACT currently have a number of projects that use recycled content including:

- the use of recycled glass fines from the ACT Hume MRF is currently being trialled by Icon Water as a pipe bedding alternative to virgin river sand
- the use of recycled glass in a display village
- trialling the use of recycled content for road asphalt.

The ACT continued to support and deliver a number of priorities in 2019-20 including:

- improving the redemption rate of the ACT Container Deposit Scheme through targeted initiatives
- continued contribution to the *National Waste Policy* agenda through the Meetings of Environment Ministers and participation in related interjurisdictional working groups
- involvement with the Australian Packaging Covenant Organisation towards achieving the National Packaging Targets
- development of waste-to-energy and single-use plastics policies
- continued work on a more regionally harmonised levy design and its implementation.

11.2 New South Wales perspective

Strategic planning for a circular economy

The NSW Government is developing a 20-Year Waste Strategy that is focused on delivering a sustainable, reliable and affordable waste system. The Strategy, informed by the NSW Circular Economy Policy Statement released in 2019, will create a vision and roadmap for reducing waste, driving sustainable recycling markets and improving the waste infrastructure network across the State. The NSW Government is developing a comprehensive NSW Plastics Plan alongside the 20-Year Waste Strategy. The Plan will build on existing government and industry initiatives and identify ways to reduce single-use plastic and support the recovery of plastic in a circular economy.

Reliable measurement of progress

NSW has significantly improved the way waste generation and recycling performance is measured after mandating data collection under legislation and implementing quality controls that are supported by a robust regulatory framework. The data provides NSW with a reliable foundation to guide future policy and program decisions to meet the significant challenges facing the sector today. This will be the first time this data is featured in the National Waste Report. Historically NSW had relied on voluntary data to measure recycling performance which provided poor quality estimates. Due to the differences in the two methodologies, NSW does not compare the new, more reliable measures with data prior to 2015-16.

NSW Waste Less, Recycle More investment for the future

NSW's $802.7 million Waste Less, Recycle More initiative has supported investment in infrastructure, education, innovation and regulation to increase recycling and reduce litter and illegal dumping.

Following the announcement of the ban of the export of waste plastics, paper, glass and tyres in 2019, the NSW Government invested almost $23 million in new and upgraded infrastructure that will

reprocess materials impacted by the ban. This investment from the NSW Government will catalyse 14 projects worth around $100 million.

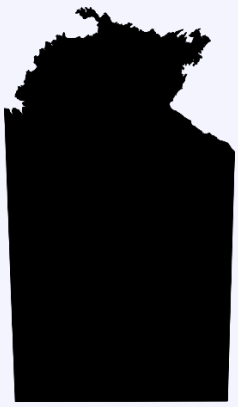
Funded through 'Waste Less, Recycle More', organics infrastructure grants will increase processing capacity by 430,000 tonnes per year. Food donation funding has increased the capacity of the sector to collect an additional 8,500 tonnes of surplus food for redistribution each year, the equivalent of 17 million meals. Support for kerbside collections has resulted in 50 councils delivering, or planning to deliver, FOGO services. Seventy per cent of households now have access to organics collections[38] and food-only trials are underway in multi-unit dwellings in three Sydney council areas.

The NSW Litter Prevention Strategy has included the successful Tosser campaign, over $9 million in funding for council and community projects and the Report to EPA program which has over 50,000 registered community litter reporters. It has also seen the introduction of Return and Earn (the NSW Container Deposit Scheme) in 2017, a phenomenal success which has fundamentally changed people's behaviour and thinking around litter. The scheme has a rolling redemption rate of 65%[38] and has reduced container litter by an average of 40%.

A statewide network of 110 community recycling centres has been established in partnership with local councils for free drop-off of problem wastes such as paints, gas bottles, batteries, oils and chemicals. In 2018-19, in combination with the Household Chemical CleanOut service, the network removed more than 4,360 tonnes of potentially hazardous household waste[39] from the waste stream, an 8% increase from 2017-18.

The Bin Trim program has supported over 29,000 businesses to reduce and recycle waste, and has diverted over 100,000 tonnes of waste from landfill, making it the largest business recycling program in Australia. Circulate grants have supported projects like Plastic Police, which recycles soft plastic into outdoor furniture and local road-making asphalt.

11.3 Northern Territory perspective



C&D and C&I streams continue to constitute the majority of the NT's waste. Waste generation in the NT is heavily influenced by major construction activity as well as the retail sector. During this period there has been a stabilisation of in residential construction activity and a slight increase in commercial construction activity associated with Commonwealth and NT investment in a number of projects. Consecutive poor wet seasons and corresponding low numbers of cyclonic events has resulted in no emergency waste disposal at landfills across the Territory.

The NT Container Deposit Scheme continues to support high levels of recycling with over 80% of all containers sold in the NT during the 2019-20 period being recovered and diverted from landfill and litter. During 2019-20, 31% of all containers were redeemed at approved depots outside of the Greater Darwin Area, representing a 2% increase over the previous financial year. This reflects an increase in public access to the CDS in regional and remote areas, including through new depots in Wadeye and East Arnhem delivering mobile services to communities in the region. Aluminium, glass and PET containers account for the majority of container sales and also have high return rates. Return rates for containers made of liquid

[38] This 2019-20 data differs from the 2018-19 data presented elsewhere in this report.

[39] Including paint, which is excluded from the data presented in Section 14.2.

paperboard, HDPE, steel and other materials are significantly less and tend to fluctuate more than the main material types. This trend has also been reported in other jurisdictions.

Close collaboration with local councils during 2019-20 has seen incremental improvements in environmental management at urban and remote landfills. Strategic agreements with City of Darwin, Barkly Regional Council and Katherine Town Council have been implemented to reduce impacts to air, water and land from landfilling activities. Priority focus areas included the management of leachate, prevention and management of fire, improved segregation and management of hazardous waste, and closure planning and rehabilitation.

The NT EPA's electronic waste tracking system is currently under development, with largely positive feedback from industry testing and implementation anticipated towards the end of 2020. All hazardous waste entering, leaving or moving within the NT will be required to be reported to the NT EPA via the online system. The system will not only assist the NT EPA to meet national and international hazardous waste reporting requirements, but will assist in tracing waste generated, reused and recycled in the NT and identify areas for improved environmental regulation.

The NT is implementing the National Waste Action Plan by:

- identifying options to reduce the use of single use plastics
- increasing opportunities to recycle waste (particularly glass, plastic, tyres and paper) across the NT including in regional and remote areas
- industry development and infrastructure to facilitate the growth of the waste sector
- improved environmental regulation, compliance and reporting of hazardous waste in the NT (waste acceptance criteria, financial assurance, waste tracking and cost recovery)
- initiating a feasibility study on the use of crumbed rubber in bitumen for road surfaces
- identifying opportunities to include targets for use of recycled material across all government procurement and construction and maintenance activities
- strengthening legislative frameworks to minimise landfilling of recycled material.

11.4 Queensland perspective

Reporting entities in Queensland handled 11 Mt [40] of headline wastes (municipal solid waste, commercial and industrial waste and construction and demolition waste). This was a 1.3% increase on the amount reported in 2017-18. By comparison, Queensland's population grew by 1.7% over the same period.

Queensland increased its recycling effort for household and business wastes by 350,000 tonnes, resulting in 5.4 Mt [40] of materials diverted away from landfill.

As Queensland's population grows and consumption increases, there is an ongoing need for effective, fit-for-purpose waste avoidance and resource recovery pathways and solutions.

In 2019, the Queensland Government introduced a comprehensive waste strategy and a waste disposal levy. The Waste Management and Resource Recovery Strategy's three priorities will guide

[40] Data given here may not be consistent with the data presented in other parts of the report due to difference in measurement method and scope.

the transition to a more circular economy, reduce the amount of waste disposed to landfill, or illegally, and provide a more sustainable source of end-of-life products and materials to create new products. Investment in diverse resource recovery technologies and markets will produce high-value products and generate economic benefits for Queensland.

The waste strategy set three targets for 2050:

- 25% reduction in household waste
- 90% of waste is recovered
- 75% recycling rates across all waste types.

The waste disposal levy provides a source of funding to support Queenslanders, local government, business and industry in reducing the amount of waste they generate and increase recycling and reprocessing of recovered materials. Central to this is the development of new end-markets and products, including uptake of recycled content in products. The levy also provides a disincentive to landfill disposal and the long-distance transport of waste for disposal into Queensland.

Tackling Plastic Waste: Queensland's Plastic Pollution Reduction Plan identifies and prioritises actions across the plastic supply chain, with the aim of reducing the amount of plastic waste generated; incentivising new and expanded recovery and reprocessing infrastructure; and reducing the environmental and economic impacts of plastic pollution. A headline action of the plan is the introduction of legislation to enable a ban on the supply of specific single-use plastic products, starting with straws, stirrers, cutlery and plates. Public consultation has been undertaken on the proposal to assess community support for the ban, and any potential impact.

The plastic pollution reduction plan also committed to expand and build on the existing Plastic Free Places in Queensland program, in partnership with the Australian Packaging Covenant Organisation and Boomerang Alliance.

To further increase the success of the container refund scheme, the Queensland Government provided grants of up to $10,000 to community groups, schools and charities to purchase infrastructure and equipment for the collection and security of containers at donation points across Queensland. These donation points complement the container refund point network and allow charities and community groups to receive refunds on donated containers.

In 2020 the Energy-from-Waste Policy was released to guide activities that recover valuable fuels, electricity and heat from waste materials that would otherwise be disposed of to landfill. The policy provides certainty to stakeholders and allows proposals, consistent with the policy, to progress.

The Queensland Government is supporting the national waste agenda to build resilience to international market fluctuations and drive improved recovery. The Queensland Government is committed to implementing a number of product stewardship programs, aimed at promoting and standardising the design and recycled content in products and packaging, including products such as batteries, bulk flexible plastic packaging, photovoltaic systems and mattresses.

The Queensland Government will continue to introduce clear and progressive policy and programs to focus on other identified problem wastes, including food and agricultural waste, textiles, tyres, and waste electrical equipment and batteries.

11.5 South Australian perspective

South Australia continues to perform well in its efforts to recycle material and reduce landfill disposal. However, the industry faces market challenges as international prices drop for mixed fibre and other commodities.

The former Council of Australian Governments bans on waste exports will add further pressure to finding on-shore solutions for resource recovery.

The state's waste streams have been impacted by bushfire waste disposal and recycling, including asbestos contaminated material, and the impact of COVID-19, with increased household waste generation.

Key trends and issues

- developing the circular economy through innovation and best practice in resource recovery and remanufacturing
- disposing resources to landfill is decreasing, supported by investment in the sector
- reforming household waste continues, requiring a uniform kerbside bin systems and state-wide food waste diversion systems and infrastructure
- realising the economic benefits of food waste avoidance by capturing unavoidable food waste, diverting it from landfill
- preparing for disaster waste management and building community resilience in the aftermath of events occurring in South Australia during 2020.

Waste levy initiatives are improving certainty, innovation and growth in the waste and resource recovery sector and the green economy:

- $0 levy for packaged asbestos waste to promote its safe and lawful disposal to now be in place on an ongoing basis
- 50% levy waiver for residual waste from donations to charitable recyclers
- 50% levy waiver for shredder floc from scrap metal recycling activities.

Major initiatives led by Green Industries SA

- the Draft South Australia's Waste Strategy 2020-2025 provides a framework for economic prosperity and community well-being with a transition to the circular economy
- the state government's national leadership to phase out certain single-use plastic products in response to strong community support
- South Australia's first comprehensive food waste strategy, Valuing our Food Waste 2020-2025
- co-investment in new and expanded infrastructure, financial incentives to develop markets, sustainable procurement, evidence-based community education and commercialisation of innovation.

Major initiatives led by the Environment Protection Authority

- review of the Container Deposit Scheme to realise the extended producer responsibility objectives for litter reduction and beverage container material recycling
- release of the EPA Position Statement: Thermal energy-from-waste activities to provide guidance to industry on the recovery of energy-from-waste to support the *Environment Protection Act 1993* and the state waste strategy

- analysing changes in behaviour, specifically relating to waste soils and asbestos movements in the state and broader market.

Policy developments

EPA's Waste Reform Program is implementing the modernised and strengthened powers of the *Environment Protection (Waste Reform) Amendment Act 2017* to better support a strong resource recovery sector and prevent illegal dumping:

- financial assurance to address stockpiling of wastes and other materials on licensed sites
- mass balance reporting on waste and other materials on licensed sites to identify further resource recovery and investment opportunities in the waste and resource recovery sector to help achieve the benefits of a circular economy
- a modernised approach to how the waste levy is applied at landfills.

Five priority areas for policy focus under Green Industries SA's Strategic Plan are:

- leading the circular economy
- supporting innovative resource recovery
- reforming household and food waste
- reforming packaging and single-use items
- building disaster waste resilience.

Major challenges and opportunities

- building the resilience, capabilities and competitiveness of the state's waste management and recycling industry
- supporting the state's post-COVID-19 economic recovery, the aftermath of China's National Sword Policy and the former Council of Australian Governments ban on the export of waste plastic, fibre, glass and tyres.

Significant events

- the response to South Australia's bushfires waste clean-up is establishing best practice procedures for national adoption
- COVID-19 – changes to the type and generation of waste with significant changes in kerbside bin collections as more householders carried out home clean-ups.

11.6 Tasmanian perspective

An ongoing challenge for Tasmanian waste management is access to markets for resource recovery due to the State's relative isolation and its smaller population. A strategic approach to these issues is being pursued with the 2019 release of the draft Tasmanian *Waste Action Plan* (the Plan). The draft Plan provides a framework for discussion with local government, business and the community on the best way to address the waste and resource recovery challenges in Tasmania. It identifies the actions the Tasmanian Government will take to tackle waste and recycling problems, in particular its commitment to establish a legislated state wide waste levy, which will replace the current voluntary regional waste levies, and to introduce a container refund scheme in Tasmania. Public consultation on the Plan was completed in October 2019 and it will be finalised in line with the Government's 2020 budget process. The draft

Plan includes actions to improve waste data collection and reporting to facilitate waste policy and resource recovery planning. The draft Plan also includes resource recovery targets, including:

- ensuring 100% of packaging is reusable, recyclable or compostable by 2025
- reducing waste generated in Tasmania by 5% per person by 2025 and 10% by 2030
- achieving a 40% average recovery rate from all waste streams by 2025 and 80% by 2030
- having the lowest incidence of littering in the country by 2023
- working at the national level and with local government and businesses in Tasmania to phase out problematic and unnecessary plastics by 2030
- reducing the volume of organic waste sent to landfill by 25% by 2025 and 50% by 2030.

A container refund scheme is to be established in Tasmania to assist with reducing litter, and to help recover the resources that beverage containers are made from. The scheme was announced in June 2019 and is intended to be operational by 2022.

On 1 October 2019 the *Report Rubbish* web application was launched. This allows a person to make a report of littering or dumping in Tasmania which is then automatically forwarded to the relevant authority for investigation. Data generated through the application will help better understand littering and dumping hotspots and assist in development of targeted reduction strategies.

A second, parallel, system called the *Litter and Dumping Management System* provides land managers with a tool for managing reports made through *Report Rubbish*. It also provides a way for public land managers (councils and state government bodies) to request the assistance of offenders on community corrections orders to help clean up litter from areas such as parks and reserves.

On 25 February 2020 the new *Waste Management Regulations 2020* commenced, replacing the *Waste Management Regulations 2010*. The new regulations include regulations dealing with registration of controlled waste transporters previously contained in the *Controlled Waste Tracking Regulations 2010*, which expired on 17 February 2020.

While there has been a general trend of increasing volume of waste generated in Tasmania the volume going to landfill has remained relatively stable. Contributing factors are the significant increase in recycling and composting rates, including the adoption of food organics and garden organics collection in several municipalities during the reporting period.

11.7 Victorian perspective

In 2018-19, Victoria's waste and resource recovery system managed 15.33 Mt [41] of material – 6% more than the previous year. Approximately 4.57 Mt [1] of waste were sent to landfill and 10.77 Mt [1] (70%) of materials were recovered for recycling.

The increase in generation and recovery has been attributed to a sharp increase in the amount of C&D waste over the last two years as a result of land development and public transport infrastructure works, including level crossing removals.

[41] Data given here may not be consistent with the data presented in other parts of the report due to difference in measurement method and scope.

Victoria's waste and recycling system faced a range of challenges throughout 2018-2019. Changes in global commodity markets led to major disruptions for household recycling services and the collapse of Victoria's largest recycler, SKM Recycling. Victoria also experienced significant chemical stockpile fires in August 2018 and April 2019.

To address these challenges, in February 2020 the Victorian Government released *Recycling Victoria: A new economy* – a 10-year circular economy policy and action plan. Through this policy, the government is investing over $300 million to transform Victoria's recycling sector. Key initiatives include:

- changing how Victorians recycle, with a new four-bin household recycling system to separate recyclables, glass, food and organics, and waste
- introduction of a container deposit scheme to begin by 2023
- regulating waste as an essential service and establishing a new dedicated waste and recycling Act and new waste authority to govern the system
- a $49.5 million investment in expanding Victoria's recycling infrastructure, with funds to initially target priority materials such as plastic, paper, cardboard, glass and chemical waste
- a $30.5 million Recycling Market Acceleration package to support new uses for recycled materials
- funding to develop new Victorian Circular Economy metrics and expand the waste data system to cover the entire Victorian economy, which will deliver high-quality and transparent data to support investment in waste and recycling, inform better decision-making and allow the government to monitor progress towards a circular economy
- a Circular Economy Business Innovation Centre, and associated grants, to support businesses improve material use and reduce waste
- grants for councils and communities to support local waste reduction or litter programs or circular economy initiatives like repair cafes and toy libraries
- funding for energy-from-waste initiatives, recognising its role in an integrated waste recovery system.

These commitments build on the $37 million *Recycling Industry Strategic Plan*, released in 2018, to stabilise the recycling sector by investing in infrastructure and developing new markets for recycled materials. This was followed by a further $34.9 million investment in 2019 to bolster the recycling sector's capacity to sort and process material and support the collaborative procurement of waste services.

The safe management of waste is fundamental to *Recycling Victoria*. Under the plan, $71.4 million will be invested to ensure high-risk and hazardous wastes are managed safely by:

- establishing a new Waste Crime Prevention Inspectorate within Environment Protection Authority Victoria
- improving intelligence sharing arrangements across regulatory and emergency management agencies
- ensuring adequate disposal points for asbestos across the state
- continuing the successful Detox Your Home program, encouraging the safe management and disposal of hazardous waste from households
- implementing the government's new Coordinated Prevention and Response Framework for high risk waste sites.

Underpinning these investments, Victoria's long-term waste and resource recovery infrastructure planning framework continues to ensure the State has the right infrastructure to maximise recycling and to safely manage waste that cannot be recovered.

Victoria also progressed a range of regulatory initiatives, with electronic waste banned from disposal in Victorian landfills as of July 2019 and a ban on lightweight plastic shopping bags from November 2019.

11.8 West Australian perspective

Western Australia's new Waste Strategy

In February 2019, the Minister for Environment, Hon Stephen Dawson MLC, released the Western Australian *Waste Avoidance and Resource Recovery Strategy 2030* outlining the vision of making Western Australia a sustainable, low-waste society in which human health and the environment are protected from the impacts of waste.

The Waste Strategy identifies high-level targets, focus materials and 50 strategies that underpin the objectives of waste avoidance, recovery and environmental protection. It is supported by the *Waste Avoidance and Resource Strategy Action Plan 2020-21* which prioritises the actions that will be implemented to achieve the Waste Strategy's objectives and sets out responsibility for leading those actions.

Western Australia's waste and recycling performance

Since 2011 there has been sustained improvement in the proportion of waste diverted from landfill and a declining trend in waste disposed of to landfill in Western Australia. These trends correspond to significant increases to the waste levy over this period.

The C&D waste sector has been particularly responsive to these increases. The sector reported surpassing the Waste Strategy C&D material recovery target of 75% for 2020. The recovery rate is likely to be inflated due to under-reporting of stockpiled materials. New reporting regulations and continued compliance and enforcement by the Department of Water and Environmental Regulation will assist in improving data quality. The State Government also recently completed consultation on proposed legislative improvements to the waste management framework and waste levy regime, which includes reforms to address issues associated with long-term waste stockpiling.

The Government is encouraging the use of recycled C&D products in civil projects such as road construction and has just completed a trial with Main Roads which used over 30,000 tonnes in major road projects.

The municipal sector is below the State's Waste Strategy waste recovery targets. Improvements to source separation and the adoption of organic recovery systems – including FOGO - are increasing and will be key to increasing the amount of municipal waste diverted from landfill.

The State Government has committed $20 million in funding through the revised Better Bins Plus: Go FOGO program to encourage local governments to provide better practice three-bin kerbside collection systems with separate FOGO services. Encouragingly, local governments that have adopted FOGO are achieving amongst the highest material recovery rates in the State. Better Bins Plus supports a headline commitment in the Waste Strategy to roll out a consistent three-bin

kerbside collection system, which includes separation of FOGO from other waste categories, by local governments in the Perth and Peel regions by 2025.

State Government's commitment to better waste and recycling outcomes

The Western Australian Government continues to demonstrate its commitment to reducing waste and increasing recycling. On 1 July 2018, it introduced a ban on lightweight plastic bags and has committed to the introduction of a container deposit scheme commencing on 1 October 2020. The State Government is keen to do more to reduce unnecessary use of plastic and has been consulting with the community. Options put forward in the *Let's not draw the short straw - reduce single-use plastics Issues Paper* include bans, sustainable product design and education programs. These options are being considered by the Government.

The Western Australian Government is committed to developing recycling infrastructure in Western Australia to reduce waste and increase recycling. The State Government has two major recycling infrastructure projects underway with calls for expressions of interest for grants to help boost the processing capacity of Western Australian's plastics, tyres, mixed paper and cardboard waste. This will assist in managing waste that will need to be processed locally following the Council of Australian Government's waste export ban that commences from 1 January 2021.

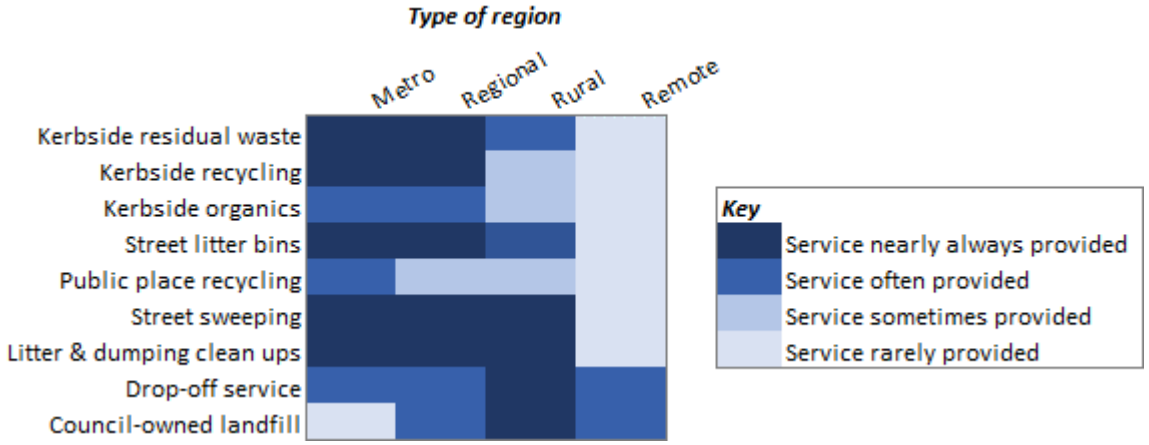
12. Local government waste management

This chapter addresses the critical role played by local governments in providing waste services to their communities. The data were mostly obtained from state government collations of council data. The chapter closes with the Australian Local Government Association's perspective on the status of waste in Australia.

