National Waste Report 2018

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Abbreviations and glossary

ABS	Australian Bureau of Statistics
ACOR	Australian Council of Recycling
ACT	Australian Capital Territory
ALGA	Australian Local Government Association
AORA	Australian Organics Recycling Association
APCO	Australian Packaging Covenant Organisation
AWT	alternative waste technologies
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
BOD_5	5-day biochemical oxygen demand
bottom ash	ash produced by burning coal or other materials that remains in the furnace or incinerator
CAGR	compound average growth rate
capita	person
C&D	construction and demolition
C&I	commercial and industrial
CDS	container deposit scheme
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
the Department	Department of the Environment and Energy
disposal	the deposit of solid waste in a landfill or incinerator, net of recovery of energy
EPA	Environment(al) Protection Authority (name varies with jurisdiction)
e-waste	electrical or electronic waste
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)
FIAL	Food Innovation Australia
FOGO	food organics and 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
GDP	gross domestic product

GO	garden organics
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
GSP	gross state product
hazardous waste (or 'hazwaste')	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
HCB	hexachlorobenzene
HDPE	high-density polyethylene
IT	information technology
KAB	Keep Australia Beautiful
kg	kilograms
kt	kilotonnes (thousands of tonnes)
LDPE	low-density polyethylene
management method	the type of infrastructure that receives waste – landfill, compost facility, alternative waste treatment facility, etc.
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
NSW	New South Wales
NT	Northern Territory
NWRIC	National Waste and Recycling Industry Council
OECD	Organisation for Economic Cooperation and Development
per capita	per person
PET	polyethylene terephthalate
PFAS	per- and poly-fluoroalkyl substances
PFOS	perfluorooctanesulfonic acid
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
PS 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
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
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 fate	what happens to a waste i.e. recycling, energy recovery or disposal
waste generation	for data collation purposes, this is the sum of resource recovery and disposal
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 'tip shop')
WMAA	Waste Management Association of Australia

Acknowledgements

We thank the states and territories for sharing their data and perspectives for this report.

We also thank the various associations, community groups and businesses for their contributions and data, namely:

- Agsafe
- Australian Battery Recycling Initiative
- Australian Council of Recycling
- Australian Local Government Association
- Australian Mobile Telecommunications Association (Mobile Muster)
- Australian Organics Recycling Association
- Australian Packaging Covenant Organisation
- Australian Renewable Energy Agency
- Boomerang Alliance
- FluoroCycle
- Metropolitan Fire and Emergency Services Board (Melbourne)
- National Waste and Recycling Industry Council
- Paintback
- Waste Management Association of Australia.

At a glance

In 2016-17 Australia generated an estimated 67 million tonnes (Mt) of waste including 17.1 Mt of masonry materials, 14.2 Mt of organics, 12.3 Mt of ash, 6.3 Mt of hazardous waste (mainly contaminated soil), 5.6 Mt of paper and cardboard and 5.5 Mt of metals. This is equivalent to 2.7 tonnes (t) per capita.

There was about 54 Mt of 'core waste' – that managed within the waste and resource recovery sector (2.2 t per capita). This comprised 13.8 Mt (560 kg per capita) of municipal solid waste (MSW) from households and local government activities, 20.4 Mt from the commercial and industrial (C&I) sector and 20.4 Mt from the construction and demolition (C&D) sector.

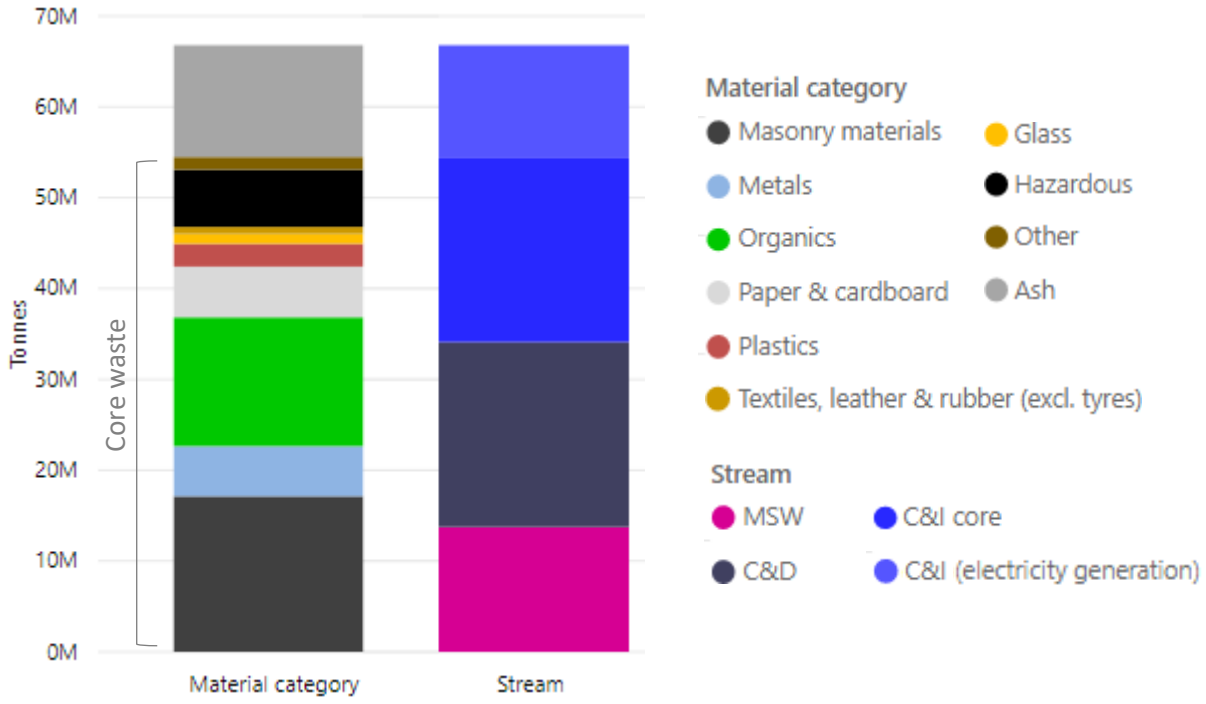
Headline numbers

Millions of tonnes	**2016-17**	2014-15
Waste generated	**67**	66
Waste recycled	**37**	36
Waste to energy	**2.0**	2.4
Waste disposal	**27**	27

Resource recovery rates

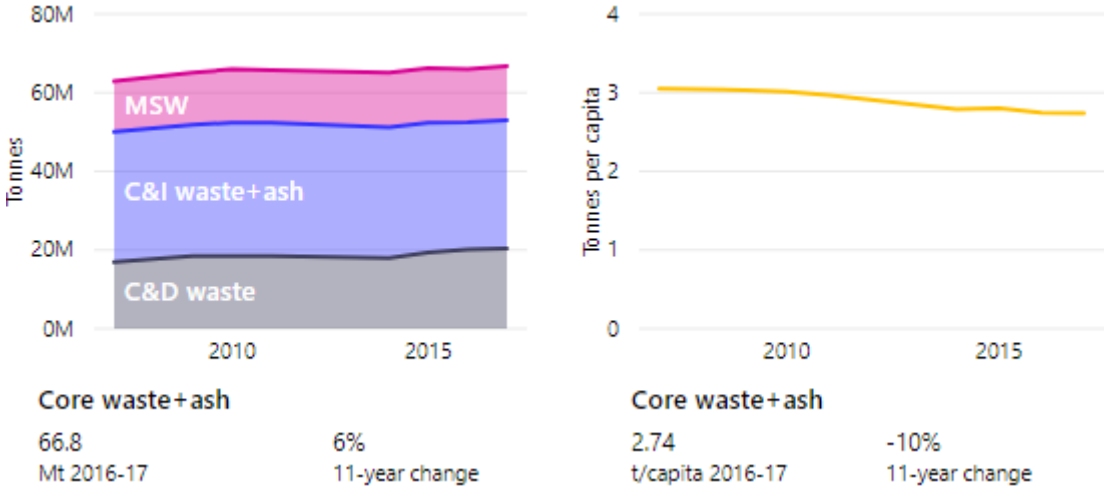
Core waste plus ash	**58%**	58%
Core waste only	**62%**	62%

Figure 1 Waste generation by material category and stream, Australia 2016-17 (core waste + ash)



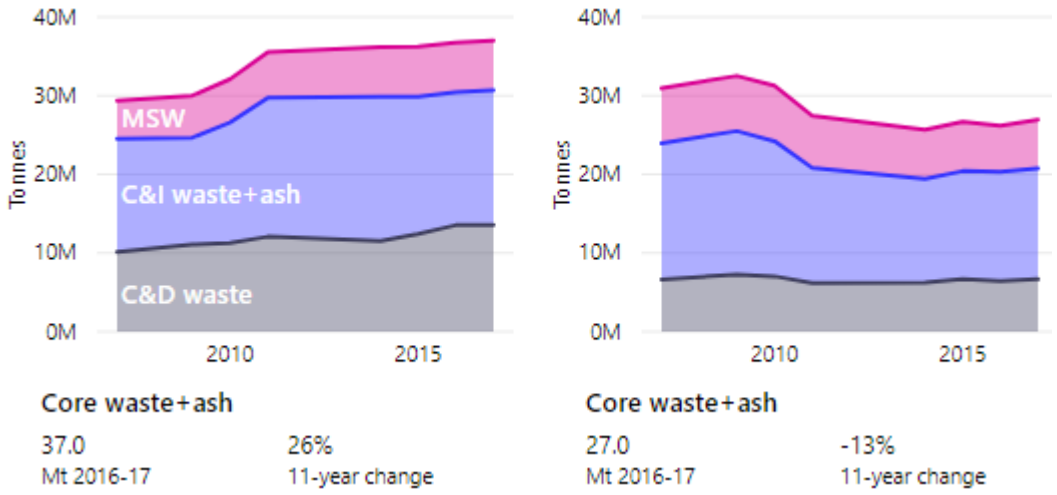
Over the 11-year period for which data is available, waste generation increased by 3.9 Mt (6%). Assessed on a per capita basis, waste declined by 10% over this timeframe (see Figure 2 overleaf). MSW generation fell by 10% per capita and C&I waste by 8% per capita, while C&D waste grew by 2% per capita.