12.1 Local government services

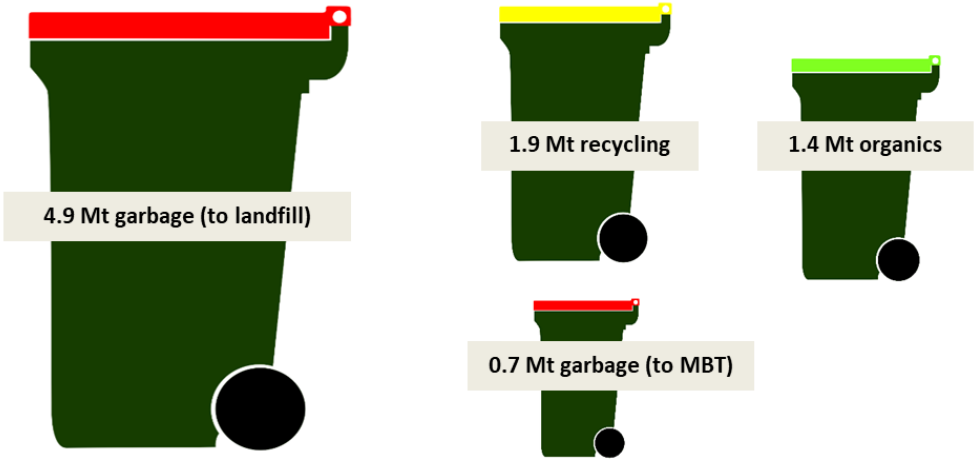
Local government waste services include kerbside collections, public place waste management and provision of recycling and disposal infrastructure. The services provided vary by local government and region type, as illustrated in Figure 45. This section focuses on kerbside services.

Figure 45 Local government waste services by region type



In 2018-19, local governments collected 8.9 Mt of waste via kerbside bin services[42]. These included collections of residual waste (or garbage) that were sent to either landfill or mechanical biological treatment[43], kerbside recycling and kerbside organics. Figure 46 illustrates the quantities and proportions of waste collected in these types of kerbside service.

Figure 46 Waste collected by Australian local governments by service type, 2018-19



[42] The significant difference between this figure and the total for MSW given in Table 9 (p.28) can be partly explained by non-domestic MSW. The Table 9 values are mostly reported under levy arrangements and more likely to be accurate.

[43] A treatment that sorts residual waste and processes the organic-rich residuals by composting or anaerobic digestion.

Figure 47 shows the proportion of households with each type of kerbside service in 2018-19 by jurisdiction. Across Australia, about 97% of households had a regular collection for residual waste, 93% had a recycling collection and 49% had an organics collection. Drop-off services are generally available in areas with no kerbside service.

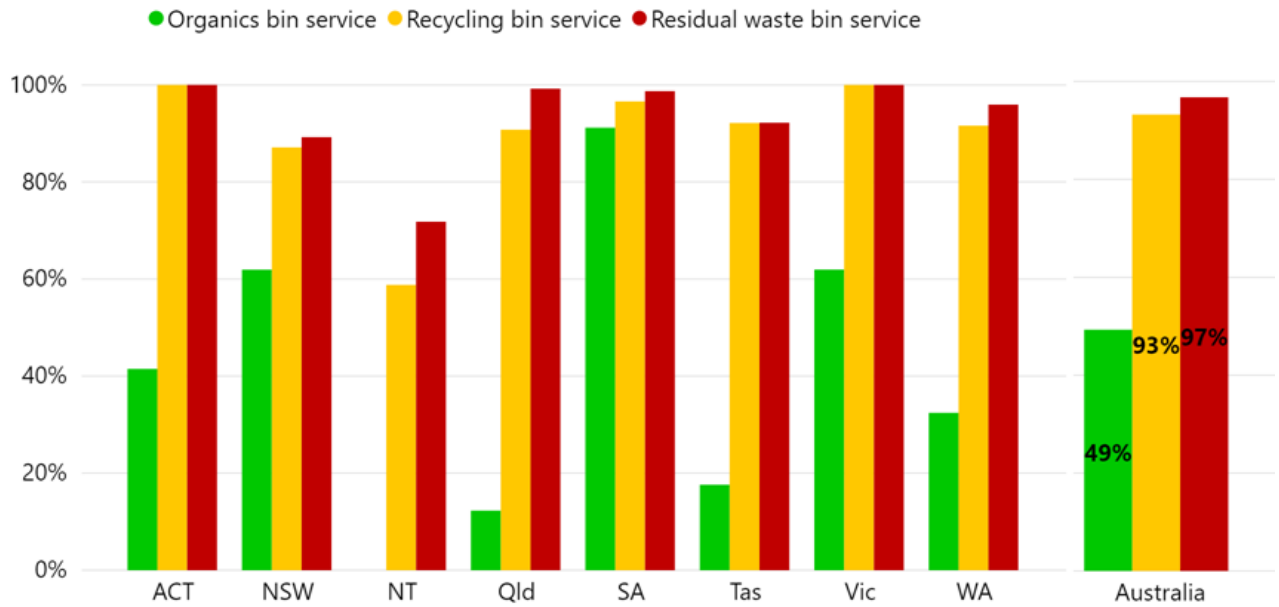
In most states and territories, more than 90% of households had a kerbside collection for residual and recycling waste. The exceptions were NSW, which was just under at 89% for residuals and 87% for recycling, and NT which covered 72% for residuals and 59% for recycling. SA had the largest coverage for kerbside organics at 91%, followed by Vic and NSW at 62%.

Photo 10 Kerbside waste bins ready for collection by local council in Sydney

The Australian Standard mobile bin colour is a dark-green or black body with a red lid for garbage, a yellow lid for recycling and a lime green lid for organic waste (AS4123.7-2006). Standardised bins help ensure correct usage. Not all local governments use bin colours consistent with the standard.

Photo by LemonMyrtle, via Shutterstock.com

Figure 47 Australian households' access to kerbside waste services by jurisdiction, 2018-19



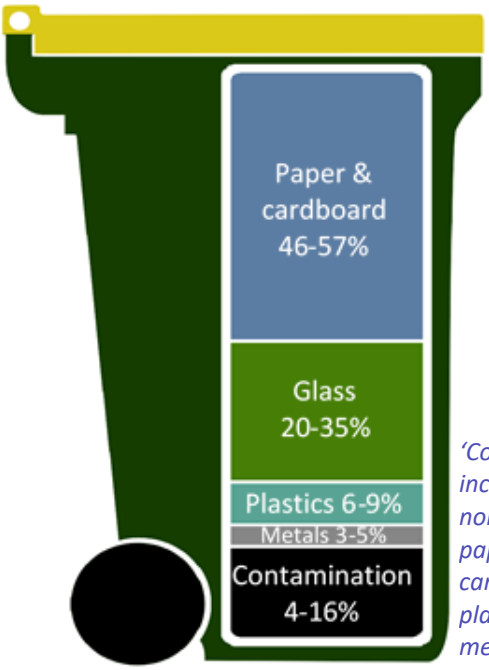
12.2 Kerbside recycling services

Kerbside recycling bins typically collect glass packaging, aluminium and steel cans, mixed paper and cardboard and plastic containers. There is some variation in materials accepted depending on the processing capacity at the receiving MRF. Victoria is moving towards separate glass-only bins because broken glass in recycling systems contaminates other materials.

Figure 48 illustrates the composition of a typical recycling bin, displaying the highest and lowest proportion of each material type based on collations of recent audits in the five largest states. The population-weighted average composition (by weight) is 48% paper and cardboard, 27% glass, 8% plastics, 3% metals and 13% contamination. Some of these states operated a container deposit system during the audit and some did not, but no impact on the composition of kerbside recycling bins is readily apparent in the audit data.

Recent bans on the import of some product types into South-East Asian countries have restricted the market for sorted domestic recyclables and disrupted some local government contracts (see Sections 4.4 and 16.2).

Figure 48 Typical composition of kerbside recycling bins (% by weight) based on states' data



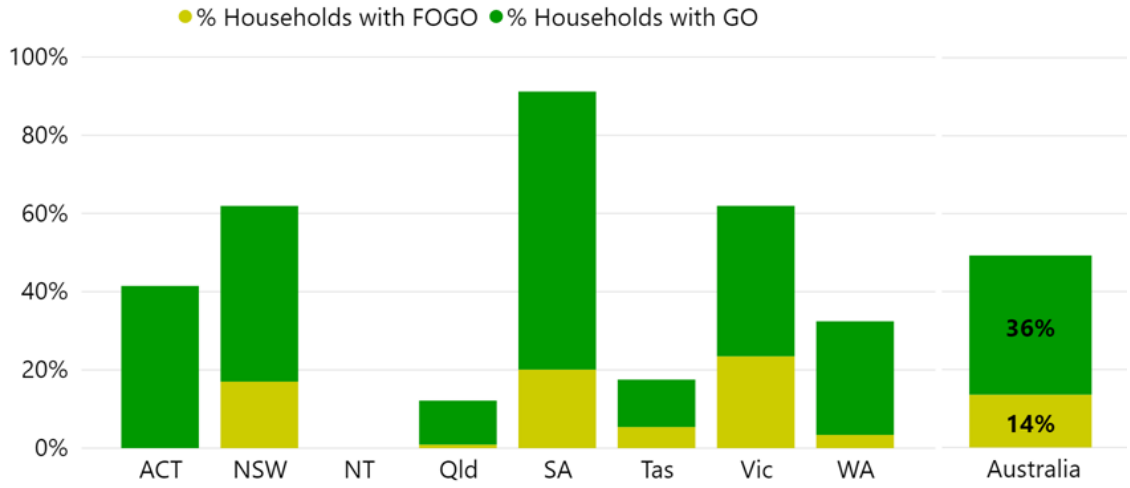
'Contamination' includes non-recyclable paper, cardboard, glass, plastics and metals

12.3 Kerbside organics services

Figure 49 shows the proportions of households in each jurisdiction in 2018-19 with a kerbside organics bin. It is split into those with a service for garden organics only (GO) and those with a service for food and garden organics (FOGO). Organics services were concentrated in the south-eastern portion of the mainland – ACT, NSW, SA and Vic. GO services were introduced into ACT relatively recently, with uptake reaching 41% in 2018-19. Organics services in WA are increasing.

Vic had the largest number of households with FOGO services (23%) followed by SA (20%) and NSW (17%). FOGO services tend to be well-used only when strongly promoted and well-designed – provision of kitchen 'caddies' with certified compostable liners is associated with high levels of use and capture rates of up to 70% of food waste from a local government area. Some councils provide a FOGO option but without much promotion, resulting in use by enthusiasts only and low capture rates. Many jurisdictional waste strategies have committed to expand FOGO services. On this basis, FOGO should be implemented across Greater Perth by 2025 and all Victoria by 2030.

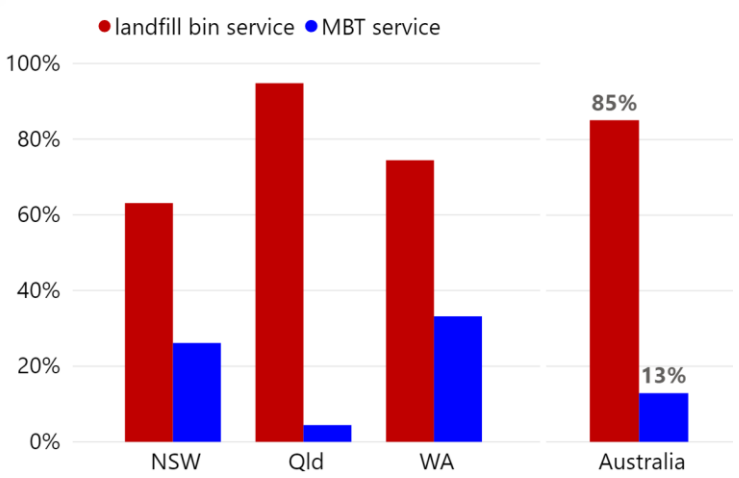
Figure 49 Australian households' access to kerbside organic waste services by jurisdiction, 2018-19



12.4 Kerbside residual waste services

About 93% of the population has access to a kerbside garbage service. In most jurisdictions this material all goes to landfill. In NSW, Qld and WA, some goes to mechanical biological treatment (MBT), in which the residual waste is sorted to extract recyclables and the remaining organics-rich fraction processed through composting or anaerobic digestion. The processed organics were typically used for land rehabilitation. In 2018 NSW EPA determined that this would no longer be allowable in NSW due to risks associated with chemical and physical contaminants. It is understood that this material now goes to landfill following processing.

Figure 50 Australian households' access to kerbside residual waste disposal in jurisdictions with a mechanical biological treatment option, 2018-19



The proportions of residual waste going to landfill and MBT in 2018-19 in states with that technology are shown in Figure 50.

Photo 11 Kerbside bin collection in Queensland

Photo kindly provided by Cleanaway

12.5 Australian Local Government Association perspective

What has been the impact of the COVID-19 pandemic on your members / stakeholders?

While COVID-19 challenged the financial viability of many local governments, none reduced waste services and only a very few adjusted recycling collection schedules. Once waste management was confirmed to be an essential service, COVID work-from-home orders were waived for waste facilities. Keeping facilities open helped to reduce the potential for illegal dumping of waste, which costs millions of dollars to clean up. While there was anecdotal evidence of increased kerbside waste disposal due to increased consumption of takeaway and home-delivered food, there was no evidence of any disruptions to collection services.

What are the most significant challenges facing Australian waste management providers and policy makers in 2020?

The most significant challenge will be the introduction of the national waste export ban. Many of the banned wastes will be those collected for recycling by local councils, i.e. mixed plastic and mixed paper. To avoid stockpiling or increasing waste to landfills, new markets will have to be found for low-value waste both in terms of processing plants and products to incorporate recycled feedstock. Key areas of focus will be:

- driving demand for recycled products through government procurement policies
- supporting improved infrastructure capabilities at materials processing facilities
- encouraging residents to continue or improve good waste management practices.

What are the greatest opportunities facing Australian waste management providers and policy makers in 2020?

The implementation of the *National Waste Policy Action Plan* offers an unprecedented opportunity to create a circular economy. New infrastructure, such as paper processing and chemical plastic recycling plants, will need to be sited appropriately and with consideration for a web of new waste hubs in regional Australia and their transport needs. Where waste is to be incorporated into new roads, federal action will be required to harmonise standards. Education programs around curtailing food waste should be harmonised nationally to ensure there is no mixed messaging or duplication, and the hypothecation of waste levies considered to ensure recycling is sufficiently resourced.

Where do you believe Australian waste management should aim to be in 10 years' time?

The waste industry in 2030 should be flourishing and economically viable. It should underpin a circular economy providing local jobs and increased demand for products made from recycled materials; it should enhance environmental sustainability through reduced quantities of waste going to landfill and more waste re-entering the product-lifecycle; and it should encourage and acknowledge the efforts and practices of Australian households and local governments.

13. The waste and resource recovery sector

This chapter provides a brief overview of the waste and resource recovery sector: its size, players, services and the main types of infrastructure. The section also includes perspectives from four of the main waste and resource recovery industry associations: the Australian Council of Recycling (ACOR), the Australian Organics Recycling Association (AORA), the National Waste and Recycling Industry Council (NWRIC) and the Waste Management and Resource Recovery Association of Australia (WMRR). These associations reflect on the impact of the COVID-19 pandemic, the most significant challenges and opportunities facing the sector, and where Australian waste management should aim to be in 10 years' time.

13.1 Sector overview

The Australian waste and resource recovery sector managed about 60 Mt [44] of waste in 2018-19, including about 36 Mt through recycling and most of the rest through landfill. Based on ABS data (2020a), in 2018-19 the sector employed around 36,000 people and provided services valued at $15.8 billion.

The sector is dominated by five large companies that are active in provision of collection services and operation of infrastructure for both household and commercial waste. In some cases, they also own and develop the infrastructure. The five large operators are Cleanaway, JJ Richards, Remondis, Suez and Veolia. International companies such as Remondis, Suez and Veolia are bringing their international experience to the development of energy-from-waste facilities and other alternative waste technologies. Other international companies (such as Sacyr) are entering or showing interest in the Australian waste industry. Cleanaway, through its subsidiary Toxfree, is Australia's largest operator in hazardous waste management. In 2019 Cleanaway also purchased most of the infrastructure assets of SKM Recycling when the business failed, expanding its involvement in recycling.

Visy remains a major operator in recycling and paper and cardboard reprocessing. Its recent purchase of the Australian and New Zealand operations of Australia's major glass manufacturer will see it expand into glass recycling and processing.

Many smaller operators specialise in particular markets, such as composting or skip bin operation, or work in particular jurisdictions or regions. Recent expansion by Bingo Industries has seen it increase its presence across jurisdictions in providing waste services to the C&D sector.

The local reprocessing industry is small though growing, but large quantities of metals, paper and cardboard and plastics are still exported to Asian markets (see Section 4.4).

13.2 Waste collection services

Municipal waste and recycling collection services are typically provided by local government through either in-house teams or, more commonly, a service contractor engaged through a competitive tender. Increasingly, local governments are joining together to purchase waste services. This allows for cost savings from economies of scale and potential processing in alternative waste technologies through longer contract periods. Some councils extend their services to smaller businesses and organisations.

[44] Comprising all 'core' wastes except biosolids, which are largely managed by the wastewater industry.

Municipal collection services usually include a weekly garbage service and fortnightly recycling service. The introduction of organic waste collection services is seeing some change to this frequency, with FOGO collection increasingly being provided weekly with accompanying garbage services provided fortnightly. The range of materials accepted in comingled recycling collections is narrowing in some cases (for example the exclusion of some plastics) and some councils are introducing glass-only bins. Periodic or at-call 'hard waste' collection services are provided by many metropolitan councils to allow residents to dispose of bulky and non-putrescible items such as furniture, bikes, etc.

Large corporate waste generators often establish a relationship with a major waste company for national or regional services. Most other businesses engage service providers on short-term contracts or informal arrangements. Often the key concern of businesses is disposal of waste, and they rely on their waste service provider to identify recycling opportunities and services. This arrangement does not always deliver optimum recycling results as the service provider may be more focused on maximising profit with minimum effort.

Hazardous wastes are typically managed by contractors with regulatory approval for the collection, transport and management of the particular types of waste. The five large states operate tracking systems in which each consignment of hazardous waste must be reported to the state, and can only be taken to facilities licensed to receive them. This has not always been successful in the past (refer Section 15) and regulatory frameworks are being enhanced.

13.3 Waste and resource recovery infrastructure

Table 20 describes the main types of waste and resource recovery infrastructure and their operators. Facilities range from small to large, and may be operated by local government, private business or charities and community groups. Each plays a different role in the waste and resource recovery cycle.

At the time of writing, the Australian Government is developing a national database of all waste and resource recovery infrastructure. Early results indicate transfer stations are the infrastructure type most Australians rely on for waste disposal.

Photo 12 Wynyard transfer station in Tasmania

Photo by Christine Wardle; used by kind permission of Waratah-Wynyard Council

Table 20 Common waste management infrastructure types and functions

Facility type	Activity and function performed	Operators
Container deposit system drop-off point	Enable return and redemption of eligible beverage containers in states with a container deposit scheme[45]. May be manually operated or automated 'reverse vending machine' which gives credit for each item deposited.	• Local governments • Private businesses • Charities and community groups
Transfer station	Allow small vehicles to drop-off waste. Usually include a resource recovery centre that provides material-specific bins or areas for particular recyclables. Garbage is consolidated for transfer to landfill, improving safety by keeping small vehicles away from landfill activities and improving transport efficiency.	• Local governments and their contractors • Private businesses
Reuse shop	Shop selling unwanted materials recovered from the waste stream; usually located at a transfer station.	• Local governments and their contractors (which can include charities and not-for-profit organisations)
Other drop-off facility	Allows for drop-off of specific materials such as e-waste and mobile phones, often by national retail chains in conjunction with a product stewardship scheme. Major supermarkets provide drop-off points for recycling of soft plastics.	• Local governments • Private businesses
Material recovery facility (MRF)	Sort comingled recyclables and other materials, mostly from domestic recycling bins, into marketable grades of materials.	• Private businesses contracted to local governments • Local governments (few)
Compost facility	Use a controlled, aerobic and naturally self-heating biological process to convert garden, food and other organic materials into soil conditioners, mulches and fertiliser products.	• Private businesses contracted to local governments or providing farm and garden product supplies • Local governments
Construction and demolition waste processing facility	C&D waste is commonly processed to recover masonry aggregates, metals and soil. Some facilities also extract timber, garden organics, plastics and glass.	• Private businesses
Other recycling/ reprocessing facility	Facility which recovers or reprocesses specific materials, e.g. metals recovery, textile recycling, plastics reprocessing.	• Private businesses (including not-for-profit organisations)

[45] Currently ACT, NSW, NT, Qld and SA.

Facility type	Activity and function performed	Operators
Alternative waste treatment facility	An umbrella term for sophisticated technologies that accept residual waste as an alternative to landfill. Most commonly applied to mechanical biological treatments that process waste to extract recyclables and create a 'derived organic-rich fraction' for land stabilisation, composting or energy recovery.	• Private businesses contracted to local governments
Energy-from-waste (EfW) facility	Facility which uses a technology such as combustion (incineration), gasification or anaerobic digestion (for organic waste) to produce energy from all or selected parts of the waste stream.	• Private businesses, often but not always contracted to local governments
Chemical/physical treatment facility	Accept a range of hazardous waste and treat it to reduce hazards.	• Private businesses
Landfill	Manage mixed residual waste. Usually engineered with a clay or geotextile lining, leachate collection and treatment, and (at larger sites) gas collection and combustion. Landfills may be 'inert' (mainly demolition waste), 'putrescible' (including biodegradable waste), 'bioreactor' (maximising energy recovery from putrescible waste) or hazardous. Public access usually restricted to a resource recovery centre near the gate. Seen as the least preferred waste management option, but required into the long-term for asbestos, disaster waste, contaminated soils, waste processing residuals, etc.	• Private businesses (mainly urban areas) • Local governments (mainly regional areas)

Local governments – and regional collectives of local governments – that manage municipal kerbside collection contracts have an important role in establishing waste infrastructure. They offer large-scale and long-term supply contracts that effectively underwrite the security of the waste infrastructure investment. This is particularly important for new facility types such as alternative waste technologies and energy-from-waste facilities, where the large capital investment requires long-term loans.

There is increasing interest in establishing thermal energy-from-waste facilities in Australia. A number have gained the necessary regulatory approvals but technical, financial and other issues remain to be addressed before development proceeds. At the time of writing, only one large scale energy-from-waste facility (in WA) is under construction. Anaerobic digestion is not well developed in Australia due to cost.

Landfill remains the option of last resort for most waste. Engineering and environmental management standards have improved markedly over the last few decades, but landfills in some rural areas continue to operate at a low standard.

13.4 Geographical variations

In metropolitan and provincial city centres most waste infrastructure is operated by private businesses (sometimes under contract from local government owners). Local governments are responsible for collecting MSW and sometimes run transfer stations, but usually have little involvement with C&I and C&D waste.

In regional and remote areas, the financial viability of waste management and resource recovery operations is typically more marginal. Here, local government has a larger role. In most regional areas, local governments own and operate or contract out the operation of landfills and transfer stations (see Feature 3).

As recycling infrastructure is mostly located in metropolitan areas, there is a continual flow of materials: recovered resources from regional areas are transported to metropolitan recycling facilities, while waste from the metropolitan area is disposed to landfills in peri-urban locations (or hundreds of kilometres away in some instances). The transport of this material adds an additional element to disposal and recovery costs.

Recycling facilities for all materials are not necessarily available in each jurisdiction, with some materials requiring transport from one state to another. For example, few reprocessing facilities in Tasmania means many recyclables are shipped to Victoria, while various materials recovered in Queensland may be sent to processing facilities in Sydney or Melbourne.

Feature 3 Regional waste management

Regional and remote areas face many waste challenges not experienced elsewhere in Australia. Limited human and financial resources in regional and remote local government areas generally translate to lower levels of services provided for waste management and resource recovery. Regional authorities may not have dedicated waste resources, with personnel multi-tasking across a range of activities. This can sometimes result in waste issues not receiving the attention or skill-set needed.

Regional communities do not receive the same level of kerbside collection services or have the same access to waste and recycling facilities as their urban counterparts. Achieving a parity of outcomes relies on many individuals travelling large distances to drop-off waste and recyclables. This is not always practicable, particularly in remote communities, where significant distances are involved. Similarly, resource recovery infrastructure may be limited where the distance to markets (and resulting transport costs) make recovery unviable. Lower quantities of materials generated by regional and remote communities contribute to reduced availability of recovery infrastructure.

Conversely, large quantities of some materials may be generated where the region's major economic activity is tied to a particular industry, such as mining. Apart from material (such as overburden) which can be reused in rehabilitation, remote mining activities can generate wastes resulting from large-scale equipment use and servicing of temporary communities (such as used oil, tyres, metals, plastics, wastewater). The distance involved in returning end-of-life material to facilities in urban areas is a barrier to recovery. This can be overcome where back-loading of materials on empty transports can occur, but this option is often not feasible. In some areas, end-of-life equipment, tyres and other waste are deposited in mine site landfills.

13.5 Australian Council of Recycling perspective

The Australian Council of Recycling (ACOR) welcomes this newest edition of the National Waste Report. The report is a key tool in decision-making for both policy makers and resource recovery industry operators and investors. It fundamentally shows all stakeholders where Australia is on its resource recovery trajectory, including against public policy targets, and what we need to do more and less of to further succeed in claiming the environmental, social, and economic opportunities of using waste as a resource.

To that end, ACOR welcomes the renewed focus by governments on resource recovery, including significant investment in infrastructure, particularly given changing export conditions and COVID circumstances, as well as the greater emphasis on product stewardship initiatives to deal with problematic waste material/product streams. A critical aspect beyond collaborative infrastructure investment, and driving efficiencies in recycling supply chains, will be the development of strong domestic markets for recyclate, including through public procurement of recyclate.

Therein lies the opportunity:

1. established and efficient collection systems
2. mature infrastructure for sorting, processing and remanufacturing
3. then buying recycled.

If we can deliver on these fundamentals, then Australia can look forward to a more circular and sustainable economic future.

13.6 Australian Organics Recycling Association perspective

Overview

The Australian organics recycling industry in 2018-19 recycled 7.5 Mt [46] of organic material (AEAS 2020).

Over the last decade the recycled tonnage has grown by 3.4% annually, versus a population growth rate of 1.4%. Our national organic recycling rate is 51.5%-298 kilograms of organic material recycled for every Australian.

The industry's 305 businesses pay over $366 million in salaries. The average industry salary is $75,540, which compares favourably to Australian average weekly earnings of $64,390.

The industry employs 4,845 Australians, with one job supported for every 1,550 tonnes of organic material recycled. A further 4,070 indirect jobs are provided through flow-on activity.

The industry has a turnover above $2 billion and provides $1.9 billion in supply chain benefit. It contributes $724 million in industry value add to the economy, with a further $579 million value added through flow-on demand.

[46] Data given here may not be consistent with the data presented in other parts of the report due to difference in measurement method and scope.

The greenhouse gas saving from organics recycling is 3.8 million tonnes annually. This is equivalent to planting 5.7 million trees or taking 876,663 cars off the road.

COVID-19 impact

The COVID-19 pandemic has had an impact across the organics recycling industry. Processors relying on commercial premises for their feedstock have experienced difficulties with a drop in their inputs. Conversely, many processors relying on kerbside collection have noticed an increase in feedstock, perhaps driven by a greater focus on home cooking and gardening during the isolation period.

Similarly, retail demand for the industry's products has also grown in some markets, reflecting an increased interest in home gardening. In summary, COVID-19 has been problematic for a number of businesses in the industry, but the overall industry impact has been less severe than many others.

Our challenges

In the midst of the 'recycling crisis' following the China Sword bans, organics recycling faces different challenges: our major challenge is not an offshore decision or export bans. It is siloed decision making by governments working against agreed strategic goals and stifling better economic and environmental outcomes.

Australian waste management in 10 years' time

Australia's recycling rate of organic materials is 51.5% [46]. Were we to achieve a recycling rate of 95%, the industry would generate an additional $1.6 billion in supply chain opportunity and deliver 4,094 more jobs.

An extra 3.2 million tonnes of greenhouse gas emissions would be saved: equivalent to 4.8 million trees planted or 741,524 cars taken off the road each year.

13.7 Australian Packaging Covenant Organisation perspective

What has been the impact of the COVID-19 pandemic on your members / stakeholders?

The COVID-19 pandemic has had mixed economic impacts for the APCO membership community. While increased consumption and purchasing behaviours at home have driven demand for some manufacturers, packaging suppliers and grocery retailers, many others experienced a significant drop in income due to lost business in retail, hospitality and tourism.

The full impact of the pandemic on packaging consumption and waste is not yet known, but trends that are evident and will impact the APCO membership and stakeholder community include:

- the increase in online shopping is likely to generate more packaging waste at home, particularly corrugated cardboard and cartonboard
- during the most severe lockdowns most cafes were refusing reusable coffee cups, preferring single use cups for hygiene reasons
- with dine-in restrictions, many restaurants and cafes were providing pre-prepared meals for home consumption in single use packaging.

What are the most significant challenges facing Australian waste management providers and policy makers in 2020?

The economic downturn has affected waste management companies that service commercial and industrial premises, many of which have been closed or operating at reduced capacity during the second quarter of 2020. There is anecdotal evidence that municipal waste has increased over the same period as more people have been temporarily out of work or working from home, and due to the shopping trends outlined above.

Other challenges unrelated to the pandemic and the economic downturn include:

- more limited outlets for some recyclable materials due to import restrictions in Asian markets
- the falling price of virgin resins has flow on impacts on prices for recycled resins and the commercial viability of recycling plants
- high levels of contamination in kerbside recycling bins is adding to costs of collection.

What are the greatest opportunities facing Australian waste management providers and policy makers in 2020?

In 2020 there is an opportunity to build more recycling capacity in Australia, particularly for mixed paper, PET, HDPE and PP. Trends driving increased demand for locally processed recycled material include:

- commitments from large brand owners to increase the recycled content of their packaging
- the national target of 50% recycled content on average by 2025.

APCO outlined 14 critical opportunities in *Our Packaging Future* report, released in 2020.

Where do you believe Australian waste management should aim to be in 10 years' time?

Australia has the opportunity to build a sustainable and cost-effective approach to packaging recovery that is world-leading in terms of government and community impact, job creation and economic growth.

By 2030 we need to have successfully implemented the 2025 National Packaging Targets and be well on the way to achieving a circular economy for packaging. This approach is outlined in APCO's collective impact framework *Our Packaging Future* (APCO 2020).

13.8 National Waste and Recycling Industry Council perspective

The National Waste and Recycling Industry Council (NWRIC) is a not-for-profit industry association, funded by major waste and recycling businesses operating Australia wide. It brings together national business leaders and state affiliates to formulate policies to advance waste and recycling services in Australia.

NWRIC
NATIONAL WASTE AND RECYCLING INDUSTRY COUNCIL

2020 has not been the year everyone planned, the outbreak of the coronavirus globally has had unprecedented impacts on society and the economy. The impact on NWRIC members and customers has been substantial. But our members adapted quickly to new COVID-safe work environments to keep our 16,000 plus workforce safe and employed, our processing facilities open and our customers' services maintained.

Financially, businesses have had to adjust to changing volumes and revenues across the C&I, MSW, C&D and organic collection channels and export markets. Planned investments have been deferred and staff scheduling altered to keep as many staff employed as possible. Government has assisted financially with its business and employment support programs and deferral of levy increases and payments, and operationally with temporary changes to curfew times, opening hours and stockpiling thresholds.

Since the last National Waste Report in 2018 a national action plan has been established to address the many waste challenges Australia faces. The priority now is to implement these actions quickly.

Specifically, increasing Australia's capacity and investment in waste and resource recovery infrastructure to produce 'input ready' recovered materials for reuse in manufacturing or agriculture; creating greater local demand for recovered plastics, paper, glass and tyres; recovering energy from non-recyclable materials that otherwise will end up in landfill; and harmonising state policies and regulations for collections, licensing, end-of-waste definitions and energy-from-waste policies.

Two of the greatest opportunities for Australia are organics/food waste and energy recovery. Recovering organics and food waste as compost or energy, and recovering energy from non-recyclables can reduce emissions and leachates from landfill, build soil carbon, regenerate the land, capture carbon and provide renewable baseload power to the national grid.

Looking forward to 2030, the *National Waste Policy Action Plan* sets clear targets and actions which the NWRIC supports and is committed to working with governments to achieve.

NWRIC's immediate priorities are to continue to advocate for stronger markets for recovered materials; better enforcement of existing regulations to drive better practice; streamlining planning, licensing and approvals for infrastructure; greater source separation at collection to deliver cleaner inputs; national consistency between state waste policies, landfill levies, landfill management and infrastructure planning; removing hazardous substances from waste streams; and greater recovery of energy from material that cannot be recycled.

13.9 Waste Management and Resource Recovery Association of Australia perspective

Status of waste management and resource recovery

Focus on, and awareness of, our essential sector continues to grow, keeping industry firmly on the agenda at the smattering of Meetings of Environment Ministers and the former Council of Australian Governments over the last two years, in large part due to unprecedented public interest, global shifts, and continued industry advocacy. A series of devastating events over the last two years – floods, bushfires, and more recently, the ongoing COVID-19 pandemic – have cemented the fact that we provide essential services. Much policy development and awareness have occurred since the last report, including the waste export ban, the need for end-markets, greater involvement by upstream manufacturers and producers, and greater collaboration between jurisdictions; the latter being evident particularly during COVID-19 when we saw a number of consistent harmonised decisions.

Challenges

The lack of a consistent and agreed vision that values minimising reliance on natural resources and maximises demand for recycled remains a significant challenge, and will become more urgent with the waste export ban. An emphasis on design, extended producer responsibility and market development would shift this thinking, particularly when underpinned by a regulatory framework that supports a circular economy. Too many policies enable producers to treat end-of-life costs as someone else's problem, and too many barriers remain to turning disposed material (waste) back into valued resources.

Opportunities

As the export bans approach, bold complementary policy is needed that emphasises producer responsibility for managing environmental impacts across the supply chain. Mandated product stewardship schemes are required, starting with packaging. By putting the onus (including financial) on the generators of these products, we could achieve real change as we build our post-COVID-19 resilience. Moreover, mandatory schemes will take Australia closer to the circular economy, as producers and manufacturers are required to think more about design and material selection, as well as end-of-life management for their products. As we start to see more coordination between jurisdictions and greater leadership from the Federal Government, we have an opportunity to ensure every stakeholder in the supply chain contributes to developing a resource efficient economy.

Waste management and resource recovery in 10 years

Australians place real value on minimising the use of natural materials, avoiding the creation of greenhouse gases and waste at every opportunity, and we buy Australian recycled and preference products that use Australian recycled materials! Our policy settings enable us to build the infrastructure and drive the innovation needed to develop a vast and viable network of facilities in accordance with the waste management hierarchy, driving domestic recycling, remanufacturing and reprocessing, and boosting local economies.

14. End-of-life products and packaging

This chapter presents information on end-of-life products and packaging wastes. The quantities reported are a subset of those in the previous sections on waste generation, recycling and disposal, etc. The chapter opens with a discussion and data on container deposit systems, then addresses household hazardous waste collections. The third section is on the various product stewardship schemes, including a feature on the Australian Packaging Covenant and a listing of products under consideration for product stewardship.

14.1 Container deposit schemes

A container deposit scheme (CDS) establishes a legislated framework where sellers of eligible containers must return a deposit to people returning an empty container, reducing the incentive for proper management and reducing litter. Eligible containers may include glass, aluminium, plastic and liquid paperboard.

During the reference year of 2018-19, a CDS was operational in ACT, NSW, NT, Qld and SA. Combined, these systems collected about 3.5 billion containers. Table 21 summarises Australian CDS in 2018-19 and shows for each scheme the number of containers collected in total, the number of containers collected per capita, and the overall return rate. The NT system performed the best in 2018-19, with 450 collected containers per capita and an overall return rate of 84%. SA was not far behind on both metrics. These two systems are Australia's oldest and best established.

Photo 13 Reverse vending machines accept and return the deposits paid on drink containers under container deposit schemes

Reverse vending machines have proven popular for container deposit redemption in NSW and Qld.
Photo kindly provided by Envirobank

Table 21 Data on container deposit schemes of by state and territory, 2018-19

	ACT	NSW	NT	Qld	SA
Establishment year	2018	2017	2012	2018	1977
No. of collected containers (millions)	73	2,080	111	617[1]	612
No. of collected containers per capita	171	259	450	183[2]	351
Estimated overall return rate	50%	61%	84%	40%[3]	76%

1 Represents eight months of collection (1 November 2018 to 30 June 2019)
2 Extrapolated based on available data
3 Approximate return rate as at July 2020[47], so may not reflect 2018-19 results

Data sources: Exchange for Change (2019) ACT CDS Annual Statutory Report 2018-19; NSW Return and Earn Annual Statutory Report 2018-19 (forthcoming at the time of writing); NT EPA (2019) Environment Protection (Beverage Containers and Plastic Bags) Act Annual Report 2018-19; Container Exchange (2019) Qld Container Exchange Annual Report 2018-19; EPA SA (2020) Container Deposits webpage.

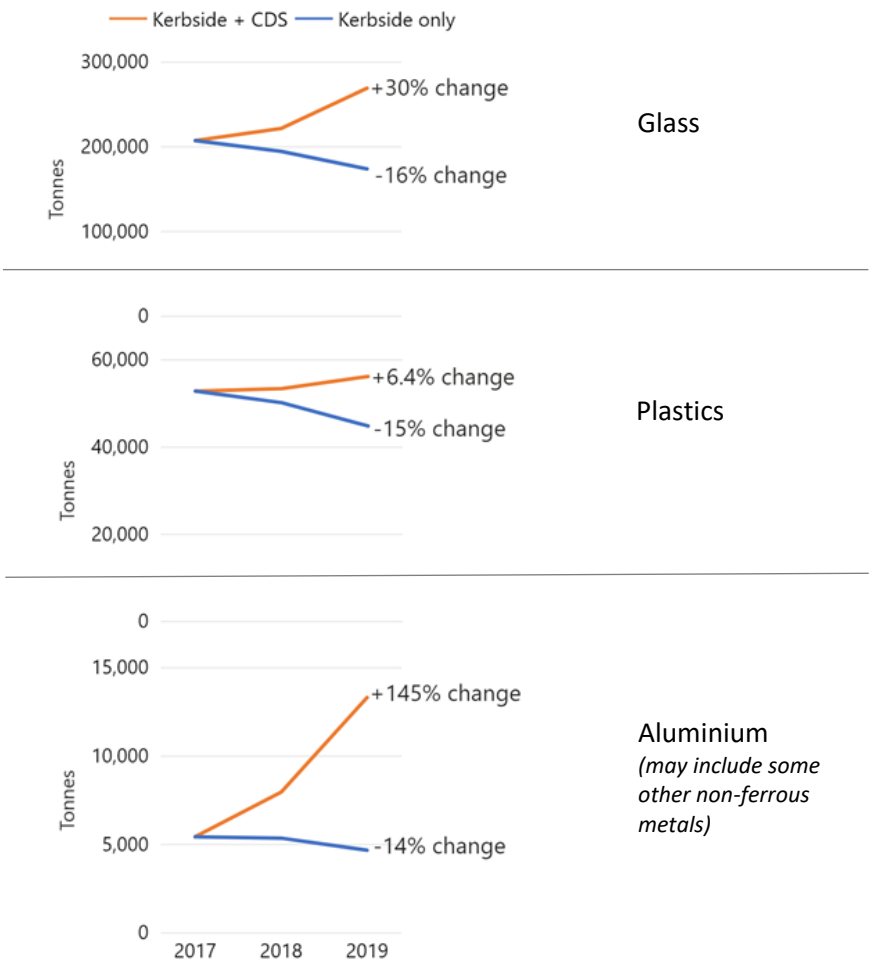
[47] See: https://wastemanagementreview.com.au/calls-to-improve-qld-container-recycling-scheme/

Establishing a CDS leads to better quality and more recovered material and reduces litter.

Figure 51 presents collected kerbside recycling quantities in NSW before and after the introduction of its *Return and Earn* scheme in December 2017.

The quantities of glass, plastic and aluminium collected at the kerbside fell by 16%, 15% and 14% respectively[48]. But when CDS quantities are added, the combined total of these material types increased by about 28%. NSW reported 33% less container litter since its scheme was implemented.

Figure 51 The impact of CDS on recycling in NSW



14.2 Household hazardous waste collections

Some state and local governments run programs to collect unwanted household products that are toxic, flammable, corrosive or explosive. While often expensive to run, these household chemical collection programs are justified by the high risks to human health and the environment from improper management or indefinite storage. Collected materials are recycled or used in energy recovery where possible, and otherwise are treated and destroyed or landfilled.

Table 22 shows the tonnes of household hazardous waste collected by some jurisdictions around Australia. Paint has been excluded from Table 22 because it is already reported in the data for the Paintback product stewardship scheme[49]. The high variability in collections reported by different jurisdictions may be attributed to different scopes of materials collected by the programs.

Table 22 Household hazardous waste collections, 2018-19

	Brisbane	Darwin	NSW	SA	Vic	WA
Tonnes of household hazardous waste collected (excluding paint)	3,205	159	1,991	40	179	376

[48] The establishment of CDS is not the only influence on material quantities over this timeframe. The quantity of non-CDS materials fell by 13%, mainly due to a 19% decline in the quantity of non-packaging paper (largely newspaper).

[49] Some jurisdictions collect paint outside the Paintback scheme, so some of the stated figures may be underestimates.

14.3 Product stewardship programs

Product stewardship is an approach to environmental management where those involved in producing and selling products share responsibility for reducing their impact, throughout their lifecycle, on the environment and public health. The *Product Stewardship Act 2011* (PrSt Act) provides a basis for establishing product stewardship programs, which may be voluntary, co-regulatory (industry action underpinned by Australian Government regulation) or mandatory[50]. Industries may also run their own schemes outside the PrSt Act. A recent review of the PrSt Act (DAWE 2020) upheld product stewardship as an essential policy tool for transitioning to a circular economy, and recommended continued and improved schemes for Australia's future.

Table 23 summarises Australian product stewardship schemes[51] in 2018-19 and shows the tonnes of relevant product collected reported by the scheme organisation. In most cases the collected materials are recycled; in others they are sent for safe treatment and disposal.

Product stewardship programs initiated or administered by the Australian Government

The **National Television and Computer Recycling Scheme** is Australia's only co-regulated product stewardship scheme under the PrSt Act, and is managed by four organisations under government-approved co-regulatory arrangements. The scheme collected about 55 kt of TVs, computers, printers and computer parts in 2018-19[52], and around 94% of the collected materials were recycled. Under the scheme's requirements, all collected materials must undergo 'first-stage recycling' (e.g. dismantling, shredding, sorting into material components) in Australia, and about a third of recovered materials were exported after this stage for further processing or sale.

MobileMuster is currently the only accredited voluntary product stewardship arrangement under the PrSt Act. The scheme collected about 84 tonnes of mobile phones and accessories in 2018-19, of which about 98% was recycled. Around 30% of available end-of-life phones were collected through the scheme.

Return Unwanted Medicines is a national not-for-profit company founded by the Australian Government to collect expired and unwanted medicines. Household medicines can be returned to any community pharmacy anytime, for safe collection and disposal. The returned medicines are disposed of by high-temperature incineration in accordance with regulatory requirements.

The **Product Stewardship for Oil Scheme**, established under the *Product Stewardship (Oil) Act 2000*, incentivises the re-refining and reuse of used oil. The scheme applies a levy on oil sales, which is used to fund oil recycling. In 2018-19, about 240 kt of recycled oil products were produced through the scheme.

Product stewardship programs initiated and administered by industry

Unwanted agricultural and veterinary chemical containers are collected through the **drumMUSTER** program. About 1,680 tonnes of containers were collected through the program in 2018-19, representing about half of the total containers available for recovery. The collected plastic and metal containers were recycled into products including wheelie bins, fence posts and irrigation pipes.

The **Chemclear** program collected about 70 tonnes of unwanted agricultural and veterinary chemicals in 2018-19. About 98% of the collected chemicals were used as alternative fuel sources,

[50] No mandatory schemes have yet been established under the PrSt Act.

[51] Our aim was to comprehensively cover active product stewardship schemes. We apologise for any oversights.

[52] 2017-18 data was used for MRI PSO, which had not submitted a 2018-19 annual report at the time of writing.

Table 23 National product stewardship schemes, 2018-19

Products covered	Product stewardship scheme	Start year	Scheme type	Tonnes of product collected[1]	Estimated capture rate[2]
TVs and computers[3]	National TV and Computer Recycling Scheme	2011	Co-regulated under the PrSt Act	55,248	47%
Mobile phones and accessories	Mobile Muster	1998	Voluntary under the PrSt Act	84	30%
Medicines	Return Unwanted Medicines	1998	Government initiated	816	
Oil	Product stewardship for Oil	2000		239,579[4]	
Agricultural and veterinary chemical containers	drumMUSTER	1998	Industry initiated and administered	1,678	50%
Agricultural and veterinary chemicals	ChemClear	2003		70	
Expanded polystyrene	Expanded Polystyrene Australia	1992		7,800[5]	25-30%
Fluorescent lights	FluoroCycle[6]	2010		Data not available	
Mattresses	Soft Landing	2009		Data not available	
Packaging[7]	Australian Packaging Covenant	1999		2,673,000	49%
Paint	Paintback	2016		6,300	
Printer Cartridges	Cartridges 4 Planet Ark	2003		1,051	
Tyres	Tyre Stewardship Scheme	2014		238,000	51%
Vinyl	PVC Stewardship Program	2002		Data not available	

1 As reported by the scheme operator
2 The estimated capture rate is the tonnes collected divided by the total eligible for collection under the scheme
3 2017-18 data was used for one of the four co-regulatory organisations (MRI PSO Pty Ltd)
4 Represents tonnes of recycled oil consumed or sold through the program
5 Estimate
6 FluoroCycle discontinued accreditation under the Product Stewardship Act 2011 in 2019
7 2017-18 data (2018-19 data unavailable)

and the remainder (chemicals such as organochlorines, arsenics and cyanides) either used as fuel to fire cement kilns, destroyed, or treated and landfilled.

Expanded Polystyrene Australia is an industry body committed to the stewardship of expanded polystyrene. In 2018-19, 52 kt of polystyrene resin was imported to Australia for expansion and use. About 70% of this material was used in long-term applications (e.g. insulation) and the remainder was mostly used in packaging. An estimated 5,100 tonnes of additional expanded polystyrene entered Australia as packaging for imported products (e.g. white goods). In 2018-19, an estimated 7,800 tonnes of expanded polystyrene were collected and recycled, representing about 25-30% of the material available for recovery.

The **FluoroCycle** scheme, administered by the Lighting Council of Australia, aims to increase the recycling of mercury-containing lamps and prevent such items from entering landfill. The scheme gained accreditation under the PrSt Act in 2014 but this lapsed in 2019. The scheme reportedly

continues to operate as a voluntary, industry-led program. The Lighting Council was unable to provide 2018-19 data on quantities recovered. In 2016-17 it reported recovery of about 900 tonnes of lighting materials.