Figure 2 Trend in the generation of core waste plus ash by stream in total (left) and per capita (right), Australia 2006-07 to 2016-17



The quantities of waste recycled continue to increase (see Figure 3). Recycling of C&D waste grew by 3.4 Mt or 34% (13% per capita) over the 11 years, the most of any of the streams. MSW recycling increased by 1.5 Mt or 31% (11% per capita). C&I waste recycling including ash expanded by 2.7 Mt or 19% (1% per capita). Conversely, there is a trend to less waste disposal.

Figure 3 Trend in the recycling (left) and disposal (right) of core waste plus ash by stream, Australia 2006-07 to 2016-17

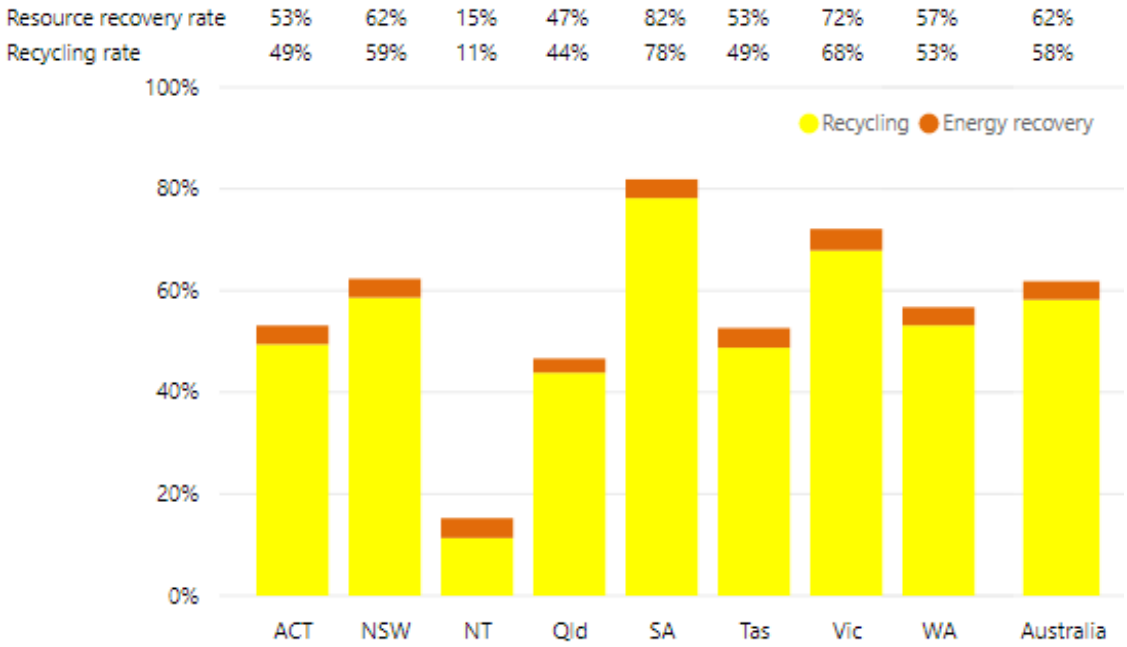


In 2016-17, 21.7 Mt of waste was deposited in landfill, comprising 40% of the 54 Mt of core waste generated.

In 2016-17, SA had the highest resource recovery[1] and recycling rates, followed by Vic, NSW, WA, ACT, Tas, Qld and NT (noting that the NSW figures are an estimate only). Across Australia, the resource recovery rate was 62% and the recycling rate was 58%. The trends in recovery and recycling rates are upwards (in 2006-07, the Australian resource recovery rate was 55% and the recycling rate was 52%).

[1] Includes materials recycled and used for energy recovery

Figure 4 Resource recovery and recycling rates of core waste by jurisdiction, 2016-17



Exports of waste materials for recycling grew during 2017-18 despite the restrictions imposed by the Chinese government.

Figure 5 Exports of waste materials for recycling by type from Australia to all destinations, 2006-07 to 2017-18

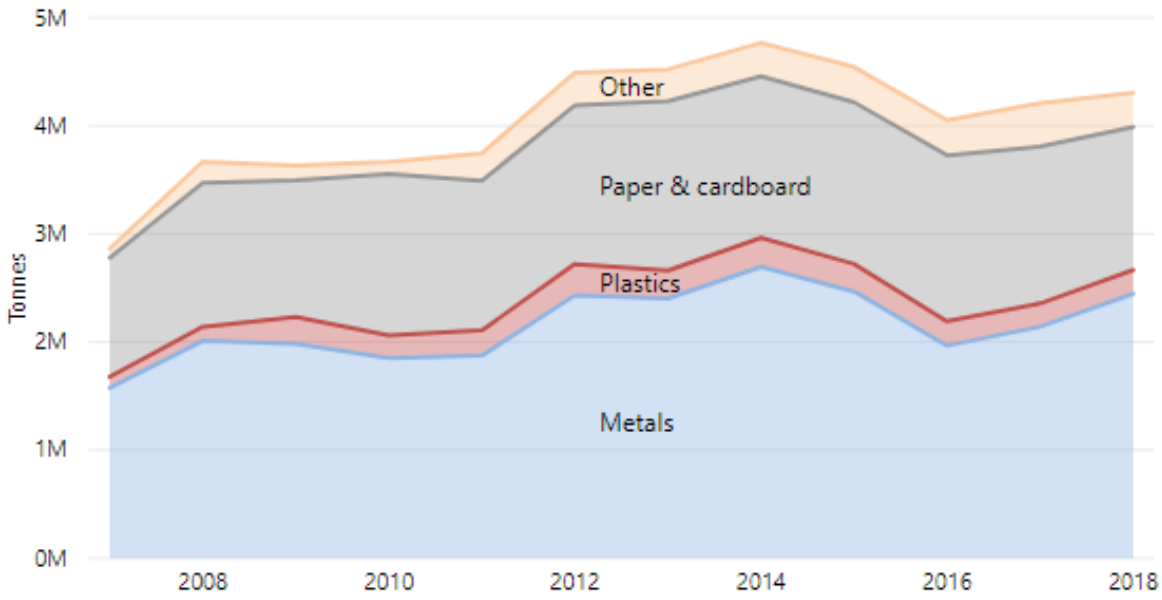
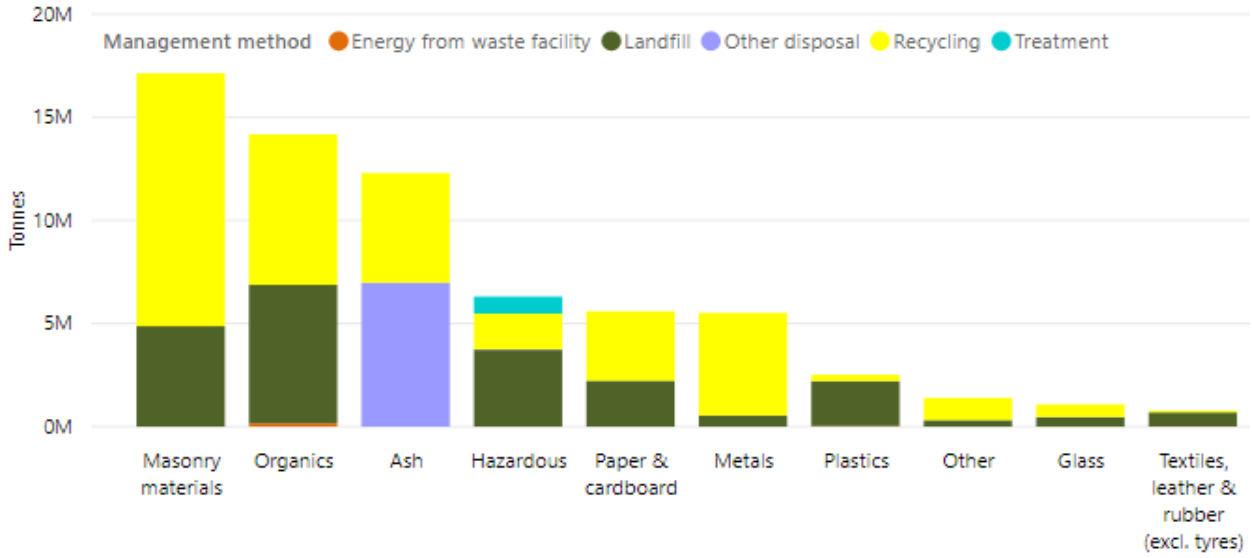


Figure 6 shows waste generation and management by material category. Estimated recycling rates by material are highest for metals (90%), then masonry materials (72%), paper and cardboard (60%), glass (57%), organics (52%), ash (43%) and hazardous waste (27%). Only about 12% of waste plastics are recycled.