Soft Landing is a national social enterprise committed to mattress recycling. Three quarters of a typical mattress is recyclable, including components made of steel, foam, latex, husk and timber. An estimated 1.6 to 1.8 million mattresses are disposed each year, of which more than half is estimated to be landfilled (SSCEC 2018).

Paintback is an industry-led product stewardship program that collects and manages unwanted paint and paint packaging. In 2018-19, the program collected about 6,300 tonnes of paint and containers – an almost 47% increase on the previous year. The collected paint was used in energy recovery or treated and landfilled. Generally, steel paint cans were recycled and plastic containers landfilled.

Printer cartridges pose leachate risks at landfills and contain recoverable metals, plastics and inks. The **Cartridges 4 Planet Ark** program collected and recycled about 3.6 million printer cartridges in 2018-19, reclaiming about 1,050 tonnes of material. Collected cartridges are dismantled and separated into plastic, toner and metal components, each of which is recycled into a range of products. The program collects more cartridges each year but the tonnes of materials collected is decreasing as newer printer cartridge models contain lighter materials and less metals.

Feature 4 The Australian Packaging Covenant and the National Packaging Targets

Australia's largest product stewardship program is managed and administered by the Australian Packaging Covenant Organisation (APCO) and underpinned by the National Environment Protection (Used Packaging Materials) Measure 2011. APCO data for 2017-18 is presented below (2018-19 data was not available).

Packaging represents about 7% of waste generated.

Material type	Consumption *(Mt)*	Recovered *(Mt)*	Recovery rate
Paper & cardboard	2.90	1.82	63%
Glass	1.27	0.58	46%
Plastic	1.07	0.17	16%
Metal	0.21	0.10	48%
Total	**5.45**	**2.67**	**49%**

Source: APCO (2019b)

APCO has led the development of Australia's National Packaging Targets, which aim to 'create a new sustainable pathway for the way we manage packaging in Australia'. The four targets, to be achieved by 2025, are:

- **100% reusable, recyclable or compostable packaging**
- **70% of plastic packaging being recycled or composted**
- **50% of average recycled content included in packaging**
- **the phase-out of problematic and unnecessary single-use plastics packaging.**

The National Packaging Targets will require a systemic change to the way we create, collect and recover our product packaging, and will apply to all packaging that is made, used and sold in Australia.

Developed following extensive industry and government consultation, the targets are in line with broader sustainable packaging shifts that are taking place globally to reduce the volume of material entering landfill, improve recycling rates, and increase the use of recycled material in future packaging.

APCO has over 1400 members including Coles, Woolworths, Coca-Cola Amatil, Nestlé, Goodman Fielder and Qantas.

For more details, see the APCO website: https://www.packagingcovenant.org.au/

The **Tyre Stewardship Scheme** participants collected about 238 kt of end-of-life tyres in 2018-19, which represented about half of the total end-of-life tyres available for recovery[53]. Around 52% of the tyres collected through the scheme were recovered, with the majority shredded or baled and exported for use as tyre-derived fuel. About 9% of collected tyres were reused or recycled domestically. The fate of a large proportion (43%) of collected tyres was reported as unknown. Analysis subsequent to the scheme annual report suggests most is exported as a fuel or disposed of at mining sites and other remote locations (TSA 2020).

[53] The total tyres available for recovery is based on a 2018-19 tyre material flow analysis (Envisage Works 2019).

The Vinyl Council of Australia aims to increase the recycling rates of polyvinyl chloride (known as PVC or vinyl) products through their **PVC Stewardship Program**. Vinyl is highly durable and is typically used in long-term applications. About 719 tonnes of vinyl was recycled locally in Australia in 2018, an increase of about 14% on the previous year.

Product stewardship priority list

Under the PrSt Act, each year the Minister for the Environment lists product classes to be considered for product stewardship approaches. Items on the 2020-21 list and some information about them is given in Table 24. Further information is available on the Department's website.

Table 24 Information about products on the product stewardship priority list

Product	Information
Batteries	In 2017-18 (data for 2018-19 was not available) an estimated 169 kt of end-of-life batteries were collected in Australia, with 88% of these lead acid batteries (≥5 kg), 11% handheld batteries, and 1% battery energy storage systems and electric vehicle batteries (Envisage Works 2020). The proportion of collected batteries sent for recycling was high for lead acid batteries (99%) and battery energy storage systems and electric vehicle batteries (81%) but low for handheld batteries (11%). Australia's recycling of handheld batteries is low compared to most European countries. The Battery Stewardship Council is progressing toward a voluntary industry scheme.
Child car seats	It is important for safety reasons that end-of-design-life child car seats are taken out of circulation. Currently most disposal is to landfill but a 2017 recycling trial suggested there are reuse and recovery opportunities including clean plastic and metal.
Electrical and electronic products	Electronic waste (e-waste) can contain valuable components as well as toxic substances (e.g. heavy metals). Blue Environment modelled the generation of e-waste by combining consumption data with lifespan distribution parameters established by the United Nations University. The model suggests that in 2018-19 about 539 kt of e-waste were generated in Australia, an increase of about 3.7% on the previous year. It is believed that most collected e-waste in Australia is recycled, mostly through operations processing white goods and similar products.
Photovoltaic systems	The volume of photovoltaic system equipment (panels, inverters and energy storage systems) reaching end-of-life is expected to grow exponentially over coming years. The quantity of panel waste alone has been modelled to rise from about 6,000 tonnes in 2018 to 100,000 tonnes in 2035 (Equilibrium 2019 p.7). Components of photovoltaic systems may contain hazardous substances as well as recoverable materials of value. At present, most material is disposed of in landfill. Work on a scheme for photovoltaic systems is being led by the Victorian Government with the support of the Australian and other state and territory governments, industry and other stakeholders.
Plastic microbeads	Plastic microbeads are manufactured plastic particles less than 5 mm in size. They are used in many cleaning products, cosmetics and personal care products and can persist in the environment for a long time. In 2016 Australia's environment ministers formally endorsed a voluntary industry phase-out of plastic microbead ingredients from cosmetic, personal care and household cleaning products. The voluntary phase-out is being run by industry and guided by a government monitoring and assurance protocol.
Plastic oil containers	Plastic oil containers have the potential to harm the environment and people because of the residual oil they contain. There is potential to increase the recovery of resources and reduce the impacts on the environment and human health through collection and recycling of these containers.

15. Liquid waste

This chapter provides an overview of liquid waste generation, management, treatment and fate in Australia in 2018-19. It reports on both non-hazardous liquid waste (sewage and trade waste) and hazardous liquid waste. This section aims to illustrate and discuss key waste flows between the solid waste management industry and the wastewater industry.

The following definitions have been adopted for this report:

- Sewerage system – the network of pipes used to deliver both sewage and trade waste to sewage treatment plants.
- Sewage – human excreta or domestic waterborne waste, whether untreated or partially treated.
- Household liquid waste – liquid waste disposed of into household bins or household chemical collection programs.
- Hazardous liquid waste – liquid waste that falls under the *National Environment Protection (Movement of Controlled Wastes Between States and Territories) Measure.* This covers most liquids not disposed directly to the sewerage system from commercial and industrial premises.
- Trade waste – non-sewage discharges to sewer from industrial and commercial premises. Excludes hazardous liquid waste but includes non-sewage discharges from hazardous waste treatment facilities.

Data sources and method

The Bureau of Meteorology publishes an annual 'urban national performance report' (BoM 2020) and supporting dataset, providing a detailed account of non-hazardous liquid waste generation and management in Australia by financial year. The report covers sewage, trade waste, treated effluent discharges and treated effluent recycled, and is compiled from 85 service providers including bulk water authorities, water utilities, and councils servicing more than 80% of the Australian population. Another report prepared on commission to the Australia and New Zealand Biosolids Partnership (PSD 2019) provides data on biosolids generation.

Figure 52 provides an overview of liquid waste generation and fate in Australia in 2018-19. Liquid waste generation, management, treatment and fate are each discussed in the sections below.

15.1 Liquid waste generation 2018-19

Sewage

Sewage is the main liquid waste from households. In 2018-19, about 1,790 gigalitres (GL) of sewage was discharged to sewer, mostly from households. This quantity represents by far the largest portion of liquid wastes.

Trade waste

Some service and manufacturing industries dispose of trade waste to the sewerage system. Trade wastes are usually controlled by individual licence agreements between a company and the local water authority. Typically, the agreement sets out contaminant types and a maximum contaminant loading that can be discharged per unit volume of discharge from the premises, and often also sets a volume limit. At about 158 GL, trade waste is the second largest of Australia's liquid waste flows.

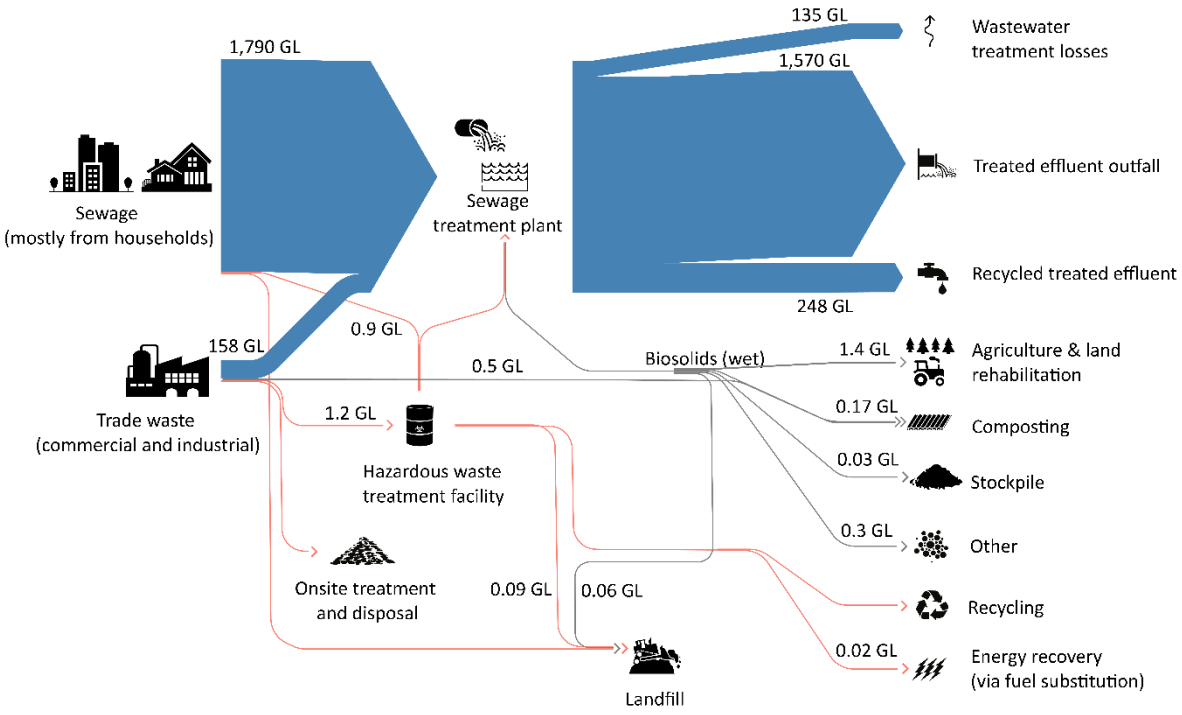
Hazardous liquid waste

Many manufacturing, food preparation and service industries generate various types of liquid hazardous wastes, totalling about 2.1 GL. Most of these are unsuited to management through the wastewater system, such as oil-based wastes (about 31% of the total) or acids, alkalis, solvents and organic and inorganic chemicals (about 16%). These materials are generally treated to reduce or neutralise the hazard levels and volumes, with residues discharged to sewer, landfilled or recycled. High calorific materials may be used as an energy source in cement kilns. Food-derived hazardous waste such as grease trap makes up a further 31% and is mostly composted.

Households also generate hazardous waste liquid when disposing of household chemicals through programs run in most states and territories (see Section 14.2) or illegally to sewer or landfill.

Hazardous wastes are analysed in detail in the *Hazardous Waste in Australia* report series, most recently the 2019 version (BE and AWE 2019) with the next of these biennial reports due in 2021.

Figure 52 Overview of liquid waste generation and fate in Australia 2018-19



Mass balances may not be perfect due to rounding, stockpiling and wastewater returned for further treatment.

15.2 Liquid waste collection and movement

Liquid waste is collected and moved through the sewerage pipe network, specialist vehicles or private transport to central collection sites (i.e. domestic liquid waste).

Sewerage pipe network

In most of Australia, sewage and trade wastes are collected through the sewerage system and stormwater is managed through separate collection and discharge system. In the late 19th and early 20th century some combined stormwater and sewerage systems were built in Australia but these have been mostly replaced. The sewerage system typically delivers the sewage to a sewage treatment plant for treatment to enable recycling or discharge to the environment.

Commercial liquid waste transport

Hazardous liquid waste and some non-hazardous liquid waste is transported from industrial and commercial premises by private waste management companies. Non-hazardous liquid waste is usually transported to a recycling facility or to a permitted sewerage system inlet.

In NSW, Qld, Vic, WA and SA, hazardous waste transport within the jurisdiction's borders is subject to a tracking system that keeps government informed on the movement of the wastes. This requires that transporters, generators and receivers verify the quantity and type of waste moved and report it to the regulator. Where hazardous waste is transported across state borders, the *National Environment Protection (Movement of Controlled Wastes Between States and Territories) Measure* establishes a different national system for reporting and control. Small amounts of liquid hazardous waste are exported overseas for treatment under permit.

15.3 Liquid waste treatment

The two types of liquid waste treatment facility are sewage treatment plants and hazardous waste treatment facilities.

Sewage treatment plants

BoM (2020) reports that in Australia in 2018-19 there were 683 sewage treatment plants operating to treat sewage and trade waste. Not all plants provide the same levels of treatment: the levels are generally defined as primary[54], secondary[55] or tertiary[56] treatment. Based on the BoM (2020) supporting database, 55% of Australian wastewater was treated to tertiary levels, 26% to secondary levels and 20% to primary levels.

After system losses, wastewater received by sewage treatment plants in 2018-19 had one of three main fates:

1. Discharge – about 1,570 GL of treated effluent was discharged to the ocean or a local water body.
2. Recycling – about 248 GL was treated then recycled, mainly as irrigation water.
3. The remainder is biosolids, which are collected from tank bottom sludge in sewage treatment processes. Based on a report by consultancy PSD (2019), in 2018-19 Australia generated about 1.8 GL of biosolids[57] of which about 82% was recycled directly to agriculture or land rehabilitation, 9% was composted and the remainder managed through stockpiling, landfill, ocean discharge or other means. The estimated 225,000 tonnes of biosolids sent to composting operations or landfills represents the largest flow from liquid to solid waste management systems.

[54] The UN (2007 p. 217) defines primary treatment of public wastewater as treatment of wastewater by a physical and/or chemical process involving settlement of suspended solids, or other process in which the 5-day biochemical oxygen demand of the incoming wastewater is reduced by at least 20% before discharge and the total suspended solids of the incoming wastewater are reduced by at least 50%.

[55] The UN (2007 p.217) defines secondary treatment of public wastewater as post-primary treatment of wastewater by a process generally involving biological or other treatment with a secondary settlement or other process, resulting in 5-day biochemical oxygen demand removal of at least 70% and a chemical oxygen demand removal of at least 75%.

[56] The UN (2007 p.217) defines tertiary treatment of public wastewater as treatment (additional to secondary treatment) of nitrogen and/or phosphorous and/or any other pollutant affecting the quality or a specific use of water (microbiological pollution, colour etc.). For organic pollution, the treatment efficiencies that define a tertiary treatment are the following: removal of at least 95% for 5-day biochemical oxygen demand and 85% for chemical oxygen demand, and at least one of the following: nitrogen removal of at least 70%; phosphorus removal of at least 80%; and microbiological removal achieving a faecal coliform density less than 1,000 in 100 ml.

[57] Assumes an average solids content of 21%.

Hazardous liquid waste treatment facilities

Large hazardous liquid waste treatment facilities are located in all jurisdictions except ACT, NT and Tas, which export the bulk of their hazardous liquid waste to other jurisdictions for treatment. In 2018-19, about 1.2 GL (or 1.2 Mt) of liquid waste was sent to hazardous liquid waste treatment facilities.

Unlike the sewerage network and treatment system, these treatment facilities are privately owned and operated. The services they provide vary widely. Some specialise in a single commonly arising type of liquid waste that is readily reused or recycled (e.g. waste oils and lubricants). Others receive an extensive and complex range of liquid and 'sludge state' wastes. Facilities generally manage these liquid wastes by either:

- reducing the hazardous characteristics to enable recycling, energy recovery or disposal to sewer or landfill
- chemically or physically immobilising the hazardous component of the liquid waste (for example by adding a binding agent such as lime) to solidify the waste and enable disposal to a hazardous solid waste landfill.

Hazardous waste treatment facilities are another major interface between solid and liquid waste management systems. They generate solid waste when hazardous liquid waste is solidified or when sludges are dried.

16. Current and emerging challenges

The management of waste operates in a dynamic environment, changing in response to community demand, government policy, technological development and market circumstances. This chapter explores some of the current and emerging challenges faced by the waste sector. It considers major challenges the sector is currently facing such as the COVID-19 pandemic, export bans on some recovered materials, climate change responses and the role of single-use plastic. It also discusses some of the challenges of growing importance in the future.

This chapter includes a contribution from the Boomerang Alliance, a grouping of 49 organisations (mainly environmental groups) with a particular concern about waste.

16.1 COVID-19 pandemic

The COVID-19 pandemic has had impacts on the waste and resource recovery sector, as it has on all sectors of Australian society. At the time of writing, Australia's social disruption is largely focused in Victoria but, as a widely available vaccine is unlikely to be available in the short-term, the wider effect on Australia and the waste and resource recovery sector may not be known for some time.

There has been general recognition that waste management is an essential service, although different jurisdictions have shown a variability in approach. In some jurisdictions (e.g. WA, SA), memoranda of understanding were developed between key industry and local government players to facilitate continuity of service and sharing of facilities during the pandemic. The concentration of the industry among a handful of major companies has contributed to some stability. It is understood some smaller companies (especially those servicing regional areas or the non-government sector) have reported cash flow and solvency issues.

To date, kerbside waste collection services have been largely uninterrupted, especially in jurisdictions that have reported low virus numbers. Waste management facilities in some areas have reported significant increases in traffic and waste quantities (as people staying at home undertook home improvement projects), while others have reported a reduction in traffic (as police fined people travelling to drop-off facilities) or were closed to the general public (in Victoria). There has been some change in waste generation patterns reported (e.g. an increase in household waste, a reduction in waste from central business districts and C&I waste) but it is too soon for clear trends to be evident.

Material processing is believed to have slowed at some recycling facilities, especially in states most affected by the pandemic. Organic processing facilities have reported a decrease in feedstocks from commercial sources, off-set to some degree from increased food waste from residential kerbside collections, sometimes with higher levels of contamination. The impact of the pandemic is not strongly apparent in the data on exports of waste-derived products.

Some international media have reported significant dumping of pandemic-related waste, such as medical masks and hand sanitising containers) in marine and other environments. No major incidents have been reported in Australia.

The pandemic is forecast to have long-term financial impacts on the Australian economy and all sectors of business and the community. The waste and resource recovery industry is unlikely to be exempt.

16.2 Banning the export of waste plastic, paper, glass and tyres

Exports of wastes came to public prominence after China's 2017 and 2018 announcements restricting the import of certain waste-derived products[58]. Global flows of these materials were displaced to other south-eastern Asian countries, many of which have now implemented their own restrictions[59].

The disruption and uncertainty of end-markets drove prices lower (see Table 6 on page 17) and led to a slump in markets, stockpiling by Australian recyclers, diversion of some recyclables to landfill, and the collapse of a major recycling company servicing SA, Tas and Vic.

In response, in August 2019 the then Council of Australian Governments announced that bans would be established on the export of some waste-derived products. A detailed strategy was released the following March (COAG 2020). The bans will apply to waste plastic, paper, glass and tyres that have not been processed into a value-added material. The four-year implementation timetable is set out in Table 4 (p.8).

Feature 5 Recycling and Waste Reduction Bill 2020

In August 2020 the Australian Government introduced legislation to provide a national framework for managing waste and recycling. The legislation implements the export bans and incorporates the existing *Product Stewardship Act 2011* with improvements to encourage companies to take greater responsibility for the waste they generate, including through better product design and increased recovery and reuse of waste materials.

As a consequence, local processing opportunities have increased in importance. In July 2020 the Australian Government announced it will commit $190 million to a new Recycling Modernisation Fund. Funding will be provided to the states and territories through National Partnership Agreements, and allocated to specific projects by state and territory governments following assessment of their jurisdiction's major gaps in local reprocessing capacity. Taking into account additional funding from jurisdictions and industry, the Government anticipates that $600 million of recycling infrastructure will be developed and 10,000 jobs created (Ley and Evans 2020).

Most states and territories have also announced support for local processing through initiatives such as the release of circular economy policies, funding programs for infrastructure development, and promoting purchase of products which include recycled content.

It will take some time for these local initiatives to result in more on-shore processing facilities and the development of a stable market for recovered resources. In the interim, the waste and resource recovery industry can likely expect to see continued pressure on supply contracts and market prices as Asian import bans are phased in over the next few years.

16.3 Solid waste management and climate change

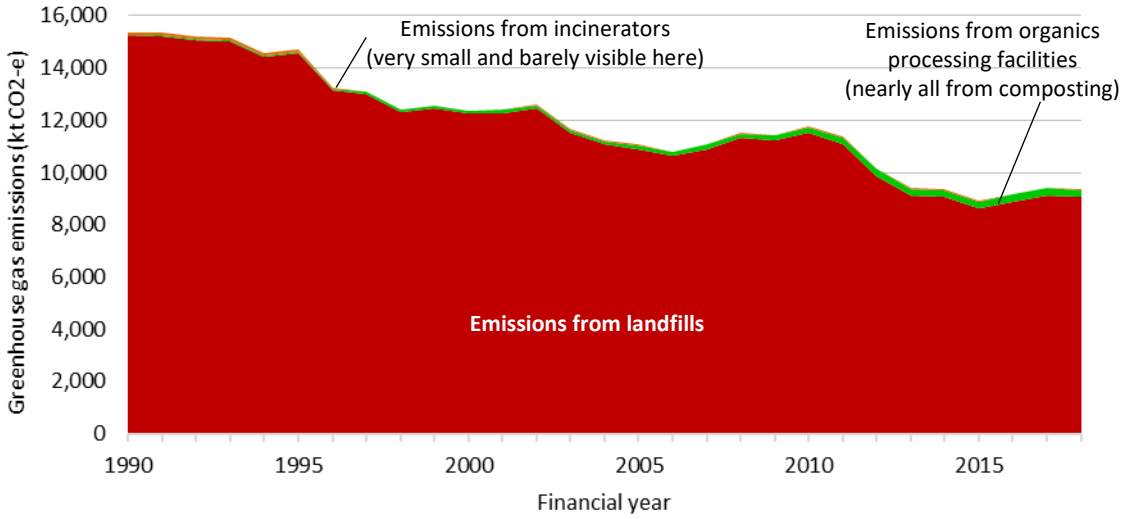
The carbon footprint of waste management is complex. The National Greenhouse Gas Inventory 2018, published by the Department of Industry, Science, Energy and Resources puts the direct emissions from solid waste management (landfill, biological treatment and incineration) at 9.4 Mt of carbon dioxide equivalent (CO_2-e) in 2017-18, or 1.7% of Australia's total. Methane from landfills represented 97% of these emissions. Landfill emissions have declined substantially over 25 years due to increasing methane capture and combustion.

[58] In 2018-19 4.4 Mt of waste was exported, including 1.4 Mt (or 32%) of waste plastic, paper, glass and tyres (COAG 2020).