Figure 6 Generation and management method of core waste and ash material categories, Australia 2016-17

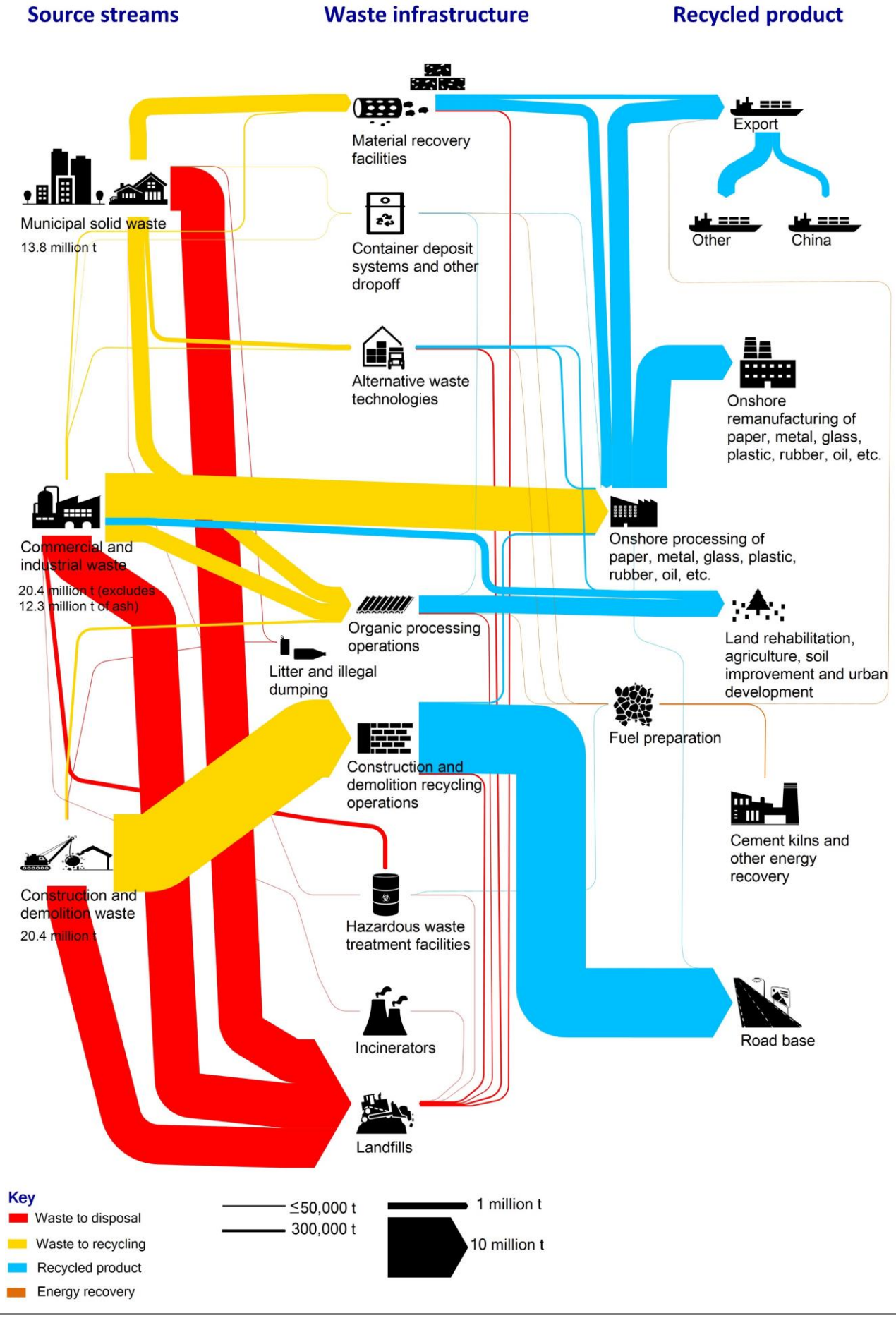


Compared with a selection of other developed economies, Australia generates more waste than the average and the proportion it recycles is a little less than the average.

The value of activities in the waste and resource recovery sector in 2014-15 were about $15.5 billion, comprising $12.6 billion from service provision and $2.9 billion from sale of recovered materials (CIE 2017).

Waste flows in Australia in 2016-17 are illustrated in Figure 7.

Figure 7 Waste flows in Australia, 2016-17 (core wastes only; arrow thickness is proportional to flow size)



1. Introduction

This report was prepared on commission to the Australian Government Department of the Environment and Energy (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 2016-17, including data on waste generation, source streams, materials and fates. Trend data is included back to 2006-07. The final report is to be released together with:

- the *National Waste Reporting Tool 2016-17*, containing the data reported for 2016-17
- the *National Waste Database*, containing data for all available years and established to allow users to undertake their own data analyses.

1.1 Scope

Waste included

The report covers waste generated or managed in Australia. Different parts of the report cover different types of waste. Most of the report focuses on core waste – materials generally managed by the waste and resource recovery sector, comprising solid non-hazardous materials and hazardous waste[2] including liquids. 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, which is a large stream that could be recycled to a greater extent. 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
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, 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	Liquid paperboard, newsprint and magazines, office paper
Plastics	PET (1), HDPE (2), PVC (3), LDPE (4), PP (5), PS (6), Other (7)
Glass	
Textiles, leather and rubber	Textiles; leather and rubber (excluding tyres)
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 (including contaminated biosolids); clinical and pharmaceutical; tyres; other miscellaneous; unclassified hazardous wastes
Other	Other unclassified materials

[2] The report series *Hazardous Waste in Australia* considers hazardous waste in detail. A new version of this report will be released in 2019.

The period covered

The National Waste Report 2018 focuses on waste generated and managed during the financial year (July to June) 2016-17. For the core data set, trend data is presented covering the period 2006-07 to 2016-17. National data covering 2007-08, 2011-12 and 2012-13 was not collected – the data in the trends for those years is interpolated. Some more recent information is presented where available, particularly in relation to exports of waste-derived materials.

The geographic area covered

The report covers waste generated or managed in Australia, including imports and exports of waste and waste-derived products. It 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 in three generating source streams: municipal solid waste (MSW) from households and council operations; commercial and industrial (C&I) waste; and construction and demolition (C&D) waste. For the first time, we have included an expanded scope of reporting for the C&I waste stream to provide a limited report of waste generation from Australia's mining, minerals processing, agriculture and fisheries sectors[3].

A separate section quantifies and considers waste collected by local governments. These wastes are not additional to the core data set, but form part of it.

Waste management method and fate

This report considers what happens to waste in two ways:

1. waste management method, which refers to the infrastructure that receives waste – landfill, compost facility, alternative waste treatment facility, etc.
2. waste fate, which is categorised into:
   - disposal
   - recycling
   - energy recovery
   - long-term storage[4].

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

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. This portion is back-calculated in the *National Waste Reporting Tool 2016-17* by applying formulas from the National Greenhouse and Energy Reporting (NGER) system, and 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 and not included in this report.

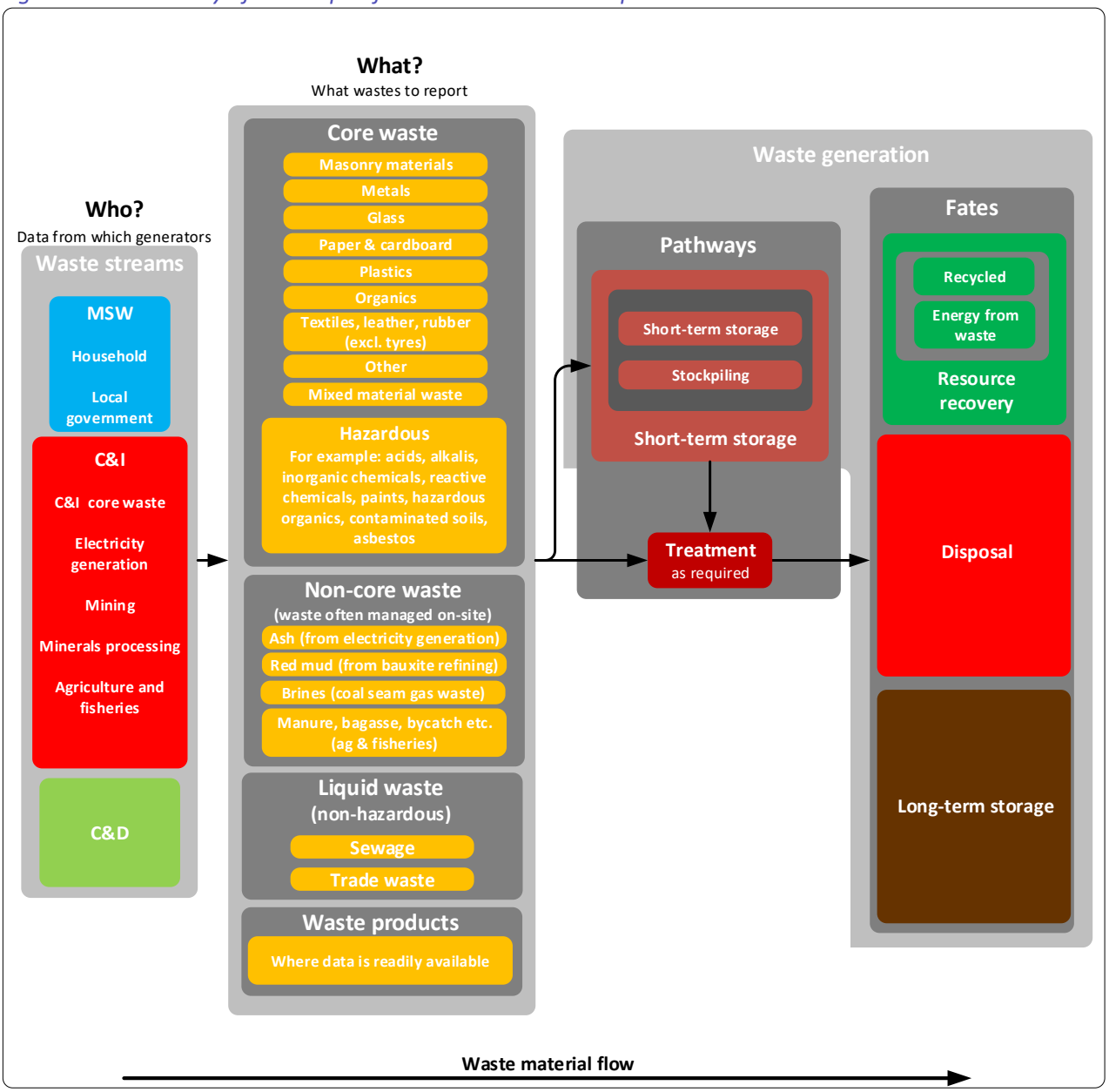
Reuse and 'waste reuse' are discussed briefly in Section 3.

[3] See Section 2 for further discussion.

[4] Reporting of long-term (or short-term) storage is limited due to lack of data.

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

Figure 8 Summary of the scope of the National Waste Report 2018



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).

1.2 Data

Data sources

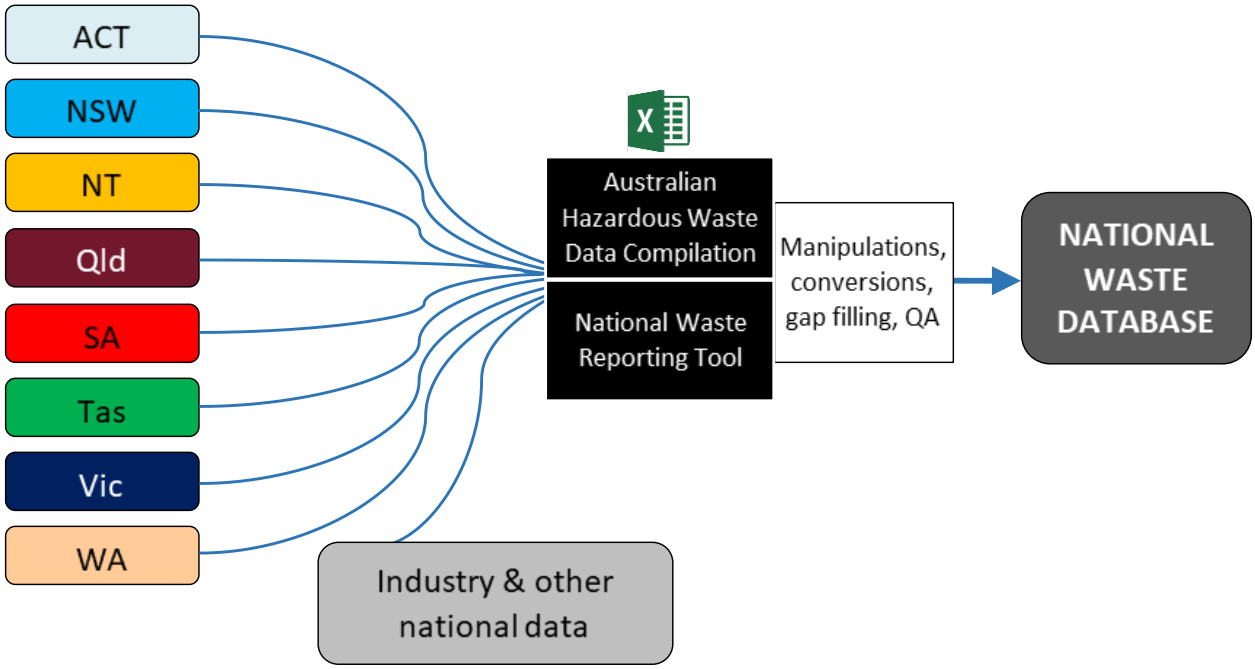
Much of the data included in this report was obtained from state and territory governments, which collect it for their own monitoring and reporting. This mainly comprises tonnes of waste sent to landfill and various forms of recycling. State and territory data is supplemented, and sometimes replaced, 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 2016-17*.

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 recategorisation, 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 2016-17* and the *Australian Hazardous Waste Data Compilation 2016-17*. The *National Waste Reporting Tool 2016-17* is to be published online together with the final version of this report. The outputs of this tool and previous versions of it are combined into a *National Waste Database*, going back to 2006-07. It is planned that this database will also be made available online, allowing users to undertake their own analyses via Microsoft Power BI. 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



More information about data collation methods is given in Section 17.

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 the 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, we believe the data reliably supports the key messages presented here.

Data quality issues can arise in a number of ways. Many of these can be attributed to the difficulty and cost in collecting the data and the fact that state and territory data systems have evolved largely independently. The issues include the following:

1. Some data may be based on incomplete surveys or estimates converted through volumetric measures or truck counts (see below).
2. Data encompassing the full scope of geography, waste categories, source streams and management types is not always available. In these cases, a best estimate is made, often using data from other states and territories.
3. 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 2016-17*.
4. State and territory data systems focus on material managed in their jurisdiction and are often weak in identifying material imported from other jurisdictions. This creates risks of double-counting and incorrect estimates of recovery rates.
5. 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.
6. 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.

In recognition of the quality limitations, data is generally presented to only two or three significant figures. Specific data quality issues are addressed in Section 17 and throughout the document.

Indicators of the underlying quality of the data reported here include:

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

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

Several significant data gaps and quality issues, and how they were addressed in the report, are described in the 'Method' chapter in Section 17.4.

Table 2 Indicators of data quality in the core 2016-17 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]	✗ [3]	Unknown	✓	✓	80%	✓
NSW (other)	✗	Unknown	✗	✓		
NT	✗	Unknown	✗	✗	80%	✗
Qld	✓	Unknown	✓	✓	95%	✓ [4]
SA	✗	Unknown	✓	✓	99%	✓
Tas	✗	26%	✗	✗	70%	✗
Vic	✗	Unknown	✓	✓	97%	✓
WA (metro Perth) [5]	✗ [1]	34%	✓	✓	49%	✓
WA (regional)	✗	Unknown	✗	✗	Unknown	

Notes 1 Will become compulsory in the coming 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 From August 2015, it was compulsory to report recycling data in the regulated area but the data was not available for this report.
4 Qld has a tracking system but 2016-17 data was not available in time for inclusion in this report.
5 The metropolitan Perth area represents about 70% of the WA population.

Data in this report may differ from state and territory data

The methods used by the Australian Government for categorising and analysing data are not always the same as those used by individual states and territories. Consequently, figures presented here may differ from corresponding figures 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 have been transported from NSW to Qld for landfilling. 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 other types of hazardous waste (including hazardous liquid waste).
- This report uses national instead of state and territory data for some waste and some jurisdictions, including 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 data and trend data have been updated

This report incorporates data back to 2006-07. Some of the historical data has been updated from the previously reported figures due to receipt of new or amended data, and changes to assumptions or calculations. Major changes to the data include use of actual, rather than estimated, data for NSW recycling in 2014-15, and correction to some historical hazardous waste data in the early years of the trend data. Figures presented here may differ from those presented in the *National Waste Report 2016.* The information presented here supersedes previously reported information.

1.3 Layout of the report and the data

This report is primarily a data presentation. The main focus is the financial year 2016-17 but some more recent data is included where relevant, such as in Section 3.4 on exports of waste for recycling and the impact of the Chinese restrictions. Data for 2016-17 is shown mainly in static bar charts, often with absolute tonnages split in several ways (material category, management method, source stream or jurisdiction). Trend data back to 2006-07 is presented mainly in area charts, showing both absolute tonnages and, where applicable, tonnes per capita. The chart data is tabulated in Appendix A.

The data presentations are generated using Microsoft Power BI and are subject to that program's limitations. Chart labels are given by calendar year but refer to financial year. Hence '2015' means '2014-15' and so on. It is planned that the data set will be made available online via the Department's website so that users can do their own analyses.

Data is generally presented to only two or three significant figures. In some cases, the figures presented may appear inconsistent or incorrectly added because of this rounding.

Technical terms and abbreviations are explained in the glossary on pages vii to ix.

Photo 1 Turning a compost windrow

Photo by Bill Grant

2. Waste generation

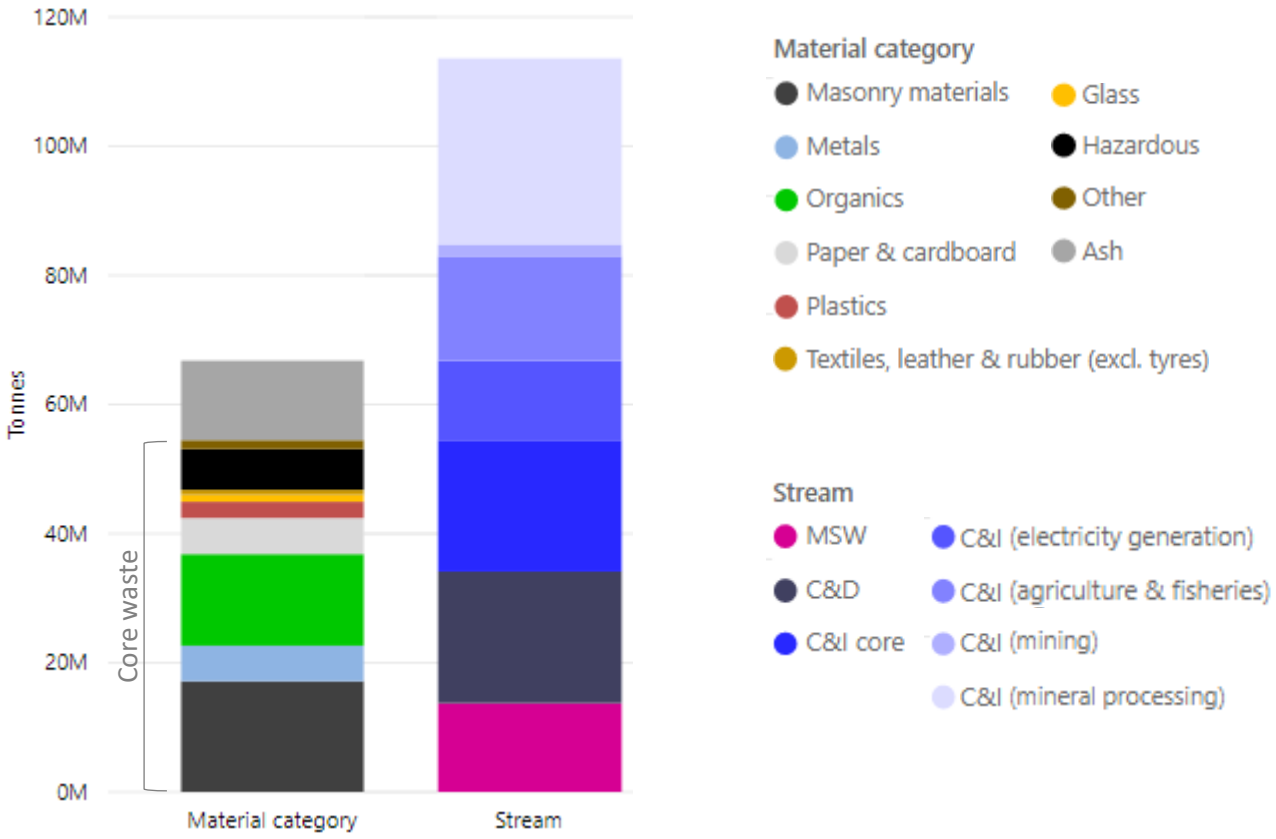
This section reports on the quantities of waste generated in Australia in 2016-17 and the trends since 2006-07.