[59] These include Indonesia, India, Vietnam, Malaysia, Thailand, Republic of Korea and Taiwan, all of which receive Australian waste-derived products.

In addition to the direct emissions from solid waste management are those from use of fossil fuels and electricity at waste facilities, and waste transport[60]. Some waste management operations use large amounts of on-site fossil fuels or electricity, including paper recycling, MRFs and, in particular, scrap metal reprocessing. Emissions from collecting and transporting waste are relatively low – depositing a 20-tonne load of municipal waste in a landfill with no gas capture would produce more emissions than driving that load on a 14,000 km lap of the continent.

Figure 53 Trends in greenhouse gas emissions from solid waste management, 1989-90 to 2017-18



Source: Australian Greenhouse Emissions Information System

Some other interactions between waste management and carbon emissions are tabulated below.

Table 25 Interactions between waste management and carbon emissions

Activity	Interaction	Comment
Recycling	Recovered material substitutes for primary material that is more emission intensive	This effect can be large, and is particularly significant for metals
Extracting energy from waste	Can supply low or zero emission energy that substitutes for fossil fuels	Currently, energy is extracted mainly from landfill gas, but there is major growth in 'solid recovered fuels', and energy-from-waste infrastructure is being planned or under development
Carbon storage in soils and landfills	Decay of organic carbon is prevented or delayed	Smaller impact

This complex footprint points to opportunities for reducing net emissions by:

- managing landfills to reduce emissions, including by capturing and combusting landfill gas
- directing organic wastes away from landfills towards soil improvement or energy generation
- generating low emissions energy, particularly from organic wastes, through thermal energy-from-waste, anaerobic digestion, waste-derived fuels and landfill gas electricity generators
- increasing recycling, especially of metals.

[60] In the National Greenhouse Gas Inventory, these emissions are reported as arising in the energy sector.

16.4 Plastics

The environmental impact of use and disposal of single use plastic has gained increasing attention in recent times. The effect of marine litter on aquatic ecosystems and developing countries has led to public support for strategies which eliminate or minimise the use of single use plastic. Other sources of plastic pollution include tyre dust, worn road marking residues, microfibres from washing machines and microplastics in cosmetics.

Previous plastic bag bans by state and territory authorities have been complemented by recent initiatives implemented by local governments in most states to reduce the use of plastic. In one case (City of Hobart) this has included a local by-law ensuring food retailers use only plastic that is certified compostable based on Australian Standard AS4736.

Plastics recovery levels remain generally low in Australia, with only 15% of plastics estimated to be recycled or used for energy recovery in 2018-19. Early moves by some councils to collect soft plastics for recycling have largely ceased due to the collapse of Asian markets, with the recycling of soft plastics now reliant on systems established by large supermarket chains. Market constraints have also led some waste companies to reduce the range of hard plastics accepted for recycling.

Photo 14 Used plastic that is improperly managed is a hazard to wildlife

Photos from via Shutterstock.com by Tunatura (left), Sue Martin (top right) and Maxim Blinkov (bottom right)

Plastic consumption remains on an upward trajectory. WEF (2016) advises that global production of 15 Mt in 1964 grew to 311 Mt in 2014, is expected to double again by 2034 and almost quadruple by 2050. There are currently few incentives for reducing or eliminating the use of plastic at the production level. In some countries, bans or taxes will be introduced to drive change[61].

[61] In 2021 the European Union will introduce a ban on some single use plastics; in 2022 the UK Government will introduce a tax on plastic packaging produced or imported into the UK that does not contain at least 30% recycled content.

16.5 Waste crime

Waste is associated with goods having zero or negative value to their owners. This can incentivise improper management at cost to the environment and society. The imposed costs can range from reduced enjoyment of the environment through to fire risks, serious health impacts and pollution. Waste crime undermines the legitimate waste sector and limits its ability to operate sustainably and profitably. It costs society significantly each year through direct clean up and regulatory costs and lost government revenue.

This chapter discusses various types of illegal waste activities experienced in Australia and the efforts to limit them. The term 'waste crime' is used here to cover all types of offences centred on waste.

Photo 15 A burning warehouse containing illegally stored solvents spreads smoke across Melbourne's western suburbs

In August 2018, a fire broke out at a warehouse containing over 20 million litres of allegedly illegally stockpiled solvent waste. It took more than a week to fully extinguish and polluted the local creek. The fire led to the discovery of over 50 million litres of illegally stored or buried waste solvents in warehouses and a rural property – more than double the quantity recorded as legally managed in Australia in 2017-18.

Photo by Shuang Li, via Shutterstock.com

Types of waste crime

Table 26 describes and gives examples of types of waste crime. It covers the spectrum of seriousness, from petty littering to organised criminal activity with major environmental and social impacts. Illegal activities are described that can be committed along the length of the supply chain, from waste generators, to transporters, to waste facility operators. A particular illegal operation may depend on collaboration, or at least a 'blind eye', from participants at more than one part of this supply chain. It may also involve more than one of the activities listed in the table.

Table 26 Types of waste crime

Activity	Description	Examples
Littering	Small scale improper disposal of waste to save effort, often done spontaneously	Keep Australia Beautiful (2018) reports cigarette butts and packaging are the most commonly littered items
Dumping	Larger scale improper disposal, typically involving planning and transport	Deposition of construction and demolition waste on vacant industrial or rural land. Dropping unwanted furniture in laneways, bush areas or outside charity shops
Hiding	Placing waste requiring special management amongst waste that does not	Concealing asbestos contaminated materials at the bottom of skip bins, or household chemicals in garbage bins
'Shandying'	Mixing hazardous and non-hazardous materials to reduce contamination below regulated thresholds	Commonly undertaken with contaminated soils
Disguising	Passing a waste off as something it is not	Pretending contaminated soil is 'clean'
Illegal export	A type of disguising to bypass the requirements of the *Hazardous Waste (Regulation of Exports and Imports) Act 1989*	Export of used lead acid batteries without a permit; export of electronic waste for fake 'repairs'; export of recyclate highly contaminated with garbage
Cost falsifying	Claiming for non-existent additional costs	'Finding' asbestos in a half-demolished building
Levy fraud	Avoiding landfill levies by dishonestly describing the waste type or origin	May be occurring in WA with C&D waste taken from metropolitan to non-metropolitan landfills
Illegal acceptance	Unauthorised acceptance of waste	Acceptance of organic-rich loads at an 'inert' landfill; transport without proper certification
Illegal stockpiling	Storage of waste at a facility to levels exceeding requirements	Storage of combustible recyclables beyond levels prescribed by the regulator
Illegal management	Acceptance of waste requiring specific management, then undertaking cheaper management or stockpiling	Solvents received for treatment and disposal but then stockpiled or stored in warehouses (see Photo 15)
Inadequate management	Management of waste at a facility to a standard that does not meet requirements	Inadequate control of run-off, litter, dust, noise, odour risks, fire risks, etc.
Illegal combustion	Setting fire to waste as a means of disposal, potentially also involving insurance fraud	May be undertaken by 'recycling' operations in financial trouble
Illegal landfilling	Acceptance of waste at a location not authorised to receive waste	Receipt of demolition waste as 'fill' for a low-lying area
Abandonment	Deliberate accumulation of waste with a view to not managing the materials but keeping gate fees	Renting a warehouse under a false name, advertising receipt of skip bins for 'recycling', then disappearing
'Phoenixing'	Repeated closure and re-establishment of an operation to avoid liabilities	As 'Abandonment', but instead of a false name and disappearance, use of a company that is subsequently dissolved with the operation restarted under a different name

Controlling waste crime

Measures governments can take to control waste crime include monitoring and enforcement, ensuring waste generators take due care, incentivising proper management, and phasing out easily littered materials.

Monitoring and enforcement
State and local governments commit significant effort into detecting and enforcing major waste crime. Monitoring and enforcement regimes cover:

- intelligence gathering and data analysis
- waste facility permitting, monitoring, reporting and auditing
- tracking systems for reporting waste movements
- surveillance and detection regimes such as cameras, 'dob-in' hot-lines and aerial observation
- detective work to trace offenders
- strong penalties when offenders are identified.

Better waste management standards increase costs and, unfortunately, make illegal activity more lucrative. EPA Victoria reports rogue demolition businesses building the cost of fines into quotes[62]. States and territories have been boosting their enforcement capacities and fines in recent years. NSW has regional illegal dumping squads that specialise in combating illegal dumping. NSW and Victoria have established waste crime divisions focusing on organised crime in the waste sector.

Sometimes an operator offers too-cheap prices for recycling then goes bankrupt, leaving a waste legacy for the state to manage. This has commonly occurred with construction and demolition waste (see Photo 16) and end-of-life tyres. The operator may have criminal intent or simply be an imprudent business person. States and territories are guarding against this difficult challenge through increased vigilance and limiting allowable stockpile sizes.

Photo 16 Abandoned construction and demolition waste near Geelong, Victoria

At the time of writing, the estimated 340,000 m^3 is being removed at a cost to taxpayers expected to exceed $30 million[63]. The bankrupt operator received an 18-month community corrections order and a $15,000 fine. The landowner also went into liquidation. EPA is pursuing clean-up costs from the liquidator.

Photo kindly provided by the Geelong Advertiser

62 https://www.epa.vic.gov.au/about-epa/what-we-do/compliance-and-enforcement/tackling-waste-crime/the-state-of-waste-crime-in-victoria
63 https://www.premier.vic.gov.au/lara-waste-stockpile-clean-up-begins/

Ensuring waste generators take due care

Environmental legislation often includes provisions placing liability on companies, and sometimes their directors personally, to ensure the environmental impacts of their activities are properly managed. A waste producing company and/or director could potentially be held accountable for using a waste service offering a price 'too good to be true' if that operator subsequently mismanaged the waste.

Incentivising proper management

Incentives for proper management reduce the pay-off for waste crime. This is one of the foundations of container deposit systems, which return a fee for empty drink containers. The NSW 'return and earn' scheme reportedly led to a 33% reduction in littering of drink containers (NSW EPA 2019 p.33). Australia's Product Stewardship for Oil scheme (see Chapter 14) similarly subsidises the recycling of waste oil using funds from a levy included in the purchase price. Several states impose no or low landfill levies on asbestos to reduce the price of landfilling.

Phasing out easily littered materials

Some often-littered materials can be readily phased out. Until the 1980s, aluminium can tops were not fixed to the can and were ubiquitous in litter. Over the past few years, single-use plastic bags have been banned across most of Australia. Other items likely to be phased out in the coming years are plastic straws, stirrers, cutlery, plates and expanded polystyrene containers.

Feature 6 Cleaning up litter and dumped waste

When prevention and enforcement fail, responsibility for cleaning up large-scale waste dumps typically falls to the state or territory government, and small-scale dumping and litter to local governments. States and territories were asked for data on the tonnes and costs of cleaning up dumped waste. Qld reported that local governments cleaned up 4,700 tonnes at a cost of $25.3m. Vic local governments reportedly cleaned up 41,600 tonnes at a cost of $17.3m.

Many non-government and industry organisations, including Clean Up Australia and Keep Australia Beautiful, work to reduce litter through education, provision of bins and clean-up events. Most states and territories have 'Adopt-a-Roadside' and 'Adopt-a-Spot' programs under which community groups including service organisations such as Rotary, Lions and Apex, as well as schools, sports clubs and other groups, adopt an area and keep it clean of litter.

Photo 17 Clean Up Australia Day focuses community effort on cleaning up dumped waste

Photo by Joe Pickin

16.6 National harmonisation

The Australian Government is working with state and territory authorities to harmonise waste management policies and initiatives across jurisdictions. The *National Waste Policy Action Plan* (Australian Government *et al.* 2019) was developed in collaboration with all jurisdictions, setting out targets and actions for national efforts. Recent Australian Government announcements of financial support under the Recycling Modernisation Fund are expected to integrate with state and territory funding programs.

A standard for waste and resource recovery data and reporting is currently under development, led by the Australian Government with collaboration from all state and territory authorities. This is intended to establish a reference of common definitions for non-hazardous waste. This follows previous work on a similar standard for hazardous waste.

All states and territories have now either introduced or committed to introduce container deposit schemes, but there are some differences in the schemes for each jurisdiction. Interest is emerging in standardising the schemes into a common national approach.

16.7 Circular economy

Circular economy policies have been released by most state and territory governments. This should result in continued reuse and recycling of materials, reducing the need for extraction of virgin materials and minimising the amount of waste disposed to landfill. Implementation of a circular economy requires a fundamental shift across the Australian economy and is a long-term initiative. Interim waste management steps would involve increasing the reuse and recyclability of materials.

16.8 Infrastructure planning

There has been recent attention given by the Australian Government and states and territories to the adequacy of waste and resource recovery infrastructure in managing a variety of material streams. This is expected to prove especially critical to local processing of recyclables arising from the implementation of Australia's waste export ban.

The Australian Government is leading the development of a national waste and resource recovery infrastructure database, building on previous databases. Its first edition is expected to be released in late 2020. An accompanying report will identify infrastructure gaps and needs. Similar analyses have been carried out or are currently under development by most states and territories.

16.9 PFAS contaminated soils

The disposal of large quantities of soils contaminated with per- and poly-fluoroalkyl substances (PFAS) from major infrastructure projects is proving problematic in some metropolitan areas. With infrastructure developments expected to lead Australia's post-COVID economic recovery, this issue is likely to grow in the short term. Potential PFAS contamination of biosolids is a major industry concern.

16.10 Energy-from-waste

Increasing attention is being given to the establishment of energy-from-waste facilities in Australia, with relevant policies in place in most jurisdictions. To date, Australian facilities have been mostly small scale or focused on selected industrial waste streams. However, a number of proponents are

planning or developing large energy-from-waste facilities capable of managing more than 100 kt/year of MSW. At the time of writing, a large-scale facility is under construction in WA and others are planned in NSW, Qld, Vic and WA. The development of these facilities is subject to successful resolution of a number of factors including establishing long term supply contracts, accessing large capital investments and commissioning of new technology in Australia. There is generally a long lead time in addressing these issues prior to development proceeding.

Energy-from-waste facilities require a baseline calorific content in the waste feedstock to ensure the energy output is high enough to offset the cost of developing and operating the facility. Some proposals have relied on mixed feedstocks incorporating large quantities of plastics to supply the high calorific content. This increases their greenhouse gas emissions. Some competing proposals have also been predicated on accessing the same waste feedstock. As circular economy policies are implemented and the amount of plastics and other recyclable materials available for energy recovery diminishes, the viability of energy-from-waste facilities may be undermined. The context for each energy-from-waste facility proposal therefore becomes increasingly important.

16.11 Organics recovery

There continues to be significant roll-out by local governments of FOGO collection services, mostly in metropolitan and provincial city areas. Some areas in Australia have established policies for completion of FOGO roll-out programs[64]. In response to increasing amounts of wet food waste being processed, some regulatory authorities are requiring the use of in-vessel composting to manage odour and biosecurity risks. Previously, open-air windrow composting was the predominant method used to process municipal organics. In some areas greater reliance on in-vessel processing is resulting in production of large amounts of less-mature compost, and this has impacted on marketability, with more materials going to lower value markets such as broadacre agriculture and land rehabilitation and less to the urban amenity and horticultural markets.

Contamination is the ‘single greatest operational challenge’ facing the composting industry (AORA 2020). It increases costs and devalues products, and increasingly limits the development of potentially high-value and high-volume markets. Increased diversion of food waste has also seen contamination issues arise, particularly related to plastic packaging and the use of bin liners in food recovery systems. Some liners marketed as biodegradable or compostable do not readily compost in commercial systems, leading to increased processing times and management costs.

In NSW, the suitability of mixed waste organic outputs from MBT facilities for land application is a recent vexed issue. The NSW EPA no longer allows this long-standing practice, requiring significant changes by the industry to its processes and markets.

The organic processing sector is also seeing increased involvement of the water treatment industry, which is interested in incorporating solid wet organic waste into wastewater and biosolid management systems.

[64] Perth and Peel regions by 2025, Vic by 2030.

16.12 Boomerang Alliance perspective

There's no doubt the last 18 months have been a turning point for waste and recycling in Australia. The China embargo; a new *National Waste Policy*; a timetable to prevent the export of certain wastes; announcements of federal and state funding support; implementation of container deposit schemes; and moves to ban single use plastics – have all pushed the agenda into new territory.

At the same time, waste incineration (EfW) has tried to gain a foothold under the guise of diverting waste from landfill. State governments are developing new policies that recognise EfW's failings including cannibalising of recyclate, but still want it to be part of a waste management mix. Whether they can control it sufficiently is unclear – certainly EfW is not part of a circular economy and the European Union is now moving to curtail its contribution.

A key challenge is organics and despite FOGO collection being proven on economic and recycling grounds – repeated plans for widespread adoption have failed. With organics a big portion of the red bin, we need to generate much more FOGO recycling activity.

We are seeking all states to take action by 2021 banning polluting single use plastic items, like straws, plates and foodware containers (including polystyrene) and cutlery. Several states (SA, Qld, ACT) are already moving. More need to get on board and our Plastic Free Places program has shown there are acceptable alternatives and customers and businesses are happy to adapt.

The other critical challenge is recycled content for packaging and other products. There is resistance from states and business to embrace mandatory standards. The voluntary approach has failed in the past and unless we can guarantee new markets for recyclable material, we won't take effective strides towards the circular economy.

17. Influences on waste generation and management

This chapter discusses five factors that influence Australia's waste generation and management as presented in this report: population growth; economic growth; technological change; access to recycling markets; and community expectations and government policy. The section concludes with a discussion on how waste generation and management might change in the future.

17.1 Growth in population and economic activity

Population

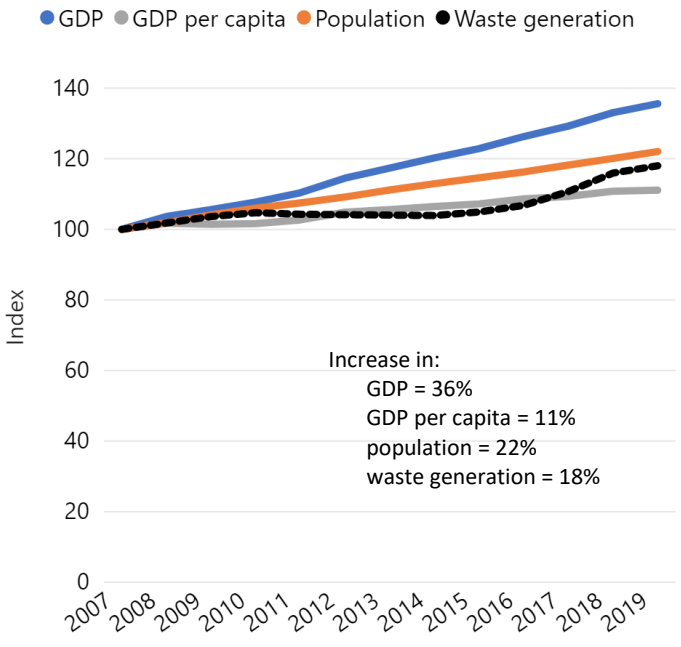
Other things being equal, more population means more waste. Over the 13-year data period, Australia's population grew by 22%, an average of 1.7% per year, climbing from 20.6 to 25.2 million people (see Figure 54). The fastest growing state was Victoria, which grew by 28%, and the slowest was Tas, which grew by 8%. The three biggest states—NSW, Vic and Qld—represent about 78% of Australia's population.

Economic activity

Economic growth is also linked with waste generation. Greater wealth results in more waste from renewal of material goods, infrastructure development and increased emphasis on convenience and time-saving. When the value we put on our time grows faster than the price of material goods, the production of waste is promoted.

Over the 13-year data period, Australia's gross domestic product (GDP[65]) grew by 36%, an average of 2.6% per year, from $1.4 to $1.9 trillion (see Figure 54). The fastest growing state was WA, which grew by 54%, and the slowest was SA, which grew by 22%.

Figure 54 Growth in GDP, population and GDP per capita (indexed), 2006-07 to 2018-19



Economic activity per person

Much of our economic growth can be attributed to population growth.
Figure 54 also shows growth in economic activity per capita, removing the effect of population growth. GDP per capita grew by 11% over the data period, from $67,400 to $74,900. The fastest growth was in WA (23% per capita) and the slowest in Vic (6.7% per capita).

17.2 Technological change

Technological change is affecting waste types and quantities. The shift from paper to digital communications is leading to less paper wastage. High strength but light weight packaging is reducing

[65] Calculated by a 'bottom up' process of adding state and territory gross state product.

the weight of our recycling bin contents. And while the quantity of e-waste items is growing strongly, the weight of these wastes is rising more slowly[66] because items are getting lighter.

In industrial systems, waste is typically an indicator of inefficiency. Waste is often reduced through machinery and system upgrades, just-in-time purchasing, smart packaging systems, light-weighting and inventory controls.

Technological change also affects waste management. Energy-from-waste is making inroads, 'smart bins' that tell operators when they are full are starting to come into operation, and robotic and optical sorting equipment are improving material recovery facilities.

17.3 Access to recycling markets

The financial viability of recycling is lower in towns and settlements that are a long way from the major population centres where most recovered materials are processed and sold. States and territories with large remote populations or which lack ready access to the major markets tend to have lower recycling rates.

17.4 Community expectations and government policy

These two issues are inextricably linked: community expectations drive government policy, and government policy shapes community expectations and behaviours. In general, Australians support waste reduction and recycling and want to see more of it (NSW EPA 2015a, Ashton-Graham 2017, Walton *et al.* 2019). Policy in this area has traditionally been the province of state, territory and local government, and they remain active as described in Chapters 11 and 12. Increasingly, the Australian Government is playing a role, most recently in developing the *National Waste Policy* (Australian Government *et al.* 2018) and *National Waste Policy Action Plan* (Australian Government *et al.* 2019). The policy focus has shifted from focusing on waste management to a more integrated push to develop a circular economy (see Section 16.7).

17.5 The future of waste generation and management

Given these influences and current trends, how can we expect waste quantities and their management to change over the coming decade?

Long-term trends suggest waste quantities are likely to continue increasing slowly despite slight falls in the tonnes of waste per capita. Domestic waste may level off in absolute terms. As materials get lighter, we could see higher volumes even as the weight of waste levels off. Major projects and programs could stymie these trends with large quantities of soils contaminated with asbestos, PFAS and other substances.

The long-term trend towards increasing levels of recycling is likely to continue, helped by government policies, targets and infrastructure investment. Each additional percentage of recycling can be expected to be harder than the last, but better design linked to circular economy policies may change that equation. Better recycling of food waste, e-waste and skip bin material is readily achievable.

Use of waste as an energy source is likely to continue increasing, including through investment in large-scale thermal energy recovery infrastructure.

[66] Estimated at 3.8% per year at present – see Table 23.

18. Method

This chapter summarises the method, main assumptions and main data problems and adjustments used for collating the data presented in this report. Appendix A summarises national waste reporting history, development and plans.

18.1 Data sources

The data in this document came from many sources, the most important of which were the states and territories. These obtain the data in various ways from waste operators and local governments. To provide that data to the Department, states and territories completed National Waste Reporting Tools for 2017-18 and 2018-19. The completed tools were released on the Department's website with this report, and include, for each state and territory:

- tonnes of landfill waste, disaggregated by source stream where known
- imports and exports of landfill waste across jurisdictional boundaries where known and significant
- the composition of waste to landfill in percentage terms, where local audits have been undertaken and are considered representative
- tonnes of waste sent for recycling, disaggregated by material type and source stream where known
- tonnes of waste to energy, disaggregated by material type and source stream where known.

States and territories provided additional data, to the extent available, on local government waste management, product waste, litter and dumping and other issues.

Many other data sources were used. Significant sources are listed in Table 27.