2.1 Waste generation in 2016-17

Waste generation in 2016-17 is illustrated in Figure 10[5]. On the left, the figure shows the waste by material category, encompassing core waste and ash. In total, an estimated 67 Mt of this waste was generated, including 17.1 Mt of masonry materials, 14.2 Mt of organics, 12.3 Mt of ash, 6.3 Mt of hazardous waste (mainly contaminated soil), 5.6 Mt of paper and cardboard and 5.5 Mt of metals. This is equivalent to 2.7 t per capita. Of the 67 Mt generated, 9% is classified as hazardous.

There was about 54 Mt of core waste (2.2 t per capita), comprising 13.8 Mt (560 kg per capita) MSW from households and local government activities, 20.4 Mt from the C&I sector and 20.4 Mt from the C&D sector.

Figure 10 Waste generation by material category and stream, Australia 2016-17



The core waste data set excludes many C&I wastes that are managed on-site or are generated upstream in the production system, such as primary production wastes. The Department seeks to expand the scope of national waste reporting beyond the core waste traditionally included in state, territory and national waste reporting[6]. Some additional material categories are included in the bar on the right of Figure 10.

[5] Full data for all charts is given in Appendix A.

[6] This is consistent with the international System of Environmental Economic Accounting.

These are materials that fit the general definition of waste, for which reasonable 2016-17 data was available, and that may be of interest to some readers. They are:

- mineral processing waste, comprising
  - 26.4 Mt of 'red mud', an alkaline by-product of bauxite refining that was deposited at sites in Australia (about 812 Mt of red mud has been deposited in Australia over the last 50 years)
  - 2.4 Mt of coal-seam gas brine, a residue of the desalination of extraction waters that was deposited in much higher volumes in ponds mainly in south-east Qld (about 9.5 Mt of brine waste has been deposited in Australia over the last 10 years)
- agriculture and fisheries waste, comprising
  - about 16.1 Mt of known agricultural organics (manures, bagasse and cotton gin trash, discussed further in Section 7.8)[7]
  - about 0.1 Mt of organic fisheries waste including bycatch, offal, shells
- mining waste, comprising about 1.8 Mt of various materials, mostly deposited in tailings dams at many sites around Australia[8]
- electricity generation waste, amounting to some 12.3 Mt of ash that is recycled or deposited in storages in NSW, Qld, Vic and WA – discussed further in Section 7.2 (about 350 Mt of ash has been deposited into 'ash dams' in Australia since around 1975).

Other additional materials fitting the definition of waste may be absent from this data. Also missing is an unknown quantity of waste that is illegally disposed of, for example by dumping or burning, and not subsequently collected by government agencies (discussed in Section 13) and waste missed due to data issues (see Section 17.4).

Photo 2 Baled plastics at a materials recovery facility

Photo by Christine Wardle

Waste stockpiles

Waste stockpiling is a significant concern and has resulted in several recent major fires. Substantial stockpiling of C&D waste and glass is understood to occur. A recent Department of the Environment and Energy study (REC & AWE 2016) on stockpiling of hazardous and controlled waste identified stockpiles of arsenic waste (speiss), asbestos, contaminated biosolids, dieldrin-impregnated timber, end-of-life tyres, hexachlorobenzene (HCB), mercury waste, perfluorooctanesulfonic acid (PFOS), aluminium spent pot liner, aluminium dross recycling salt cake and other waste.

Reporting on stockpiles is limited by lack of data. Ideally, this report would account for additions to and removals from stockpiles in the reporting year. Possible solutions to allow for more complete reporting are proposed in Appendix B.

Unrecorded waste in stockpiles leads to underestimates of waste generation. Recorded waste in stockpiles (e.g. at a glass recycling plant) leads to overestimates of recycling.

[7] This is not a complete set of agricultural waste, but is rather known quantities of potential interest to organic waste processors.

[8] This is 2016-17 waste 'transfers' data reported to the National Pollutant Inventory. The data set has good coverage of the mining sector, the waste generators and the fate of waste reported, but these tonnages will not represent all waste generated by the mining sector that is disposed on-site.

2.2 Trends in waste generation

Figure 11 (overleaf) shows the trend in the generation of core waste plus ash between 2006-07 and 2016-17 by source stream. The charts on the left are total tonnes and those on the right are tonnes per capita. Over the eleven-year data period, waste generation has increased by 3.9 Mt (6%) or by 5.9 Mt (12%) when ash is excluded. By stream, MSW grew by 0.9 Mt (7%), C&I waste including ash by -0.5 Mt (-1%), C&I waste excluding ash by 1.6 Mt (8%) and C&D waste by 3.5 Mt (20%). Full data is given in Appendix A.

Question: The *National Waste Report 2016* said core waste per capita had grown by 11% since 2006-07. This report says it has declined by 5%. What's changed?

Answer: Historical waste quantities were further investigated and updated. Quantities of hazardous waste early in the data timeframe, in particular, were found deficient. The estimated quantity of core waste in 2006-07 increased by about 6 Mt, so the change since then is reduced.

Presented on a per capita basis, waste has declined on most measures. In total, and across most streams, whilst we are producing more waste overall, we are producing less waste per person.

The proportional changes over the data period are tabulated below.

Table 3 Changes in the quantity of waste generated per capita, Australia 2006-07 to 2016-17

	Total incl. ash	Total excl. ash	MSW	C&I incl. ash	C&I excl. ash	C&D
11-year change	-10%	-5%	-10%	-17%	-8%	2%

Figure 12 (p.12) shows the generation trend by jurisdiction, this time focusing only on core waste[9]. There were increases in all jurisdictions except the NT and WA. The falls in both these jurisdictions may be attributable to data difficulties (see discussion in Section 17.4).

Photo 3 Vehicle bumper bars baled for recycling

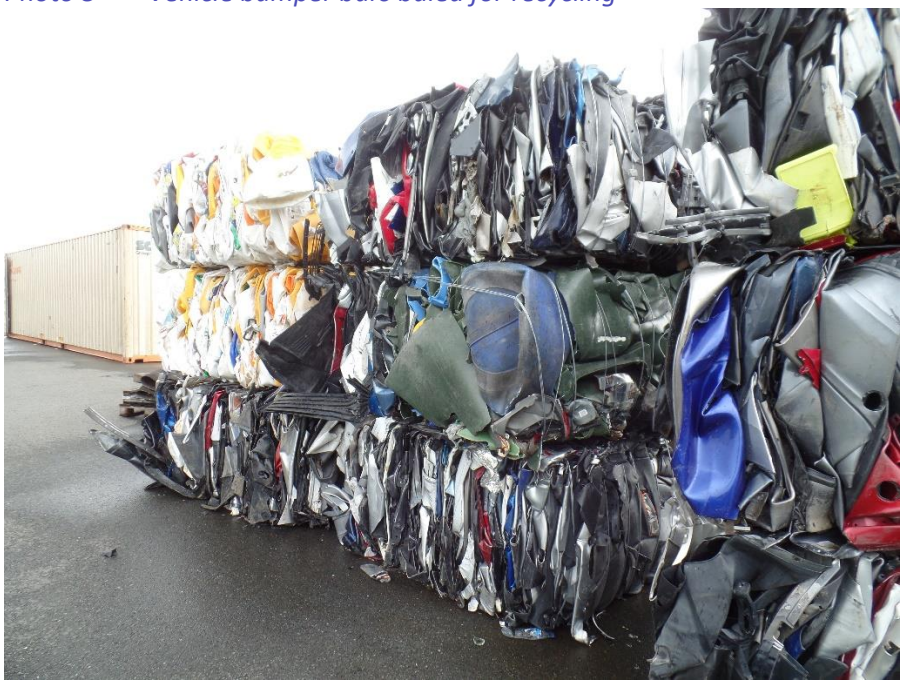


Photo by Christine Wardle

[9] Ash is excluded because generation numbers are not accurately tallied by state and territory.

Figure 11 Trends in the generation of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2016-17