Table 27 Significant data sources additional to the states and territories

Data	Data sources
CORE DATA	
Biosolids	Pollution Solutions and Designs surveys for the Australia and New Zealand Biosolids Partnership
Hazardous waste	State and territory data previously provided to the Australian Government for use in the annual report to the Basel Convention
Material flow data (glass, metals, paper and cardboard, plastics, tyres)	APCO (2019b) – data on packaging material flows IndustryEdge – data on paper and cardboard material flows TSA (2019) – data on tyre material flows
Methane recovered from landfills for energy generation by state and territory	Australian Government Department of Industry, Science, Energy and Resources
Organic waste to landfill composition (some states and territories)	NGER (Measurement) Determination 2008 as amended
Plastics recycling	Envisage Works and SRU (2019, 2020) plastics recycling surveys
OTHER DATA	
Agricultural waste	Various (see bibliography)
Ash from coal-fired power	Australian Ash Development Association surveys
Economic data	ABS Waste Account 2018-19
Liquid waste	Bureau of Meteorology (2019)
Local government waste data	Various local government surveys and reports
Mining waste	National Pollutant Inventory; resources and energy quarterly reports from the Office of the Chief Economist; annual audit compliance reports developed by WA licensees, various others
Population data	ABS (2019a, b)
Product and packaging waste	Various annual reports and personal communications from product stewardship organisations and other industry groups

18.2 Assumptions

To present a comprehensive core data set, various assumptions were needed to fill data gaps. These are described at each relevant calculation or data entry point in the National Waste Reporting Tool 2018-19, which is released with this report. The methods for gap-filling often include assuming that proportions or rates in a jurisdiction, time period, area or waste stream were similar to those in another, or had particular values.

A key area of uncertainty is the composition of waste to landfill. Assumptions in this area included that the composition of each non-hazardous waste stream (MSW, C&I and C&D) to landfill:

- in the ACT, SA and Vic is as determined through their own landfill and bin audits
- in NSW is as worked out in a separate workbook drawing on audits and historical breakdowns
- in NT, Qld, Tas and WA is based on national average figures calculated by assuming
  a) the organic proportions are equal to those set out in the NGER (Measurement) Determination 5.11
  b) the inert proportions are equal to the population-weighted average calculated from ACT, NSW, SA and Vic.

NSW reports some of its material to recycling in broad categories that required conversion to material types. The most significant assumptions applied were that:

- the compositions of recycled 'residues and rejects' and 'mixed waste' were
  - for MSW, as per an audit of MRF residuals to landfill (APC 2009)
  - for C&I, as per an audit of residuals to landfill (NSW EPA 2015b)
  - for C&D, as per masonry materials sent for recycling
- the composition of recycled 'organics' was the same as NSW reported in 2014-15.

18.3 Calculating rates

Rates of resource recovery, recycling, energy recovery and disposal were calculated by dividing the tonnes of waste to the relevant management type by the total waste generated that has a known fate. The only type of core waste for which the waste fate is unknown is hazardous waste sent for treatment. Most of this material is in the C&I waste stream; much smaller quantities are in the C&D waste stream.

Based on this approach, as an example, the recycling rate (RR) for C&I waste in 2018-19 was calculated using the following formula (where 't' means tonnes):

$$RR_{C\&I,\ 2018\text{-}19} = t\ C\&I\ waste\ recycled_{2018\text{-}19} / (t\ C\&I\ waste\ generated_{2018\text{-}19} - t\ C\&I\ waste\ to\ treatment_{2018\text{-}19})$$

Due to insufficient available data, all material exported for recovery – including contaminants within these materials – is counted as being recovered.

18.4 Calculating energy recovery from landfills

When organic waste decays in the anaerobic environment of a landfill, the greenhouse gas methane is formed. Many large landfills capture methane-rich landfill gas and extract or sell its energy value, commonly through combustion to generate electricity that is sold to the grid (see Photo 6). In the national method used in this report, this is considered a form of energy recovery. The national waste reporting tool applies formulas from the NGER system to back-calculate the quantity of waste associated with captured landfill gas and includes these under 'energy recovery'. For convenience, the method assumes instantaneous decay of waste in the landfill. The methodological steps are set out below.

1. obtain data on methane collected from landfills and used for its energy value (mostly aggregated data from the NGER system, plus data from smaller jurisdictions where the Government is constrained by commercial confidentiality)
2. convert to tonnes of recovered carbon
3. calculate the amount of carbon that actually degrades in landfill per tonne of material drawing on NGER default values
4. calculate carbon that actually degrades per tonne of waste for each jurisdiction
5. calculate the tonnes of recovered carbon attributable to each waste type by jurisdiction
6. calculate the tonnes of recovered waste types by jurisdiction, drawing on NGER default values
7. allocate the recovered waste by source stream.

18.5 Significant core data gaps and quality issues

Table 28 describes the main weaknesses in the core data and how they are dealt with in the report.

Table 28 Main data problems and how they were dealt with

Issue	Known cases of this issue	Adjustments and rationale
Data unavailable	Data on Qld hazardous waste data incomplete for 2016-17, 2017-18 and 2018-19	Extrapolated missing data from 2015-16 values assuming no change in waste per capita. Required for a complete national data set.
	No waste data for 2007-08, 2011-12, 2012-13	Data interpolated in trend displays
Data from current reporting year missing	The levy on disposal of inert waste from metropolitan Perth rose steeply in 2015. The data shows a strong decline in waste disposal from around that time that is only partly offset by increased recycling. Data from landfills outside Perth is not comprehensively captured. By regulation, these landfills should be collecting levy funds on waste transported from Perth. Some of the 'missing' waste may be associated with a downturn in construction activity, or be stockpiled or have been reused without processing. Levy fraud on a significant scale also appears plausible.	None. There is no strong basis on which to estimate the 'missing' waste.
Data from historical reporting years missing	Lack of consistency across data sources affects the accuracy of trends. WA reported that a significant portion of the increase in recovered C&D waste between 2017-18 and 2018-19 was data from a new data source.	Not able to be adjusted due to insufficient time and data. Adjustments to historical data should be explored for future national waste reports.
Data inconsistencies across years	Inconsistencies in data comprehensiveness and quality over time, risking misleading trend data.	Historical data was reviewed and, to the extent practicable, updated based on new information. Major revisions are listed in Appendix A.
	ACT contaminated soil available for few years.	Excluded for all years.
Double-counting	Some waste may have been counted twice. Particular risks are discussed below.	Corrected when identifiable and quantifiable.
	Interstate transfers are at risk of being included in data from both generating and receiving jurisdiction, for example: • ACT non-organic recyclables sent to NSW (and elsewhere?) • NSW recyclables sent to Qld and vice-versa • SA recyclables sent to Vic	ACT recycling quantities were deducted from NSW recycling data and estimates (all years). Qld data on interstate flows were used to adjust NSW data. For others, data was not identifiable and quantifiable. No adjustment made.
	Organic hazardous waste may be included in both hazardous waste data from tracking systems and non-hazardous organics recycling data from the compost industry data.	For several states the relevant data did not match up. No adjustment made.
	Material delivered to a reprocessing facility is generally counted as recycled, but a portion may be subsequently sent to landfill where it is counted again.	None. Likely to be small, and restricted to a few waste streams in a few jurisdictions.
	Organics recycling data – NSW experience suggests there may be significant movement of material between facilities, with risk of double-counts.	None.

Issue	Known cases of this issue	Adjustments and rationale
	WA and SA asbestos and contaminated soil data is likely to be included in both hazardous waste and landfill data.	Totals in hazardous waste data were deducted from SA and WA landfill data (all years).
Misallocated fate	Some tonnes allocated to recycling may in fact have gone to energy recovery, as not all states and territories distinguish well between these fates.	NSW, SA and Vic energy recovery estimates were reallocated from recycling data.
Misallocated jurisdiction	Interstate transfers are also at risk of being included in the data from the receiving, but not the generating, jurisdiction, for example: • NSW landfill waste sent to levy-free landfills in Qld (not an issue after July 2019 as Qld introduced its own levy) • Vic and ACT landfill waste sent to levy-free landfills in rural NSW • recyclables sent interstate and not identified.	Corrected when identified. Data on NSW landfill waste to Qld was recorded, allowing reallocation. Vic landfill transfers to NSW were estimated and reallocated to Vic. ACT landfill transfers to NSW could not be quantified so no adjustment was made. Flows of recyclate into and out of Qld were assumed to be from and to NSW. Interstate flows of hazardous waste mostly recorded and accounted for but some errors may remain.
Misallocated stream	Some MSW may be included in C&I or vice-versa, e.g. transfer station waste all counted as MSW.	None.
Outdated data	End-of-life tyres tonnages were not updated to take into account a better data source (TSA 2020)	None. Issue identified too late. Difference is 16 kt = 3.5% of tyre flows and 0.02% of all waste.
Over-reporting of recycling in Australia	Material is counted as recycled if recorded in state and territory data. However, some of this material may have been delivered but not processed, or processed but then stockpiled on- or off-site.	None. Data on these quantities is not available. However, the quantities are generally relatively small. NSW regulates and restricts stockpile sizes.
Over-reporting of recycling overseas	Material is counted as recovered if it was exported for recovery. However, some of this material has significant contaminants that required disposal overseas. The Australian Government has committed to implementing bans on the export of such materials, which should eliminate this problem.	None. Data on these quantities was unavailable. However, data may be adjusted at a subsequent date based on data in the material flow analyses reported in Chapter 8.
Stockpiles inadequately reported	The reporting approach sums waste generation by year based on materials counted at waste facilities. However, some waste is produced in one year but processed in another, e.g. unprocessed materials at recycling facilities or bankrupt operators, or SA contaminated soils stored for use on subsequent major projects (439 kt in 2017-18 and 2018-19).	Piecemeal response. SA stored soils counted as recycled. A national approach to resolve this issue is needed. Data can be subsequently adjusted.
Data allocation error	Exports of end-of-life-tyres to energy recovery fates were not included in hazardous waste totals.	Issue identified after cut-off for data corrections. Impact represents 2% of hazardous waste and 0.2% of all waste.

The Department is developing a national standard for data and reporting in relation to waste and resource recovery in consultation with the states and territories and the waste industry. This should help alleviate the data problems listed above.

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Appendix A National waste reporting – history, developments and plans

National waste reporting – history, developments and plans

History

National waste reporting was first attempted in the 1990s to measure progress in implementing the 1992 *National Waste Minimisation and Recycling Strategy.* This first attempt had little success, mainly because the scope, categories and comprehensiveness of the data collected by each state and territory did not match the proposed system and there was little appetite to change.

During the 2000s, the Department commissioned several snapshots of national waste quantities titled *Waste and Recycling in Australia*. Data quality and comprehensiveness improved over time, but differences between these reports meant trends could not be readily compiled. There were concerns from the states and territories about the transparency of the data transformations used to create a common national platform.

Following the release of the 2009 *National Waste Policy*, the Department started to develop a national waste data system. The first National Waste Report was released in 2010 using 2006-07 data and the second in 2013 using 2010-11 data. In between these two reports, the Department commissioned a 'method report' to describe what data would be collected and how it would be transformed. This was applied in the *National Waste Report 2013*, which was released with a calculation workbook so states and territories could track how their data had been transformed. Subsequently, a procedural document was released describing the whole process and setting out a slightly revised method (REC and BE 2015). This was agreed to by all states and territories in mid-2015. Accompanying the document was a Microsoft Excel tool established to implement the agreed method, into which states and territories would enter their data and in which it would be transformed to standardised output tables and charts.

On completion of the agreed method, process and tool, the available historical data was revisited and transformed for consistency with the agreed approach, producing, in four separate tools, a historical record back to 2006-07. Data for 2007-08, 2011-12 and 2012-13 are missing from this record.

The *National Waste Report 2016* and *National Waste Report 2018* each incorporated an additional two data years and presented trends back to 2006-07. As part of *National Waste Report 2018* development process, a National Waste Database was developed to house all data for all years.

Detailed reporting and analysis of hazardous waste has been undertaken in separate *Hazardous Waste in Australia* reports in 2015, 2017 and 2019.

A national consultation on improving Australia's waste data and reporting took place in late 2017 and early 2018. For details see *Improving national waste data and reporting* (BE *et al.* 2018). The results of this informed improvements made in *National Waste Report 2018* and *National Waste Report 2020*, as well as informing actions to improve national waste data and reporting committed to in the 2019 National Waste Policy Action Plan.

Accompanying documents

Released alongside this document are:

- National waste reporting tools for 2017-18 and 2018-19 data. These Microsoft Excel files contain the 2017-18 and 2018-19 included in this report. The input data from the states and territories is transformed within the files into the consistent output categories reported here.

- The National Waste Database 2020. This database contains much of the data in the two new tools, and also the 'core' and ash data back to 2006-07 (except three missing years where data was not collected). It is presented in 'flat' format so that users can easily do their own analysis. This second issue of the national waste database has been improved to provide better explanations, metadata and instructions. Some of the historical data has been amended as listed below.

Methodological changes

The general methods used for collating and transforming data to produce the *National Waste Report 2020* are mostly consistent with those used for the *National Waste Report 2018*. Methodological changes that affect historical data include the following:

- A revised method for correcting for potential 'multiple counts' in tracking systems for hazardous waste, as described in the *Australian Standard for Hazardous Waste Data and Reporting* (BE *et al.* 2019).
- Allocation of some end-of-life tyres to the management category 'energy recovery', which was not done previously due to weaknesses in the reporting of hazardous waste data.
- Allocation of SA stored contaminated soils to 'recycling' – the previous method assumed that the proportional fates of stored hazardous wastes are the same as those for non-stored soils.
- A breakdown of ash waste by management type (disposal, recycling) has been included by state and territory, rather than national data only. The method, data and assumptions are set out in the 'national waste' worksheet of the national waste data tool 2018-19.

Data changes

Some of the data presented in the *National Waste Report 2018* (BE and REC 2018) has been revised for this report. The changes and the reasons for them are listed in Table 29 in approximate order of significance from the perspective of total tonnes.

These amendments resulted in the following changes to the headline 2016-17 data reported in the *National Waste Report 2018*, rounded to two significant figures:

- waste generation changed from 67 Mt to 69 Mt
- waste recycled changed from 37 Mt to 40 Mt
- waste disposal was unchanged at 27 Mt
- the resource recovery rate changed from 58% to 61%.

Plans

An Australian Waste and Resource Recovery Data and Reporting Standard is under development and due for release next year. It is intended to provide a framework for gradual harmonisation of data and reporting across the country.

The Australian Government has committed $24.6 million over four years for improving national waste data. At the time of writing, details of this expenditure are being formulated. It is understood that the Department will continue to prepare the *National Waste Report* and *Hazardous Waste in Australia* every two years.

Table 29 Revisions to historical waste and resource recovery data for this report

Data revision	**Years**	**Rationale and impact** (where significant and readily quantifiable)
NSW recycling	2015-16 2016-17	Data provided by NSW (was previously estimated). **Adds 1820 kt** to the 2016-17 recycling and waste generation figures reported in the *National Waste Report 2018*. Increases the recycling and recovery rates reported for NSW.
Vic landfill	2015-16 2016-17	Reporting error by Vic. **Adds 640 kt** to the 2016-17 landfill and waste generation figures reported in the *National Waste Report 2018*. Reduces the recycling and recovery rates reported for Vic.
Energy recovery from landfills (and as a corollary, disposal in landfills)	2013-14 to 2016-17	Revised data provided by Department of Industry, Science, Energy & Resources. **Shifts 180 kt** recorded as 'disposal' in the 2016-17 figures reported in the *National Waste Report 2018* to 'energy recovery' (mostly in NSW). Slightly increases the reported recovery rates for the affected jurisdictions.
Hazardous waste	All years	Due to methodological changes as described above. **Adds 73 kt** net to the 2016-17 hazardous waste figures reported in the *National Waste Report 2018*. SA is the most affected: adds 38 kt contaminated soil and shifts >100 kt to 'recycling' from other management.
SA landfill	2006-07 to 2016-17	Error in double-count adjustment by Blue Environment. **Adds 47 kt** to the 2016-17 figures reported in the *National Waste Report 2018*.
NT non-hazardous waste generation	2015-16 2016-17	Revised data provided by NT. **Adds 27 kt** to the 2016-17 figures reported in the *National Waste Report 2018*.
Ash	All years	Due to methodological changes as described above. Changes the reported recycling and recovery rates for jurisdictions generating electricity from coal (NSW, Qld, Vic, WA and SA until 2015-16).
NSW energy recovery	2013-14 2014-15	Double-counting error identified in previous collation.
Biosolids	2006-07 to 2016-17	Historical consistency, including the assumed moisture content.

Appendix B Chart data

Chart data

The data used in generating the charts in this report is set out below. 'CAGR' means compound annual growth rate.

The charts in the 'At a glance' section are extracts or duplicates of other charts given in the report – their data can be found in the data for the original chart as listed below:

- Figure 1 – see data table for Figure 10 (grey-highlighted data only)
- Figure 2 – see data table for Figure 13 (grey-highlighted data only)
- Figure 3 – see data table for Figures 20 and 26 (grey-highlighted data only)
- Figure 4 – see data table for Figure 28
- Figure 5 – see data table for Figure 17
- Figure 6 – see data table for Figure 31.

Figure 10 Waste generation (core waste and ash) by material and stream, Australia 2018-19

Material category	Generation (Mt)	Stream	Generation (Mt)	Jurisdiction	Generation (Mt)
Ash	12.53	MSW	12.57	ACT	1.10
Glass	1.16	C&D	27.03	NSW	25.27
Hazardous	7.83	C&I core	21.94	NT	0.44
Masonry materials	22.89	C&I (electricity generation)	12.53	Qld	16.99
Metals	5.60			SA	4.41
Organics	14.27	**Total core wastes**	**61.54**	Tas	0.96
Paper & cardboard	5.92	**Total**	**74.07**	Vic	18.11
Plastics	2.54			WA	6.79
Textiles	0.78				
Other	0.54				

Figure 11 Waste generation (all measured materials) by stream, Australia 2018-19

Material category	Generation (Mt)
Core waste	61.5
Ash	12.5
Mining	502.2
Agriculture & fisheries	17.1
Mineral processing	28.1
Total	**621.5**

Figure 12 Estimated mining waste by sector, Australia 2018-19

Mining type	Waste generation (Mt)
Bauxite Mining	0.0
Coal Mining	32.3
Copper Ore Mining	49.1
Gold Ore Mining	188.7
Iron Ore Mining	89.5
Mineral Sand Mining	0.06
Nickel Ore Mining	9.6
Oil and Gas Extraction	62.1
Other Construction Material Mining	0.0
Other Metal Ore Mining	19.5
Other Non-Metallic Mineral Mining and Quarrying	4.4
Silver-Lead-Zinc Ore Mining	46.8

Figure 13 Trends in the generation of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2018-19

	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019	CAGR
Core waste plus ash (Mt)											
MSW	12.89	13.34	13.56	13.47	13.79	13.96	13.02	12.61	12.64	12.57	-0.2%
C&I	33.09	33.25	33.79	33.65	33.66	32.80	33.10	33.52	33.81	34.46	0.3%
C&D	16.79	18.44	18.36	18.32	17.77	19.08	20.90	23.35	26.32	27.03	4.1%
Total	**62.76**	**65.03**	**65.71**	**65.44**	**65.22**	**65.84**	**67.02**	**69.48**	**72.77**	**74.07**	**1.4%**
Core waste (Mt)											
MSW	12.89	13.34	13.56	13.47	13.79	13.96	13.02	12.61	12.64	12.57	-0.2%
C&I	18.73	19.09	19.91	20.07	21.34	20.56	20.90	21.30	21.47	21.94	1.3%
C&D	16.79	18.44	18.36	18.32	17.77	19.08	20.90	23.35	26.32	27.03	4.1%
Total	**48.41**	**50.88**	**51.83**	**51.86**	**52.90**	**53.61**	**54.82**	**57.26**	**60.43**	**61.54**	**2.0%**
t per capita											
Core waste plus ash	3.042	3.029	3.006	2.952	2.800	2.786	2.795	2.849	2.938	2.942	-0.3%
Core waste	2.346	2.369	2.371	2.339	2.271	2.268	2.286	2.348	2.440	2.444	0.3%
MSW	0.625	0.621	0.620	0.608	0.592	0.591	0.543	0.517	0.510	0.499	-1.8%
C&I core plus ash	1.604	1.548	1.546	1.518	1.445	1.388	1.380	1.375	1.365	1.369	-1.3%
C&I core	0.908	0.889	0.911	0.905	0.916	0.870	0.872	0.873	0.867	0.871	-0.3%
C&D	0.814	0.859	0.840	0.826	0.763	0.807	0.872	0.958	1.062	1.074	2.3%

Figure 14 Trends in the generation of core waste by jurisdiction, Australia 2006-07 to 2018-19 (Mt)

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019
ACT	0.70	0.73	0.70	0.89	0.84	0.71	0.87	0.94	0.93	1.10
NSW	15.74	18.37	17.26	17.14	17.89	17.55	18.43	19.93	19.63	19.40
NT	0.52	0.35	0.35	0.34	0.54	0.46	0.32	0.37	0.40	0.44
Qld	9.55	9.67	9.09	9.05	10.25	10.21	10.28	11.28	12.32	12.31
SA	3.13	3.33	3.35	3.92	3.96	3.94	4.12	4.19	4.55	4.41
Tas	0.80	0.76	0.81	0.89	0.91	0.97	1.09	0.94	0.82	0.96
Vic	12.09	11.62	12.82	13.15	12.48	13.05	13.92	14.35	16.38	17.25
WA	5.87	6.05	7.45	6.47	6.03	6.71	5.80	5.26	5.41	5.67
Total	**48.41**	**50.88**	**51.83**	**51.86**	**52.90**	**53.61**	**54.82**	**57.26**	**60.43**	**61.54**

Additional information – trends in generation of core waste + ash by jurisdiction, Australia 2006-07 to 2018-19 (Mt)[67]

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019
ACT	0.70	0.73	0.70	0.89	0.84	0.71	0.87	0.94	0.93	1.10
NSW	22.35	25.02	23.65	23.30	23.49	22.88	23.78	25.56	25.40	25.27
NT	0.52	0.35	0.35	0.34	0.54	0.46	0.32	0.37	0.40	0.44
Qld	14.42	14.57	13.80	13.60	14.26	14.45	14.54	15.77	16.91	16.99
SA	3.56	3.77	3.77	4.32	4.34	4.34	4.53	4.19	4.55	4.41
Tas	0.80	0.76	0.81	0.89	0.91	0.97	1.09	0.94	0.82	0.96
Vic	13.45	12.71	14.14	14.61	13.83	14.30	15.07	15.38	17.25	18.11
WA	6.95	7.13	8.50	7.48	7.00	7.73	6.82	6.34	6.52	6.79
Total	**62.76**	**65.03**	**65.71**	**65.44**	**65.22**	**65.84**	**67.02**	**69.48**	**72.77**	**74.07**

Figure 16 Recycling of core waste and ash by material category, jurisdiction and stream, Australia 2018-19

Material category	Generation (Mt)	Stream	Generation (Mt)	Jurisdiction	Generation (Mt)
Ash	5.89	MSW	5.10	ACT	0.83
Glass	0.69	C&D	20.53	NSW	16.14
Hazardous	1.97	C&I core	11.95	NT	0.08
Masonry materials	18.67	C&I (electricity generation)	5.89	Qld	7.09
Metals	5.04			SA	3.44
Organics	6.99			Tas	0.32
Paper & cardboard	3.53			Vic	11.56
Plastics	0.33	**Total**	**43.47**	WA	4.01
Textiles	0.05				
Other	0.31				

[67] Excluded from the report presentation because ash data by jurisdiction is an estimate only.

Figure 17 Exports of core wastes by material category, Australia, 2006-07 to 2018-19

Material category (kt)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	CAGR
Glass	2	2	2	2	2	3	2	2	2	11	15	23	16	21.3%
Metals	1,575	2,011	1,981	1,852	1,874	2,432	2,401	2,695	2,466	1,965	2,141	2,446	2,637	4.4%
Paper and cardboard	1,105	1,332	1,265	1,497	1,384	1,466	1,567	1,497	1,497	1,535	1,453	1,317	1,112	0.1%
Plastics	99	118	197	147	150	175	170	171	201	203	182	159	187	5.4%
Textiles	1	0	1	0	0	36	78	89	91	90	94	50	53	44.1%
Tyres	9	39	61	70	105	136	107	125	100	60	70	90	115	24.1%
Total	**2,789**	**3,502**	**3,507**	**3,568**	**3,516**	**4,247**	**4,324**	**4,579**	**4,357**	**3,863**	**3,955**	**4,084**	**4,120**	**3.3%**

Figure 18 Comparison of core waste exported and recycled by material category, Australia, 2018-19

Material	Exported (kt)	Recovered (kt)
Glass	`	688
Masonry materials	-	18,670
Metals	2,637	5,038
Organics	-	6,990
Paper & cardboard	1,112	3,529
Plastics	187	325
Textiles	53	53
Tyres	115	155
Total	**4,120**	**35,450**

Figure 20 Trends in the recycling of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2018-19

	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019	CAGR
Core waste plus ash (Mt)											
MSW	4.83	5.33	5.50	5.78	6.25	6.34	5.49	4.89	5.05	5.10	0.4%
C&I	14.04	13.22	14.98	17.25	18.37	17.40	16.94	17.99	18.17	17.83	2.0%
C&D	10.13	11.08	11.26	12.07	11.37	12.29	14.60	16.77	19.22	20.53	6.1%
Total	**29.00**	**29.63**	**31.74**	**35.10**	**35.99**	**36.03**	**37.04**	**39.65**	**42.43**	**43.47**	**3.4%**
Core waste (Mt)											
MSW	4.83	5.33	5.50	5.78	6.25	6.34	5.49	4.89	5.05	5.10	0.4%
C&I	9.76	9.69	10.82	11.32	12.23	12.03	11.89	11.96	11.85	11.95	1.7%
C&D	10.13	11.08	11.26	12.07	11.37	12.29	14.60	16.77	19.22	20.53	6.1%
Total	**24.72**	**26.10**	**27.58**	**29.17**	**29.85**	**30.67**	**31.98**	**33.62**	**36.12**	**37.58**	**3.6%**
kg per capita											
Core waste plus ash	1.41	1.38	1.45	1.58	1.55	1.52	1.54	1.63	1.71	1.73	1.7%
Core waste	1.20	1.22	1.26	1.32	1.28	1.30	1.33	1.38	1.46	1.49	1.8%
MSW	0.23	0.25	0.25	0.26	0.27	0.27	0.23	0.20	0.20	0.20	-1.2%
C&I core plus ash	0.68	0.62	0.69	0.78	0.79	0.74	0.71	0.74	0.73	0.71	0.3%
C&I core	0.47	0.45	0.49	0.51	0.52	0.51	0.50	0.49	0.48	0.47	0.0%
C&D	0.49	0.52	0.51	0.54	0.49	0.52	0.61	0.69	0.78	0.82	4.3%

Figure 21 Trends in the recycling of core waste by jurisdiction, Australia 2006-07 to 2018-19 (Mt)

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019
ACT	0.49	0.51	0.52	0.64	0.61	0.49	0.59	0.46	0.61	0.83
NSW	9.31	10.61	10.75	10.72	10.71	10.84	11.26	12.43	12.56	11.88
NT	0.04	0.04	0.04	0.04	0.06	0.08	0.03	0.04	0.05	0.08
Qld	4.12	4.05	3.66	4.25	4.50	4.58	4.48	4.94	5.55	6.26
SA	2.29	2.49	2.52	2.99	2.92	3.03	3.17	3.28	3.51	3.44
Tas	0.27	0.28	0.34	0.36	0.41	0.43	0.54	0.45	0.29	0.32
Vic	6.33	6.23	7.51	7.66	7.62	8.22	9.02	9.23	10.74	11.56
WA	1.87	1.89	2.25	2.52	3.02	3.00	2.90	2.78	2.80	3.20
Total	**24.72**	**26.10**	**27.58**	**29.17**	**29.85**	**30.67**	**31.98**	**33.62**	**36.12**	**37.58**

Additional information – trends in recycling of core waste + ash by jurisdiction, Australia 2006-07 to 2018-19 (Mt)[67]

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019
ACT	0.49	0.51	0.52	0.64	0.61	0.49	0.59	0.46	0.61	0.83
NSW	12.18	12.78	13.60	15.07	15.19	14.62	14.82	16.83	17.16	16.14
NT	0.04	0.04	0.04	0.04	0.06	0.08	0.03	0.04	0.05	0.08
Qld	4.80	4.83	4.33	4.91	5.27	5.30	5.19	5.73	6.38	7.09
SA	2.55	2.71	2.69	3.19	3.04	3.18	3.27	3.28	3.51	3.44
Tas	0.27	0.28	0.34	0.36	0.41	0.43	0.54	0.45	0.29	0.32
Vic	6.33	6.23	7.51	7.66	7.62	8.22	9.02	9.23	10.74	11.56
WA	2.34	2.25	2.72	3.23	3.79	3.72	3.58	3.62	3.68	4.01
Total	**29.00**	**29.63**	**31.74**	**35.10**	**35.99**	**36.03**	**37.04**	**39.65**	**42.43**	**43.47**

Figure 22 Energy recovery from core waste by management method, material category, stream and jurisdiction, Australia 2018-19

Management methods	kt	Material category	kt	Jurisdiction	kt
Landfill	1748	Organics	1,589	ACT	41
Energy-from-waste facility	387	Paper & cardboard	366	NSW	634
Stream	kt	Plastics	68	NT	14
C&D	75	Textiles	117	Qld	496
C&I	909	Other	0	SA	189
MSW	1157			Tas	44
		Total	**2.140**	Vic	596
				WA	127

Figure 23 Trends in energy recovery from core waste by jurisdiction, Australia 2006-07 to 2018-19 (kt)

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019
ACT	44	36	34	34	39	37	35	35	45	41
NSW	550	550	542	613	551	840	828	782	572	634
NT	17	26	27	17	17	14	12	13	13	14
Qld	403	362	379	348	420	358	397	372	394	496
SA	156	160	159	155	158	152	153	147	179	183
Tas	42	64	45	46	47	54	44	36	45	44
Vic	402	420	425	522	900	738	681	580	705	596
WA	207	234	167	163	202	235	152	177	202	127
Total	**1,822**	**1,851**	**1,778**	**1,898**	**2,334**	**2,428**	**2,302**	**2,143**	**2,156**	**2,135**

Figure 25 Disposal of core waste by material category, stream and jurisdiction, Australia 2018-19

Material category	Disposal (Mt)	Stream	Disposal (Mt)	Jurisdiction	Disposal (Mt)
Ash	6.64	MSW	6.32	ACT	0.23
Glass	0.48	C&D	6.27	NSW	8.01
Hazardous	4.64	C&I core	8.01	NT	0.33
Masonry materials	4.22	C&I (electricity generation)	6.64	Qld	9.35
Metals	0.56			SA	0.65
Organics	5.69			Tas	0.45
Paper & cardboard	2.03			Vic	5.70
Plastics	2.14	**Total**	**27.24**	WA	2.51
Textiles	0.61	**Total (core)**	**20.60**		
Other	0.23				

Figure 26 Trends in the disposal of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2018-19

	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019	CAGR
Core waste plus ash (Mt)											
MSW	7.03	7.04	7.06	6.63	6.28	6.28	6.12	6.43	6.32	6.32	-0.9%
C&I	17.80	18.74	17.55	15.07	13.55	13.74	14.56	13.99	13.79	14.65	-1.6%
C&D	6.50	7.21	6.97	6.05	6.19	6.52	6.17	6.47	6.88	6.27	-0.3%
Total	31.33	32.99	31.58	27.76	26.01	26.54	26.85	26.90	26.99	27.24	**-1.2%**
Core waste (Mt)											
MSW	7.03	7.04	7.06	6.63	6.28	6.28	6.12	6.43	6.32	6.32	-0.9%
C&I	7.73	8.11	7.82	7.42	7.37	6.87	7.42	7.80	7.76	8.01	0.3%
C&D	6.50	7.21	6.97	6.05	6.19	6.52	6.17	6.47	6.88	6.27	-0.3%
Total	**21.26**	**22.37**	**21.85**	**20.11**	**19.84**	**19.66**	**19.71**	**20.70**	**20.96**	**20.60**	**-0.3%**
kg per capita											

MSW	0.341	0.328	0.323	0.299	0.269	0.266	0.255	0.264	0.255	0.251	-2.5%
C&I core plus ash	0.863	0.873	0.803	0.680	0.582	0.581	0.607	0.574	0.557	0.582	-3.2%
C&I core	0.375	0.378	0.358	0.335	0.317	0.290	0.309	0.320	0.313	0.318	-1.4%
C&D	0.315	0.336	0.319	0.273	0.266	0.276	0.257	0.265	0.278	0.249	-1.9%
Core waste plus ash	**1.519**	**1.537**	**1.444**	**1.252**	**1.117**	**1.123**	**1.120**	**1.103**	**1.090**	**1.082**	**-2.8%**
Core waste	**1.031**	**1.042**	**1.000**	**0.907**	**0.852**	**0.832**	**0.822**	**0.849**	**0.846**	**0.818**	**-1.9%**

Figure 27 Trends in the disposal of core waste by jurisdiction, Australia 2006-07 to 2018-19 (Mt)

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019
ACT	0.16	0.18	0.15	0.21	0.18	0.19	0.24	0.44	0.27	0.23
NSW	5.72	7.06	5.78	5.67	6.30	5.61	6.05	6.41	6.05	6.39
NT	0.46	0.28	0.28	0.28	0.46	0.37	0.28	0.32	0.33	0.33
Qld	4.88	5.14	4.92	4.31	5.17	5.09	5.29	5.83	6.25	5.50
SA	0.65	0.65	0.62	0.65	0.79	0.63	0.70	0.69	0.68	0.65
Tas	0.44	0.37	0.38	0.43	0.40	0.43	0.44	0.42	0.43	0.45
Vic	5.20	4.84	4.76	4.83	3.84	3.97	4.09	4.38	4.70	4.84
WA	3.75	3.87	4.97	3.72	2.70	3.39	2.64	2.22	2.25	2.20
Total	**21.26**	**22.37**	**21.85**	**20.11**	**19.84**	**19.66**	**19.71**	**20.70**	**20.96**	**20.60**

Additional information – trends in disposal of core waste + ash by jurisdiction, Australia 2006-07 to 2018-19 (Mt)[67]

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019
ACT	0.16	0.18	0.15	0.21	0.18	0.19	0.24	0.44	0.27	0.23
NSW	9.46	11.53	9.31	7.48	7.42	7.15	7.83	7.64	7.21	8.01
NT	0.46	0.28	0.28	0.28	0.46	0.37	0.28	0.32	0.33	0.33
Qld	9.07	9.26	8.96	8.19	8.40	8.61	8.84	9.53	10.01	9.35
SA	0.82	0.86	0.87	0.86	1.06	0.90	1.01	0.69	0.68	0.65
Tas	0.44	0.37	0.38	0.43	0.40	0.43	0.44	0.42	0.43	0.45
Vic	6.56	5.93	6.08	6.29	5.19	5.21	5.24	5.41	5.58	5.70
WA	4.36	4.60	5.55	4.02	2.89	3.69	2.98	2.45	2.47	2.51
Total	**31.33**	**32.99**	**31.58**	**27.76**	**26.01**	**26.54**	**26.85**	**26.90**	**26.99**	**27.24**

Figure 28 Resource recovery and recycling rates of core waste plus ash by jurisdiction, 2018-19

Jurisdiction	Energy recovery	Recycling	Rank	Total recovery	Rank
ACT	3.8%	75%	2	79%	2
NSW	2.6%	65%	3	68%	4
NT	3.4%	19%	8	23%	8
Qld	2.9%	42%	6	45%	7
SA	4.4%	80%	1	85%	1
Tas	5.3%	39%	7	45%	6
Vic	3.3%	65%	4	68%	3
WA	1.9%	60%	5	62%	5
Australia	**2.9%**	**60%**		**63%**	

Figure 29 Resource recovery and recycling rates by source stream, Australia 2018-19

Stream	Energy recovery	Recycling	% total recovery
MSW	9.2%	41%	50%
C&I core + ash	2.7%	53%	56%
C&I core	4.4%	57%	62%
C&D	0.3%	76%	77%

Figure 30 Resource recovery rate trends of core waste and ash by jurisdiction (top) and stream (bottom), Australia 2006 07 to 2018 19

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019	CAGR
ACT	77%	76%	79%	76%	78%	74%	72%	53%	71%	79%	0.2%
NSW	57%	54%	60%	68%	68%	68%	67%	70%	71%	68%	1.5%
NT	11%	19%	19%	16%	14%	20%	13%	15%	17%	23%	6.3%
Qld	36%	36%	34%	39%	40%	40%	39%	39%	40%	45%	1.9%
SA	77%	77%	77%	80%	75%	79%	77%	83%	84%	85%	0.8%
Tas	42%	48%	51%	48%	53%	53%	57%	54%	44%	45%	0.6%
Vic	51%	53%	57%	57%	62%	63%	65%	64%	67%	68%	2.4%
WA	37%	35%	34%	46%	58%	52%	56%	61%	61%	62%	4.4%
Australia	**50%**	**49%**	**51%**	**57%**	**60%**	**59%**	**59%**	**61%**	**62%**	**63%**	**1.9%**
Stream											
C&D	61%	61%	62%	67%	65%	66%	70%	72%	74%	77%	2.0%

C&I core	58%	56%	60%	62%	64%	65%	63%	62%	62%	62%	0.6%
C&I core + ash	45%	43%	47%	54%	59%	57%	55%	57%	58%	56%	1.8%
MSW	45%	47%	48%	51%	54%	55%	53%	49%	50%	50%	0.9%

Figure 31 Generation and management method by material category, Australia 2018-19

Material category	Recycling (Mt)	Other disp. (Mt)	Landfill (Mt)	Treatment (Mt)	EfW facility (Mt)	Generation (Mt)	% Generation
Glass	0.69	0.00	0.48	0.00	0.00	1.16	1.6%
Metals	5.04	0.00	0.56	0.00	0.00	5.60	7.6%
Paper & cardboard	3.53	0.00	2.40	0.00	0.00	5.92	8.0%
Plastics	0.33	0.00	2.14	0.00	0.07	2.54	3.4%
Ash	5.89	6.64	0.00	0.00	0.00	12.53	16.9%
Hazardous	1.97	0.04	4.60	1.23	0.00	7.83	10.6%
Masonry materials	18.67	0.00	4.22	0.00	0.00	22.89	30.9%
Textiles, leather & rubber (excl. tyres)	0.05	0.00	0.72	0.00	0.01	0.78	1.1%
Other	0.31	0.00	0.23	0.00	0.00	0.54	0.7%
Organics	6.99	0.09	6.87	0.00	0.31	14.27	19.3%
Total	**43.47**	**6.77**	**22.22**	**1.23**	**0.39**	**74.07**	

Figure 32 Resource recovery and recycling rates by material category, 2018 19

Material category	Energy recovery	Recycling	% total recovery
Ash	0.0%	47%	47%
Glass	0.0%	59%	59%
Hazardous	0.0%	30%	30%
Masonry materials	0.0%	82%	82%
Metals	0.0%	90%	90%
Organics	11.1%	49%	60%
Paper & cardboard	6.2%	60%	66%
Plastics	2.7%	13%	15%
Textiles, leather & rubber (excl. tyres)	15.0%	7%	22%
Other	0.0%	58%	58%

Figure 33 Trends in the generation and management methods of key material categories, Australia 2006-07 to 2018-19

Mt Glass	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019	CAGR
Recycling	0.739	0.815	0.644	0.702	0.584	0.625	0.695	0.642	0.706	0.688	-0.6%
Other disposal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Landfill	0.517	0.529	0.543	0.509	0.484	0.475	0.478	0.492	0.467	0.476	-0.7%
Treatment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
EfW fac.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Total	**1.256**	**1.344**	**1.187**	**1.211**	**1.067**	**1.100**	**1.173**	**1.134**	**1.174**	**1.164**	-0.6%
kg/capita	**60.91**	**62.58**	**54.29**	**54.62**	**45.81**	**46.53**	**48.90**	**46.51**	**47.39**	**46.23**	
Metals											
Recycling	3.460	3.026	4.907	5.092	5.106	4.832	4.517	5.147	5.004	5.038	3.2%
Other disposal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Landfill	0.559	0.604	0.575	0.525	0.554	0.601	0.564	0.561	0.548	0.565	0.1%
Treatment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
EfW fac.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Total	**4.019**	**3.630**	**5.482**	**5.617**	**5.660**	**5.433**	**5.081**	**5.709**	**5.551**	**5.603**	2.8%
kg/capita	**194.9**	**169.0**	**250.8**	**253.4**	**243.0**	**229.9**	**211.9**	**234.1**	**224.1**	**222.5**	
Paper & cardboard											
Recycling	3.680	4.380	3.132	3.210	3.436	3.290	3.712	3.791	3.663	3.529	-0.3%
Other disposal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Landfill	1.886	1.926	1.980	1.873	2.054	2.040	2.346	2.399	2.388	2.396	2.1%
Treatment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
EfW fac.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Total	**5.566**	**6.306**	**5.111**	**5.083**	**5.490**	**5.330**	**6.058**	**6.189**	**6.051**	**5.924**	0.5%
kg/capita	**269.8**	**293.7**	**233.8**	**229.3**	**235.7**	**225.5**	**252.6**	**253.8**	**244.3**	**235.3**	
Plastics											
Recycling	0.254	0.278	0.294	0.292	0.326	0.334	0.339	0.306	0.321	0.325	2.1%
Other disposal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Landfill	2.303	2.415	2.455	2.335	2.222	2.186	2.292	2.323	2.159	2.145	-0.6%
Treatment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Mt	2007	2009	2010	2011	2014	2015	2016	2017	2018	2019	CAGR
EfW fac.	0.000	0.017	0.017	0.017	0.008	0.017	0.022	0.028	0.004	0.068	
Total	**2.557**	**2.710**	**2.766**	**2.643**	**2.556**	**2.537**	**2.653**	**2.658**	**2.484**	**2.537**	-0.1%
kg/capita	**124.0**	**126.2**	**126.5**	**119.2**	**109.7**	**107.3**	**110.6**	**109.0**	**100.3**	**100.8**	
Ash											
Recycling	4.28	3.53	4.15	5.93	6.14	5.37	5.06	6.03	6.31	5.89	2.7%
Other disposal	10.07	10.63	9.72	7.65	6.17	6.87	7.14	6.20	6.03	6.64	-3.4%
Landfill	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Treatment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EfW fac.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	**14.35**	**14.15**	**13.88**	**13.58**	**12.32**	**12.24**	**12.20**	**12.22**	**12.34**	**12.53**	-1.1%
kg/capita	**695.8**	**659.2**	**634.8**	**612.6**	**528.7**	**517.8**	**508.7**	**501.3**	**498.2**	**497.7**	
Hazardous											
Recycling	1.50	1.45	1.61	1.78	1.95	1.81	1.69	1.73	1.78	1.81	1.6%
Other disposal	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.02	0.03	0.2%
Landfill	2.31	2.09	1.95	2.10	2.72	2.32	2.84	3.53	4.49	4.47	5.6%
Treatment	0.60	0.56	0.62	0.68	0.88	0.85	0.83	0.79	1.18	1.23	6.1%
EfW fac.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	**4.45**	**4.13**	**4.22**	**4.59**	**5.58**	**5.02**	**5.38**	**6.08**	**7.47**	**7.54**	4.5%
kg/capita	**215.6**	**192.4**	**193.1**	**207.0**	**239.5**	**212.2**	**224.5**	**249.3**	**301.7**	**299.5**	
Masonry materials											
Recycling	8.94	9.69	10.15	10.63	10.28	11.23	13.47	15.37	17.47	18.67	6.3%
Other disposal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Landfill	5.54	6.21	5.88	5.03	4.50	5.04	4.82	4.81	4.71	4.22	-2.2%
Treatment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EfW fac.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	**14.48**	**15.89**	**16.03**	**15.65**	**14.78**	**16.26**	**18.29**	**20.18**	**22.18**	**22.90**	3.9%
kg/capita	**701.9**	**740.1**	**733.1**	**706.0**	**634.4**	**688.0**	**762.8**	**827.6**	**895.2**	**909.5**	
Organics											
Recycling	5.15	5.24	5.73	6.37	7.04	7.36	6.90	6.52	6.79	6.99	2.6%
Other disposal	0.34	0.35	0.36	0.37	0.28	0.16	0.11	0.05	0.07	0.09	-10.5%
Landfill	8.41	8.78	8.36	8.01	7.61	7.50	7.00	7.15	7.02	6.87	-1.7%
Treatment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
EfW fac.	0.19	0.22	0.22	0.22	0.23	0.21	0.27	0.16	0.21	0.31	4.4%
Total	**14.09**	**14.60**	**14.68**	**14.97**	**15.17**	**15.23**	**14.28**	**13.89**	**14.09**	**14.27**	0.1%
kg/capita	**683.1**	**679.9**	**671.3**	**675.3**	**651.0**	**644.5**	**595.5**	**569.6**	**568.9**	**566.7**	

Figure 36 Generation of organic waste (all) by type and stream, Australia 2018-19

Material category	kt	Stream	kt
Food organics	4,430	MSW	6,357
Garden organics	4,113	C&D	799
Timber	2,311	C&I core	7,449
Other organics	1,718	C&I (agriculture & fisheries)	27,990
Biosolids	1,677	Unknown	329
Food-derived hazardous wastes	661		
Other hazardous organic wastes	6		
Manure	15,070	**Total**	**42,920**
Bagasse (available)	10,720		
Cotton gin trash	53		
Fisheries organics	125		
Mill mud	2,020		
Unknown	18		

Figure 37 Generation of food waste by management method, Australia 2018-19

Management	kt (inc. hazardous)	kt (excl. hazardous)	Stream	kt
Landfill	3,756	3,744	MSW	3,107
Other disposal	0	0	C&I	1,318
Recycling	1,103	610	C&D	4
Energy from waste facility	75	75		
Treatment	157			
Total	**5,091**	**4,430**		

Figure 41 Supply of waste services in millions of dollars at basic prices, 2006-07 to 2016-17

Service	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Agriculture, forestry and fishing	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Mining	$178	$182	$172	$156	$244	$226	$204	$226	$240	$253	$225	$246	$277
Manufacturing	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Electricity, gas & water services	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Waste collection, treatment & disposal services	$7,559	$8,069	$8,615	$9,231	$10,262	$11,893	$12,298	$12,498	$12,782	$12,468	$13,430	$15,294	$15,791
Construction	$166	$191	$220	$230	$257	$309	$319	$328	$307	$290	$283	$332	$328
All other industries	$229	$258	$271	$300	$311	$355	$371	$365	$388	$383	$386	$448	$487
Public administration & safety	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-

Figure 42 Use of waste services in millions of dollars at purchasers' prices, 2006-07 to 2016-17