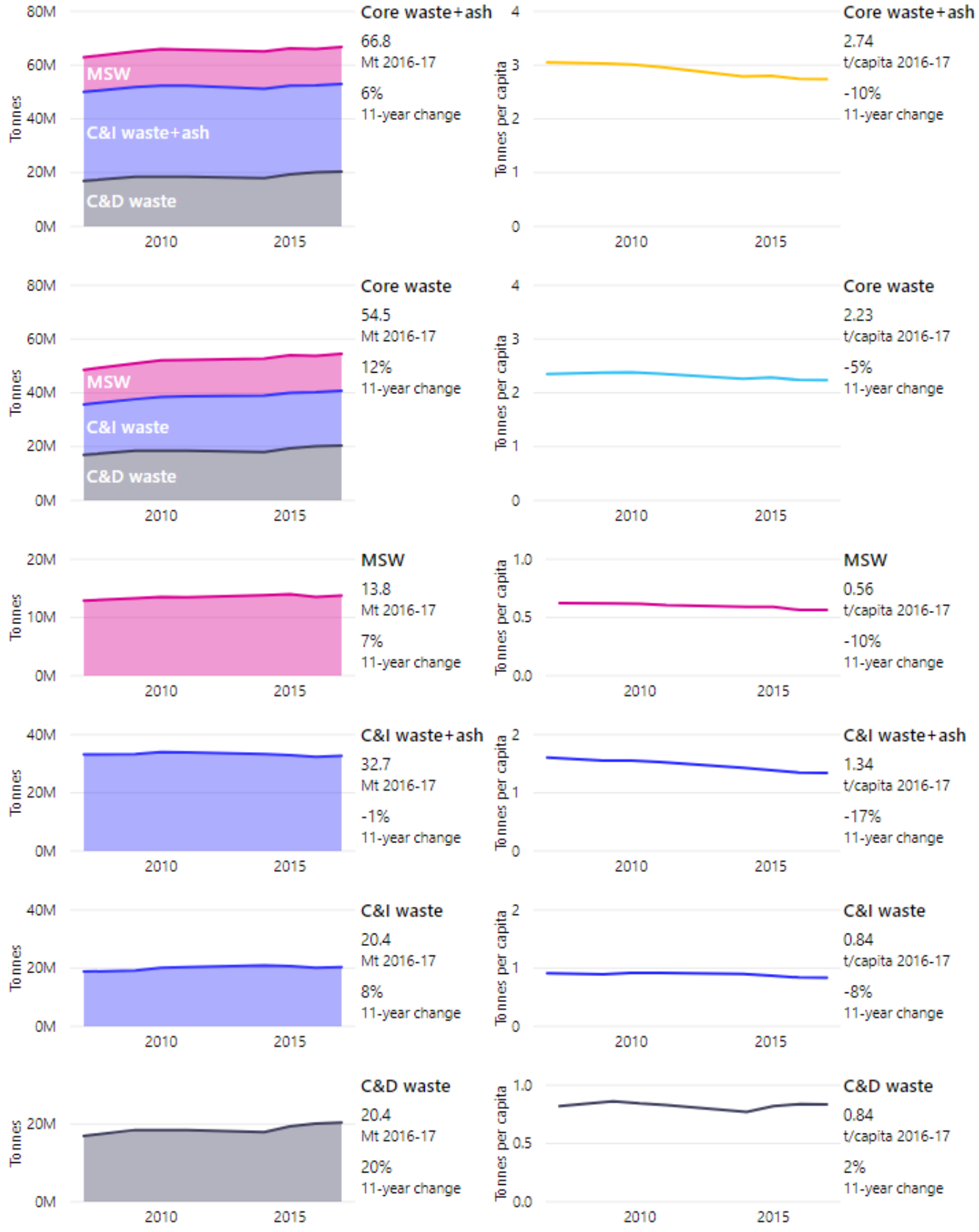
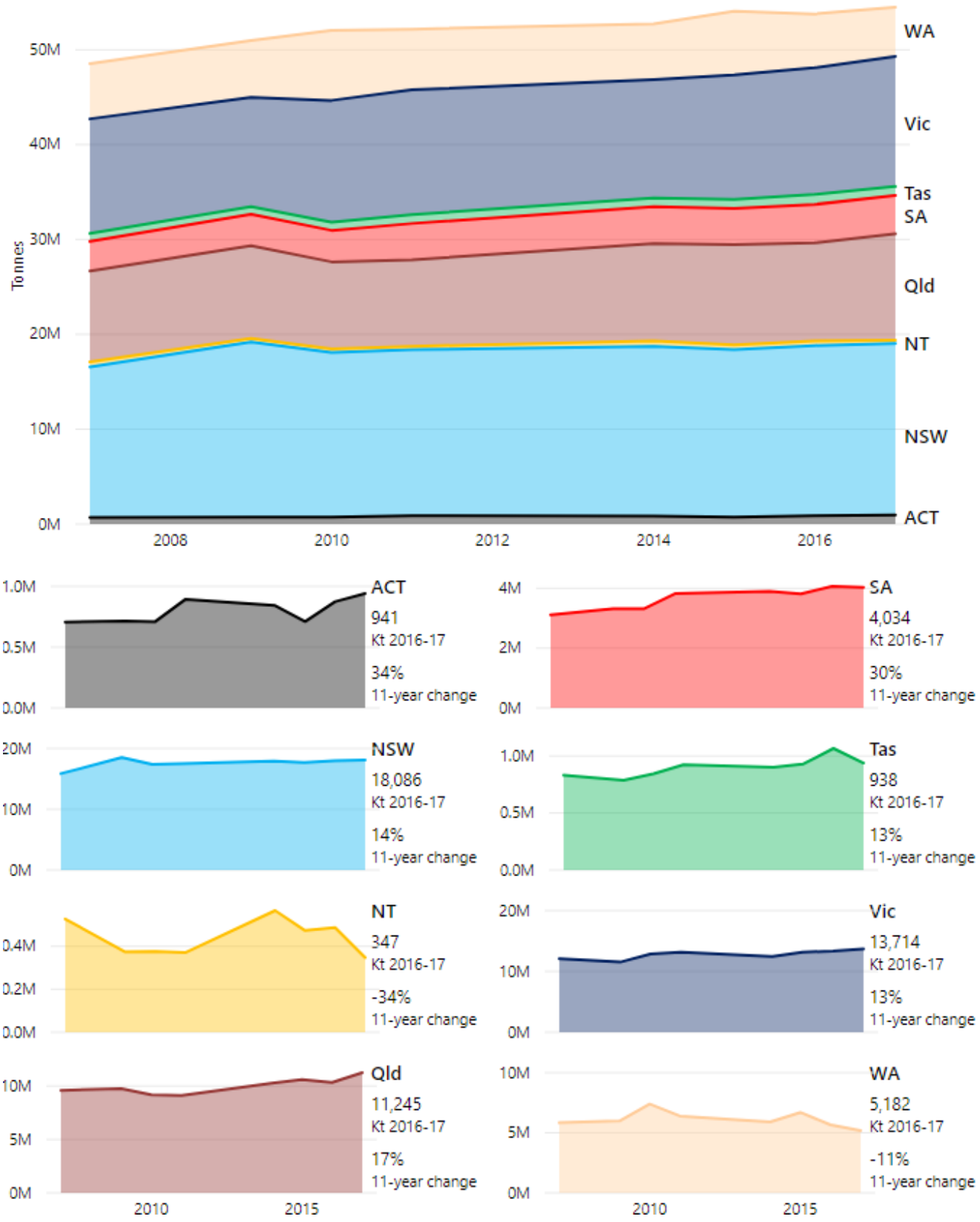


Figure 12 Trends in the generation of core waste by jurisdiction, Australia 2006-07 to 2016-17



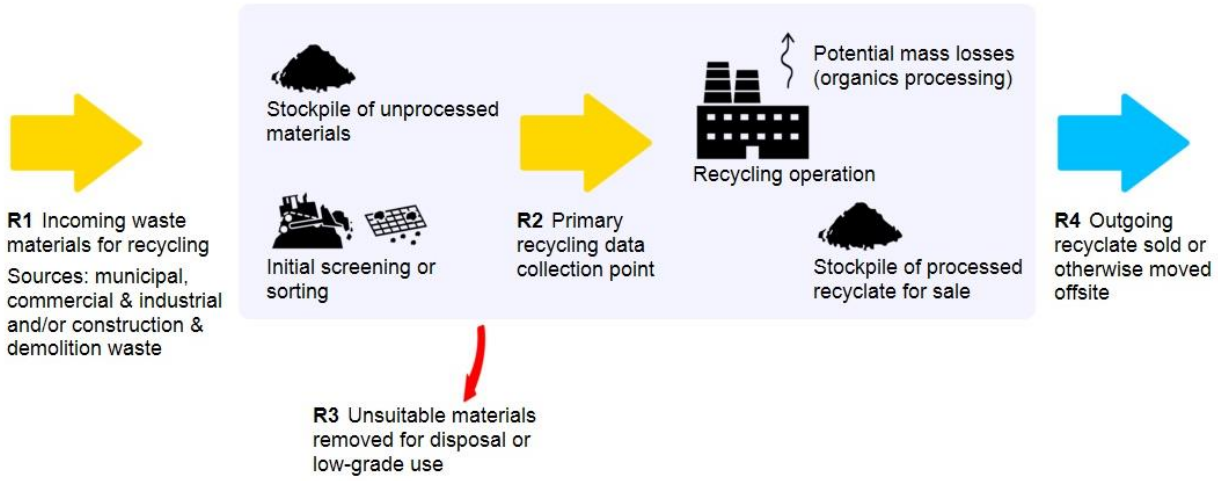
3. Recycling

This section reports on the quantities of waste materials processed for recycling in Australia in 2016-17 and the trends since 2006-07. It discusses whether the markets for waste materials for recycling were on-shore or overseas. Information on the recycling of particular waste materials is given in Section 7.

3.1 What the data covers

Figure 13 illustrates material flows at a generic recycling facility, showing the primary measurement point (R2) for the data presented in this section. The states and territories aim to collect data at this measurement point from significant recycling facilities. They aim to ensure all materials are counted, and are counted only once[10]. The data may include unsold stockpiles of processed product, and exclude stockpiles of unprocessed material[11] (noting that some states impose limits on stockpiling).

Figure 13 A generic recycling process, illustrating what is included in the data presented in this section



3.2 Recycling in 2016-17

The quantities of core wastes recycled in Australia in 2016-17 are illustrated in Figure 14[12]. About 31.7 Mt of materials were processed for recycling. The three largest fractions, making up a combined three-quarters of the total, were masonry materials (12.3 Mt), organics (7.3 Mt) and metals (5.0 Mt). C&D materials represented the largest source stream (43%) followed by C&I materials (37%) and MSW (20%).

The economic implications of increased recycling

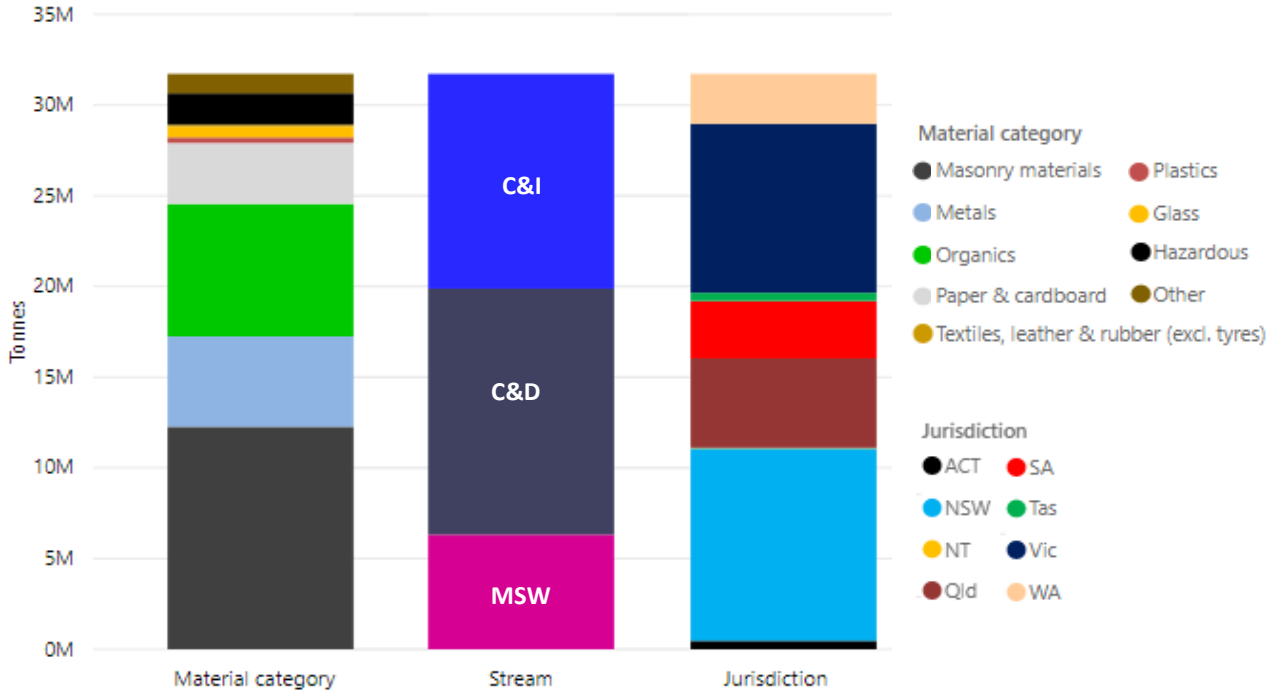
Modelling by the Centre for International Economics (2017) suggests that a 5% increase in the recycling rate could add $1 billion to Australia's gross domestic product.