Service	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Agriculture, forestry and fishing	$265	$277	$205	$271	$328	$407	$384	$390	$423	$460	$508	$494	$507
Mining	$54	$72	$69	$90	$143	$196	$358	$337	$286	$255	$274	$276	$326
Manufacturing	$810	$837	$628	$751	$964	$865	$1,163	$1,171	$1,161	$1,024	$1,085	$1,179	$1,205
Electricity, gas & water services	$123	$141	$112	$142	$186	$139	$290	$334	$295	$258	$333	$371	$355
Waste coll, t'mnt & disp. services	$580	$608	$1,893	$1,862	$1,568	$2,352	$924	$886	$1,001	$932	$1,099	$1,243	$1,419
Construction	$853	$870	$733	$782	$1,011	$1,147	$1,536	$1,605	$1,591	$1,535	$1,489	$1,895	$2,009
All other industries	$4,617	$5,010	$4,748	$5,026	$5,775	$6,554	$7,340	$7,485	$7,748	$7,720	$8,280	$9,487	$9,633
Public administration & safety	$168	$172	$127	$137	$170	$166	$249	$237	$234	$231	$264	$302	$314
Total intermediate use, purchasers' prices (pp)	$7,470	$7,987	$8,515	$9,061	$10,145	$11,826	$12,244	$12,445	$12,739	$12,415	$13,332	$-	$-
Households	$356	$387	$414	$522	$576	$601	$593	$611	$588	$567	$568	$588	$595
Exports	$-	$5	$5	$-	$-	$-	$1	$-	$9	$11	$1	$-	$-
Gov't final consumption expend.	$357	$383	$407	$413	$440	$454	$456	$468	$480	$495	$519	$583	$626

Figure 43 Comparison of annual waste generation and fate per capita, Australia and selected countries (excluding hazardous waste, ash and landfill gas energy recovery)

Country	Disposal (Mt)	Recycling (Mt)	Energy recovery (Mt)	Total (Mt)	% recycling	% recovery
Australia	704	1,414	13	2,131	66%	67%
Norway	514	721	660	1,895	38%	73%
Singapore	119	706	435	1,259	56%	91%
United Kingdom	360	1,334	110	1,804	74%	80%
United States	771	1,470	95	2,336	63%	67%

Figure 44 Comparison of MSW generation and recycling rates in selected countries

Country	Recycled (kg per capita)	Other (kg per capita)
Australia	199	284
Austria	334	242
France	232	295
Germany	411	203
Italy	249	249
Netherlands	289	227
South Korea	231	154
Switzerland	367	338
Turkey	46	368
Wales	290	202

Figure 47 Australian households' access to kerbside waste services by jurisdiction, 2018 19

Jurisdiction	recycling bin service	organics bin service	residual waste bin service
ACT	100%	41%	100%
NSW	87%	62%	89%
NT	59%	0%	72%
Qld	91%	12%	99%
SA	97%	91%	99%
Tas	92%	18%	92%
Vic	100%	62%	100%
WA	92%	32%	96%
Australia	**93%**	**49%**	**97%**

Figure 49 Australian households' access to kerbside organic waste services by jurisdiction, 2018 19

Jurisdiction	% households with GO	% households with FOGO
ACT	41%	0%
NSW	45%	17%
NT	0%	0%
Qld	11%	1%
SA	71%	20%
Tas	12%	5%
Vic	38%	23%
WA	29%	3%
Australia	**36%**	**14%**

Figure 50 Australian households' access to kerbside residual waste disposal in jurisdictions with a mechanical biological treatment option, 2018 19

Jurisdiction	Landfill bin service	MBT service
ACT	100%	0%
NSW	63%	26%
NT	72%	0%
Qld	95%	4%
SA	99%	0%
Tas	92%	0%
Vic	100%	0%
WA	74%	33%
Australia	**85%**	**13%**

Figure 51 The impact of CDS on recycling in NSW

	Collection type	2017	2018	2019
Glass (kt)	Kerbside + CDS	207.4	221.8	269.3
	Kerbside only	207.4	194.7	174.0
Plastic (kt)	Kerbside + CDS	52.9	53.4	56.2
	Kerbside only	52.9	50.2	44.9
Aluminium (kt)	Kerbside + CDS	5.4	8.0	13.3
	Kerbside only	5.4	5.4	4.7

Figure 53 Greenhouse gas emissions from solid waste management, 1989-90 to 2017-18 (kt CO_2-e)

Year	Biological treatment of solid waste	Incineration and open burning of waste	Solid waste disposal
1990	22	87	15,240
1991	31	87	15,220
1992	39	87	15,063
1993	47	87	15,018
1994	56	88	14,432
1995	64	93	14,550
1996	72	67	13,130
1997	81	28	13,011
1998	89	28	12,317
1999	98	29	12,437
2000	106	28	12,239
2001	114	28	12,282
2002	123	28	12,454
2003	131	28	11,504
2004	140	28	11,064

Year	Biological treatment of solid waste	Incineration and open burning of waste	Solid waste disposal
2005	148	28	10,902
2006	159	29	10,625
2007	168	29	10,904
2008	181	29	11,309
2009	190	30	11,231
2010	215	30	11,511
2011	250	30	11,102
2012	254	30	9,874
2013	258	30	9,106
2014	262	31	9,076
2015	266	30	8,623
2016	273	31	8,875
2017	277	31	9,123
2018	281	31	9,045

Figure 54 Growth in GDP, population and GDP per capita (indexed), 2006-07 to 2018-19

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Population	100.0	101.9	104.1	106.0	107.5	109.2	111.2	112.9	114.6	116.3	118.2	120.1	122.1
GDP	100.0	103.6	105.6	107.7	110.4	114.5	117.4	120.3	122.9	126.3	129.3	133.1	135.6
GDP per capita	100.0	101.7	101.4	101.6	102.7	104.9	105.6	106.5	107.2	108.6	109.3	110.8	111.1
Waste generation	100.0	101.8	103.6	104.7	104.3	104.2	104.0	103.9	104.9	106.8	110.7	116.0	118.0

Appendix C Data for 2016-17 and 2018-19 compared

Data for 2016-17 and 2018-19 compared

This appendix presents tables comparing data for the baseline year for the National Waste Policy (2016-17) with the most recent data (2018-19). The 2016-17 data presented here differs from the 2016-17 data presented in the *National Waste Report 2018* due to corrections and updates subsequently undertaken (details provided in Table 29 on page 120). Some jurisdictions are unable to split some waste data by stream or by waste type so some of the data presentations are incomplete. Data is expressed in kilotonnes and rounded to up to no more than four significant figures. Due to the rounding, some totals and proportions may not appear to match.

Table 30 Data for 2016-17 and 2018-19 compared – all waste (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	940	1,097	17%	464	826	78%	35	41	19%	439	229	-48%
NSW	25,560	25,270	-1%	16,820	16,140	-4%	782	634	-19%	6,408	6,390	0%
NT	375	441	18%	42	82	92%	13	14	10%	316	328	4%
Qld	15,770	16,990	8%	5,731	7,088	24%	372	496	33%	5,835	5,499	-6%
SA	4,188	4,406	5%	3,279	3,443	5%	150	189	26%	692	654	-6%
Tas	935	963	3%	455	325	-29%	36	44	21%	416	454	9%
Vic	15,380	18,110	18%	9,231	11,560	25%	580	596	3%	4,376	4,840	11%
WA	6,337	6,792	7%	3,622	4,010	11%	177	127	-28%	2,216	2,203	-1%
Total	69,480	74,070	7%	39,640	43,470	10%	2,145	2,141	0%	20,700	20,600	0%

Table 31 Data for 2016-17 and 2018-19 compared – MSW (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	220	298	35%	116	194	66%	20	25	25%	83	79	-5%
NSW	3,926	4,121	5%	1,789	1,893	6%	456	338	-26%	1,681	1,890	12%
NT	139	166	19%	7	27	282%	10	11	9%	122	128	5%
Qld	2,554	2,600	2%	708	790	12%	236	294	24%	1,610	1,517	-6%
SA	838	759	-9%	446	397	-11%	43	73	68%	349	289	-17%
Tas	248	204	-18%	74	55	-25%	20	21	8%	154	128	-17%
Vic	3,111	2,972	-4%	1,264	1,282	1%	380	313	-18%	1,467	1,377	-6%
WA	1,571	1,451	-8%	486	459	-5%	119	83	-30%	966	909	-6%
Total	12,610	12,570	0%	4,890	5,097	4%	1,284	1,157	-10%	6,432	6,317	-2%

Table 32 Data for 2016-17 and 2018-19 compared – C&I waste (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	430	596	38%	239	479	101%	12	15	23%	178	100	-44%
NSW	11,700	11,410	-2%	7,078	6,491	-8%	316	256	-19%	2,762	2,595	-6%
NT	90	133	47%	31	55	76%	2	3	11%	55	58	6%
Qld	8,843	9,434	7%	2,985	3,426	15%	125	189	51%	1,915	1,914	0%
SA	1,911	1,751	-8%	1,602	1,404	-12%	105	112	7%	161	160	-1%
Tas	647	695	7%	380	269	-29%	16	22	34%	223	265	19%
Vic	6,735	7,006	4%	3,763	3,697	-2%	187	271	45%	1,626	1,984	22%
WA	3,165	3,441	9%	1,912	2,013	5%	56	42	-24%	878	934	6%
Total	33,520	34,460	3%	17,990	17,830	-1%	820	909	11%	7,797	8,009	3%

Table 33 Data for 2016-17 and 2018-19 compared – C&D waste (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	289	203	-30%	109	153	40%	2	1	-55%	178	50	-72%
NSW	9,929	9,737	-2%	7,953	7,752	-3%	10	40	288%	1,965	1,905	-3%
NT	145	143	-2%	4	0	-100%	1	1	10%	140	142	2%
Qld	4,371	4,954	13%	2,038	2,872	41%	11	14	28%	2,309	2,069	-10%
SA	1,439	1,896	32%	1,231	1,642	33%	2	5	101%	183	205	12%
Tas	41	64	57%	1	1	-34%	0	0	85%	39	61	56%
Vic	5,535	8,133	47%	4,204	6,577	56%	13	12	-5%	1,284	1,479	15%
WA	1,601	1,900	19%	1,224	1,538	26%	2	2	-25%	372	360	-3%
Total	23,350	27,030	16%	16,770	20,530	22%	42	75	79%	6,469	6,270	-3%

Table 34 Data for 2016-17 and 2018-19 compared – masonry materials (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	147	175	19%	109	153	40%				38	22	-42%
NSW	8,679	7,814	-10%	7,152	7,002	-2%				1,527	812	-47%
NT	120	147	22%	4	16	288%				116	131	13%
Qld	3,363	3,899	16%	1,886	2,406	28%				1,477	1,493	1%
SA	1,202	1,522	27%	1,088	1,400	29%				114	122	7%
Tas	67	66	-1%	11	1	-88%				56	64	15%
Vic	5,081	7,463	47%	4,032	6,315	57%				1,049	1,147	9%
WA	1,517	1,806	19%	1,092	1,380	26%				424	426	0%
Total	20,180	22,890	13%	15,370	18,670	21%				4,802	4,219	-12%

Table 35 Data for 2016-17 and 2018-19 compared – metals (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	30	38	27%	23	32	39%				7	6	-12%
NSW	1,887	1,571	-17%	1,715	1,420	-17%				172	152	-12%
NT	13	9	-28%	1	1	5%				12	8	-30%
Qld	964	1,256	30%	790	1,118	42%				174	138	-21%
SA	332	353	6%	307	329	7%				25	24	-4%
Tas	58	20	-65%	45	7	-85%				14	14	2%
Vic	1,780	1,629	-8%	1,699	1,474	-13%				81	155	91%
WA	644	725	13%	567	657	16%				77	68	-11%
Total	5,708	5,602	-2%	5,147	5,038	-2%				560	564	1%

Table 36 Data for 2016-17 and 2018-19 compared – organics (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	388	414	7%	264	311	18%	24	29	20%	99	74	-25%
NSW	3,630	3,437	-5%	1,616	1,612	0%	541	417	-23%	1,472	1,408	-4%
NT	102	108	7%		1		10	11	10%	91	96	5%
Qld	2,504	2,682	7%	759	880	16%	296	390	32%	1,448	1,412	-2%
SA	1,508	1,331	-12%	1,117	928	-17%	102	165	61%	290	239	-18%
Tas	261	190	-27%	79	17	-79%	27	33	19%	155	141	-9%
Vic	2,771	3,203	16%	949	1,306	38%	442	446	1%	1,380	1,450	5%
WA	1,307	1,224	-6%	373	348	-7%	140	99	-29%	794	777	-2%
Total	12,470	12,590	1%	5,156	5,403	5%	1,584	1,589	0%	5,729	5,598	-2%

Table 37 Data for 2016-17 and 2018-19 compared – paper & cardboard (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	65	79	22%	29	45	55%	7	9	18%	29	26	-11%
NSW	1,995	1,835	-8%	1,118	1,007	-10%	186	124	-33%	691	704	2%
NT	28	29	5%	0	0	142%	2	2	10%	26	27	4%
Qld	1,064	1,219	15%	560	699	25%	58	82	40%	446	438	-2%
SA	322	300	-7%	249	229	-8%	7	13	82%	65	58	-11%
Tas	216	98	-55%	159	43	-73%	7	8	24%	50	46	-8%
Vic	1,999	1,856	-7%	1,445	1,249	-14%	104	107	3%	450	500	11%
WA	501	509	2%	230	256	12%	29	21	-27%	242	231	-4%
Total	6,189	5,924	-4%	3,791	3,529	-7%	401	366	-9%	1,998	2,029	2%

Table 38 Data for 2016-17 and 2018-19 compared – plastics (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	26	27	3%	2	5	140%				24	22	-8%
NSW	821	710	-14%	88	87	-1%		62		733	561	-24%
NT	34	33	-5%	1	1	72%				34	32	-7%
Qld	645	643	0%	41	48	15%				604	595	-1%
SA	104	71	-32%	28	18	-36%	28	6	-79%	47	47	-2%
Tas	69	69	0%	2	4	121%				68	65	-4%
Vic	617	672	9%	131	143	9%				487	530	9%
WA	341	314	-8%	13	20	52%				328	294	-10%
Total	2,658	2,537	-5%	306	325	6%	28	68	138%	2,323	2,145	-8%

Table 39 Data for 2016-17 and 2018-19 compared – glass (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	21	20	-3%	14	13	-5%				7	7	0%
NSW	369	397	8%	232	253	9%				137	144	5%
NT	14	14	2%	6	6	9%				8	8	-3%
Qld	241	203	-16%	107	77	-28%				134	126	-6%
SA	82	89	8%	67	74	10%				15	15	-4%
Tas	38	26	-33%	24	13	-44%				15	12	-15%
Vic	235	292	24%	137	195	42%				98	97	-1%
WA	134	122	-9%	56	56	0%				78	66	-15%
Total	1,134	1,163	3%	642	688	7%				491	475	-3%

Table 40 Data for 2016-17 and 2018-19 compared – textiles, leather & rubber (excl. tyres) (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	14	13	-5%	0	0	-51%	3	3	18%	11	10	-11%
NSW	254	206	-19%	2	1	-12%	55	31	-43%	198	174	-12%
NT	7	9	29%	0	2	880%	1	1	9%	6	6	4%
Qld	154	164	6%	1		-100%	17	25	44%	136	139	2%
SA	57	45	-22%	24	21	-11%	12	5	-62%	21	19	-11%
Tas	22	20	-9%	2	0	-88%	2	3	27%	18	17	-5%
Vic	183	240	31%	7	25	254%	34	43	27%	142	173	21%
WA	87	83	-5%	2	3	38%	9	7	-25%	76	73	-4%
Total	779	780	0%	38	53	39%	132	117	-11%	609	610	0%

Table 41 Data for 2016-17 and 2018-19 compared – hazardous (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT	220	59	-73%	7	7	0%				211	51	-76%
NSW	1,682	2,807	67%	206	104	-49%				1,165	2,210	90%
NT	29	77	167%	9	44	409%				17	16	-9%
Qld	2,027	1,899	-6%	477	687	44%				1,418	1,158	-18%
SA	443	437	-1%	274	198	-28%				103	118	15%
Tas	173	438	154%	103	204	99%				42	94	123%
Vic	1,202	1,383	15%	353	362	3%				686	764	11%
WA	603	730	21%	346	360	4%				172	227	32%
Total	6,378	7,830	23%	1,772	1,966	11%				3,813	4,637	22%

Table 42 Data for 2016-17 and 2018-19 compared – biosolids (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT												
NSW	305	397	30%	287	380	32%				19	17	-7%
NT	28	15	-47%	22	11	-51%				6	4	-31%
Qld	322	332	3%	322	332	3%						
SA	125	230	84%	125	227	83%					2	
Tas	31	35	12%	31	35	12%						
Vic	483	512	6%	478	487	2%				5	26	431%
WA	126	156	24%	101	115	14%				25	41	62%
Total	1,420	1,677	18%	1,365	1,587	16%				54	90	66%

Table 43 Data for 2016-17 and 2018-19 compared – ash (kt)

	Generation			Recycling			Energy recovery			Disposal		
Jurisdiction	2017	2019	Change	16-17	18-19	Change	16-17	18-19	Change	16-17	18-19	Change
ACT												
NSW	5,631	5,869	4%	4,398	4,251	-3%				1,233	1,617	31%
NT												
Qld	4,485	4,675	4%	787	824	5%				3,698	3,851	4%
SA												
Tas												
Vic	1,029	862	-16%							1,029	862	-16%
WA	1,078	1,124	4%	842	814	-3%				236	310	31%
Total	12,220	12,530	3%	6,027	5,889	-2%				6,197	6,640	7%

Appendix D Data on waste to landfill

Data on waste to landfill

The primary presentation of waste data in this report is by fate. Waste to landfill has two potential fates:

- energy recovery, for waste calculated to produce methane that is captured for producing energy
- disposal, for other waste.

Supplementing this data, the tables below present the quantity of waste delivered to landfill by material before allocating any tonnage to energy recovery. Note that these estimates are based on audits that may not be wholly representative of each jurisdiction's waste composition. Waste to landfill by stream and jurisdiction is given in Table 9 on page 28. Data is expressed in kilotonnes and rounded to up to no more than four significant figures. Due to the rounding, some totals and proportions may not appear to match.

Table 44 Estimated waste sent to landfill by material and jurisdiction (kt), Australia 2018-19

Waste		ACT	NSW	NT	Qld	SA	Tas	Vic	WA
Masonry materials		22	812	131	1,493	122	64	1,147	426
Metals		6	152	8	138	24	14	154	68
Organics	food organics	52	855	58	964	192	99	1,019	504
	garden organics	13	433	27	385	43	34	210	200
	timber	30	354	15	301	56	31	444	122
	other organics	8	71	6	95	24	9	166	51
Paper & cardboard		34	828	29	520	71	54	607	252
Plastics		22	560	32	595	47	65	529	294
Glass		7	144	8	126	15	12	97	66
Textiles, rubber & leather (excl. tyres)		13	205	7	164	23	20	210	80
Hazardous		50	2,204	15	1,141	114	94	756	223
Other		12	207	-	-	11	-	-	-
Total		**270**	**6,825**	**337**	**5,921**	**742**	**497**	**5,341**	**2,286**

Table 45 Estimated waste sent to landfill by material and source stream (kt), Australia 2018-19

Waste		MSW	C&I waste	C&D waste	All
Masonry materials		265	817	3,137	4,219
Metals		271	241	52	564
Organics	food	2,636	1,105	3	3,744
	garden	972	295	78	1,345
	timber	109	930	316	1,354
	other	344	84	1	429
Paper & cardboard		1,157	1,153	86	2,396
Plastics		970	1,106	68	2,145
Glass		324	147	4	475
Textiles, rubber & leather (excl. tyres)		245	456	22	722
Hazardous		-	2,063	2,533	4,597
Other		118	103	9	230
Total		**7,410**	**8,500**	**6,310**	**22,220**

Appendix E Material flow analysis method

Material flow analysis method

What is material flow analysis?

A general definition of MFA is provided by the UN Environment Programme International Resource Panel (UNEP 2020):

> *Material flow analysis (MFA) comprises a group of methods to analyse the physical flows of materials into, through and out of a given system. It can be applied at different levels of scale, i.e. products, firms, sectors, regions, and whole economies. The analysis may be targeted to individual substance or material flows, or to aggregated flows, e.g. of resource groups (fossil fuels, metals, minerals).*

A more operationalised definition of MFA (Brunner and Rechberger 2017), as applied in the analysis undertaken for this report, involves a quantitative assessment of the state and change of flows and stocks of materials within a system defined in space and time. It follows the principle of conservation of mass, tracing material flows by balancing inputs and outputs, and draws on the following concepts:

- A *system* is defined as a set of material flows, stocks and processes in a specified space and time.
- A *flow* is the rate of material transfer, which can be considered an exchange of mass between two or more connected processes (e.g. used tyres moved from tyre retailers to a reprocessor).
- A *process* involves transformation, transport or storage of materials (e.g. a processing facility transforming tyres into marketable commodities).
- *Transfer coefficients* describe how a flow is apportioned (e.g. the amount sorted, processed or exported) in a transformation process, either for a single input or for all inputs entering a process.
- Finally, a *stock* (or *reservoir*) is a process in which a portion of the flow remains as an 'accumulation' (e.g. stockpiling or landfill).

The methodology of MFA and the scientific field that is developing around it are intended to support the analysis of anthropogenic (and natural) material flows through consumption, stocks, disposal and recovery. This is the type of data needed to support the transition to a circular economy, better address waste and pollution problems, and improve environmental outcomes more generally.

Pilot MFA objectives

To test the value of the MFA approach in the national waste data context, a pilot MFA framework and exploratory MFA model were developed. The pilot MFAs have the following objectives:

- provide material flow information at important points of the system, including consumption, in addition to data at the points of disposal and recovery
- help to identify and quantify the points of material loss throughout the material life cycle
- provide a whole of system flow model that can be further developed and updated in the future, and interrogated as needs arise
- estimate the performance of the waste system against circular economy and resource recovery performance indicators
- help identify opportunities to improve resource recovery
- provide a platform for assessing the impact of system interventions
- evaluate the usefulness of building MFAs for other material categories, potentially enabling the development of metrics encompassing collection, sorting, recovery efficiencies, and material utilisation throughout the economy.

Definition of the system

The pilot MFA system covers plastics, glass, paper and cardboard and tyre flows within Australia during the financial year 2018-19. It covers the processes and flows shown in the Sankey diagrams (e.g. Figure 34 on p.37). Exports of manufactured product are excluded.

Indicator selection

A potentially large number of indicators can be established from economy-wide MFAs, as undertaken for the pilot MFAs. Those selected for this pilot work are outlined in Table 10 (p.35). These different types of indicators deliver complementary information about various aspects related to national material use.

Modelling software

The modelling for the pilot MFAs was undertaken in Microsoft Excel. Widespread use of this software supports transparency of the modelling and data manipulations and is simpler and more 'future-proof' for these pilot studies. There are numerous off-the-shelf MFA modelling products now available that may well be better options for any subsequent iterations of this work.

Time boundary

While the MFA time boundary is financial year 2018-19, the underlying model has been set up with a time boundary of 1918-19 to 2118-19. This is ± 100 years from the current national waste reporting year of 2018-19 and supports the required stocks modelling (only undertaken for the 'use process' at the current time). The modelling period is wider than is minimally necessary for the material groups modelled, but this ensures good model coverage into historical stocks, particular in the built environment, and the ongoing use of some of the materials in long-lived applications, again primarily in the built environment. The large majority of paper and cardboard and tyre inputs reach end-of-life and leave stocks within five years.

Data analysis approach

Task 1 – System description
The initial task was to describe the MFA systems across the target materials to be modelled, along with the determination of the other scope elements outlined previously in this appendix.

Task 2 – Model development
Following the system description, a working version of the MFA model was developed in Microsoft Excel.

Task 3 – Data sources and collection
The major data source for the project is the updated national waste database, supplemented by supporting research of other existing datasets.

Task 4 – Modelling and reporting
The modelling for each of the targeted material types was then undertaken, using Sankey diagrams to visualise flows. The collated MFA data is used to report on the selected circular economy metrics.