[10] This is not always easy. Materials may accumulate or be part-processed at one location before being moved to another, which could be in another state or territory. Reporters may sometimes provide tonnages of materials received, so that small quantities of residuals to landfill could be counted twice.

[11] There are currently problems with stockpiles, including unprocessed C&D waste in WA (several sites) and Vic (one large site near Geelong). The materials in those stockpiles are absent from the data presented in this report.

[12] Full data for all charts is given in Appendix A.

Figure 14 Recycling of core waste by material category, jurisdiction and stream, Australia 2016-17



3.3 Trends in recycling

Figure 15 (overleaf) shows the trends in recycling by source stream in total and, on the right, per capita. A long-term trend is apparent of increased recycling in each stream.

Over the 11-year timeframe, recycling of C&D waste grew by 3.4 Mt or 34% (13% per capita), the most of any of the streams. Demolition waste recycling is a success story in most jurisdictions, providing an alternative source of materials for road base and construction aggregates. MSW recycling increased by 1.5 Mt or 31% (11% per capita). This can be attributed to improved access to recycling services, including organics bins. C&I recycling including ash grew by 2.7 Mt or 19% (1% per capita). Excluding ash, C&I grew by 1.7 Mt or 17% (-1% per capita).

Waste reuse

The waste management hierarchy recognises reuse of products and materials as the highest order solution for waste, apart from avoiding its generation. National waste reporting distinguishes between:

- *Reuse*: defined as 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).
- *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 tip shop).

Reporting of all material and product reuse is impractical and is beyond the scope of this report. Waste reuse is within the scope of this report where data is available. States and territories were asked for data on tip shop numbers and throughput but most were unable to respond as the data is not collected. Qld reported 18,673 tonnes of waste reuse in 2016-17.

While waste reuse tonnages are relatively low, the number of full-time equivalent jobs per thousand tonnes of material sold per year is much higher for waste reuse than for recycling. Similarly, the dollar value of the materials sold is much higher.

Figure 16 (p.16) shows trends in the quantities of core waste to recycling by jurisdiction. Overall, a strong growth trend is apparent, with recycling increasing by 26% over the 11-year timeframe. The increase was greatest in Vic (2.7 Mt). Proportionally, the largest increases have been in Tas and WA, both of which increased recycling by about 50%. NSW recycling data for 2015-16 and 2016-17 is an estimate only, extrapolated from 2014-15 data.

Figure 15 Trends in the recycling of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2016-17

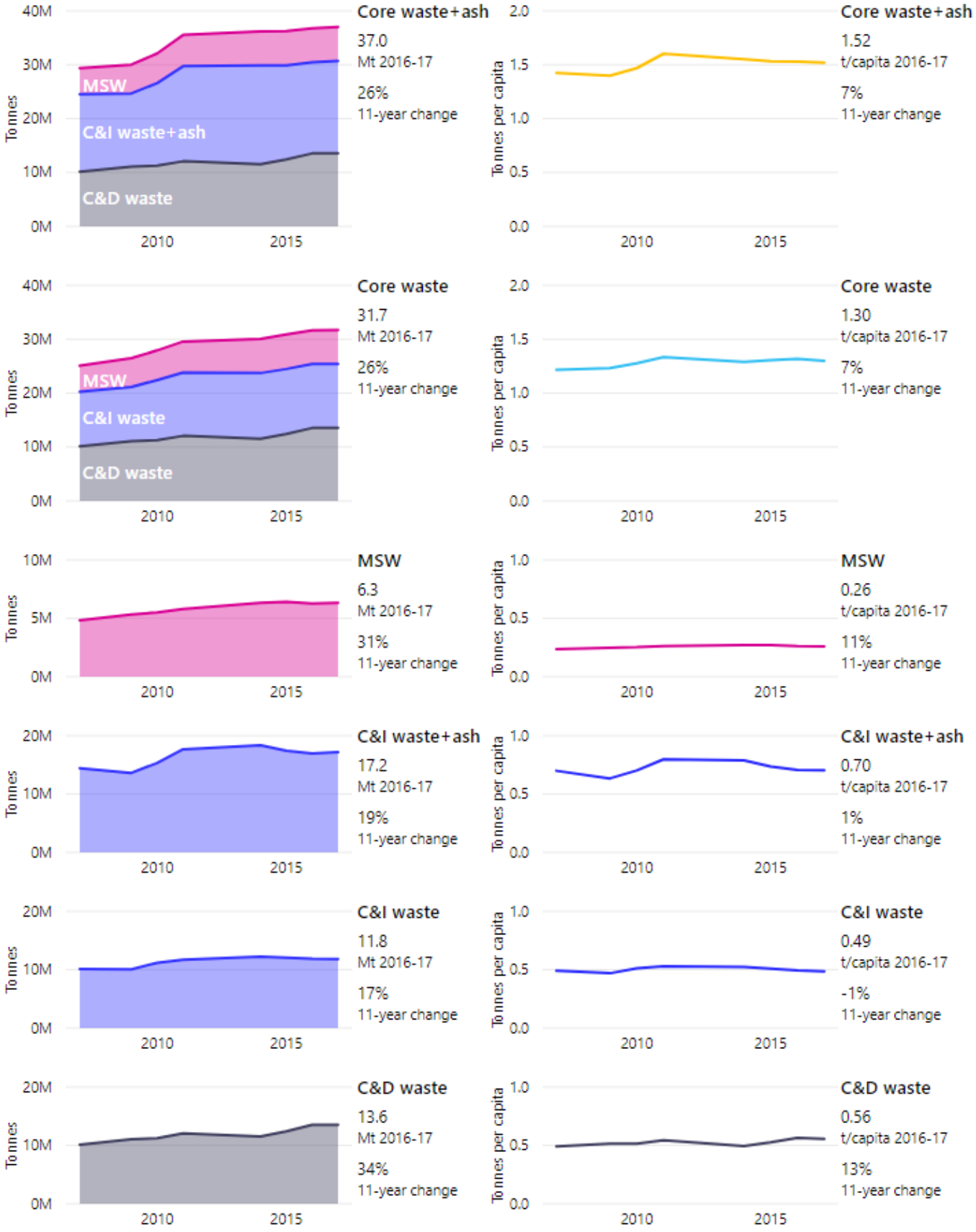
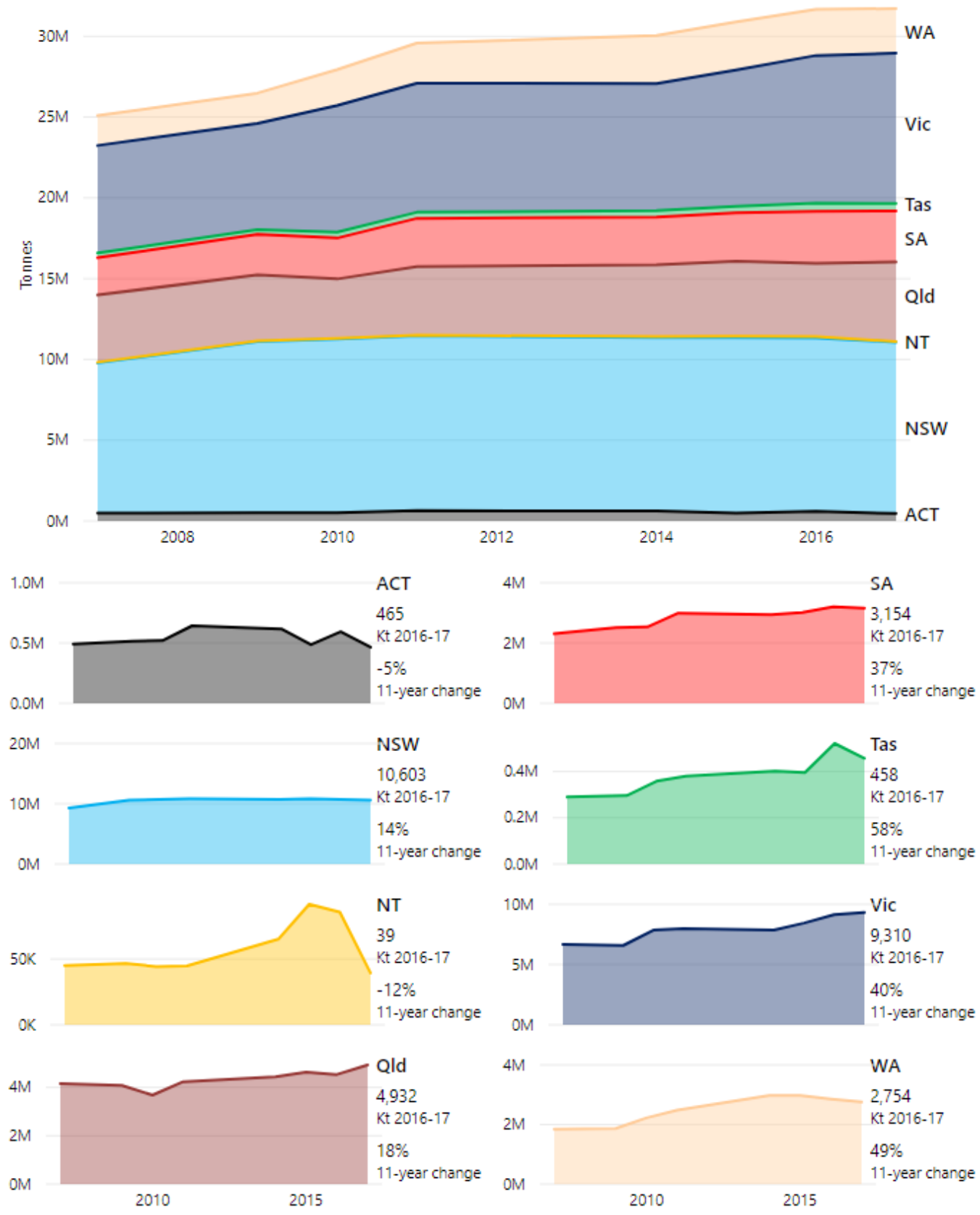


Figure 16 Trends in the recycling of core waste by jurisdiction, Australia 2006-07 to 2016-17[13]



[13] NSW recycling data for 2015-16 and 2016-17 is an estimate only, extrapolated from 2014-15 data.

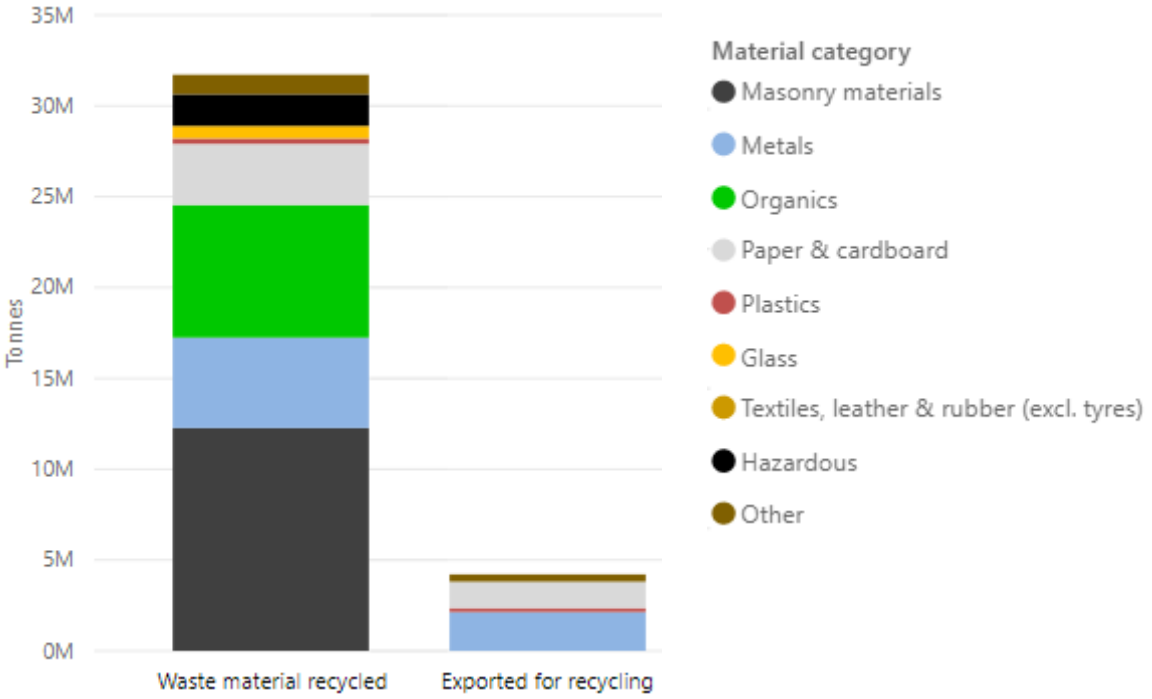
3.4 Exports of waste materials for recycling

Data on export tonnages and types are collected by the Australian Bureau of Statistics. This section reports on 94 export codes identified as comprising or containing waste materials sent for recycling[14].

Exports by material category, 2016-17

Figure 17 compares Australia's exports of waste materials for recycling with the estimated quantities of materials collected for recycling. Exports are small compared with the overall throughput of Australia's recycling industry. Almost all recycling of masonry materials, organics, glass and hazardous waste occurs on-shore. For metals, paper and cardboard and plastics, however, exports are significant. In 2016-17, about 43% of recycled metal, 70% of recycled plastic and 43% of recycled paper and cardboard was exported for processing overseas.

Figure 17 Comparison of core waste recycling and exports of waste materials for recycling from Australia to all destinations by material category, 2016-17



Export trends and the Chinese waste import restrictions

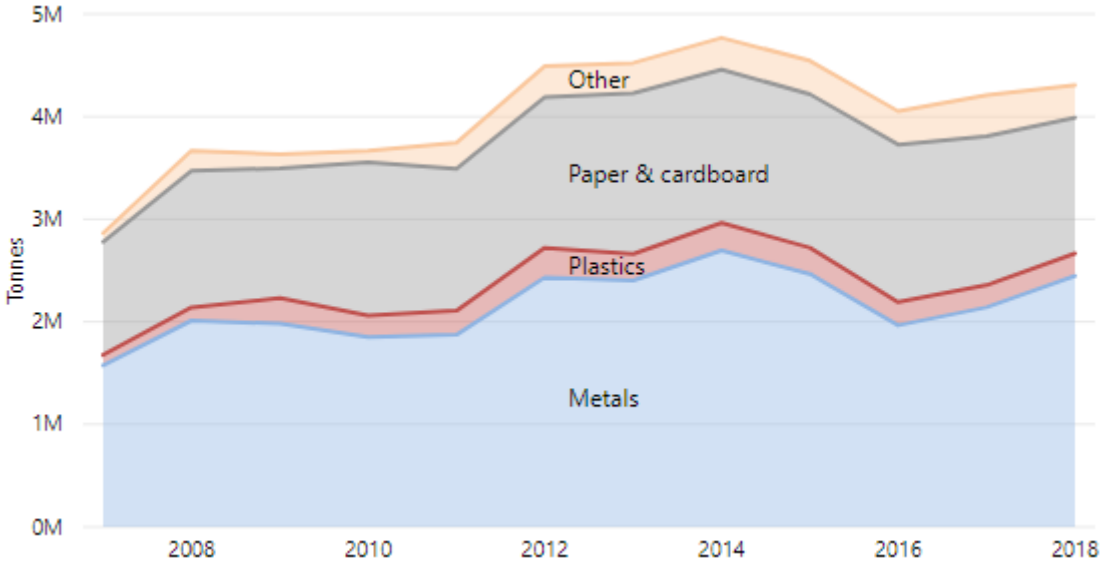
Figure 18 displays exports of waste materials for recycling from Australia to all destinations by financial year (July to June) and type during the 12 years to 2017-18. (Data for 2017-18 is included in this section because it was an important year for waste exports, due to the Chinese restrictions that began to be implemented during that financial year. See the discussion in Section 15.1.)

The chart shows a long-term increasing trend in export of waste materials for recycling, except for a decline between 2013-14 and 2015-16 associated mainly with scrap metals. No effect of the Chinese restrictions is visible in this chart. Rather, in 2017-18 exports of waste materials for recycling grew by 97 kt

[14] The list includes some materials that may be used overseas for energy recovery, for example waste tyres. It excludes 41 hazardous waste codes that are believed to be exported primarily for treatment rather than recycling. The excluded hazardous waste represents about 3% of waste export tonnages. More information about this waste will be included in the forthcoming *Hazardous Waste in Australia 2019*.

(2.3%) to reach 4.3 Mt. There were increases in exports of scrap metals (14%) and plastics (2%) but paper and cardboard exports fell by 9%.

Figure 18 Exports of waste materials for recycling by type from Australia to all destinations, 2006-07 to 2017-18

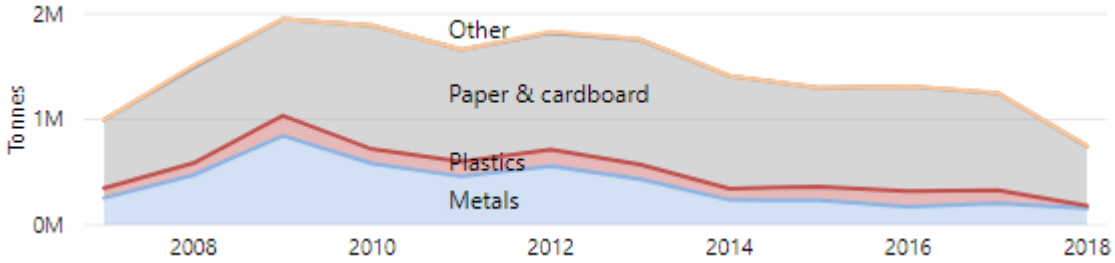


The 'other' component is mainly tyres, textiles, glass and organics

Figure 19 shows exports of waste materials for recycling from Australia to China over the same time period. On this chart the impact of the China restrictions in 2017-18 is readily apparent – exports of scrap metals fell by 23%; plastics by 78%; and paper and cardboard by 39%. Overall, between 2016-17 and 2017-18 exports of waste materials for recycling to China decreased from 1.25 million tonnes (Mt) to 0.75 Mt, a decline of 40%.

Exports to China peaked in 2008-09. Most of the subsequent decline has been due to falling exports of scrap metal.

Figure 19 Exports of waste materials for recycling by type from Australia to China, 2006-07 to 2017-18



The 'other' component is mainly tyres, textiles, glass and organics

The two trend charts suggest that exports of waste materials for recycling were strongly affected by the Chinese restrictions but the displaced materials mostly found new export destinations. More detailed analysis of the data shows this occurred for both paper and plastics, the material types most affected by the Chinese restrictions. In both cases, exports increased to other destinations, mainly Indonesia, Vietnam, India, Malaysia and Thailand. Despite its restrictions and reduced Australian imports, in 2017-18 China remained Australia's biggest destination for exports of waste materials for recycling.

4. Energy recovery

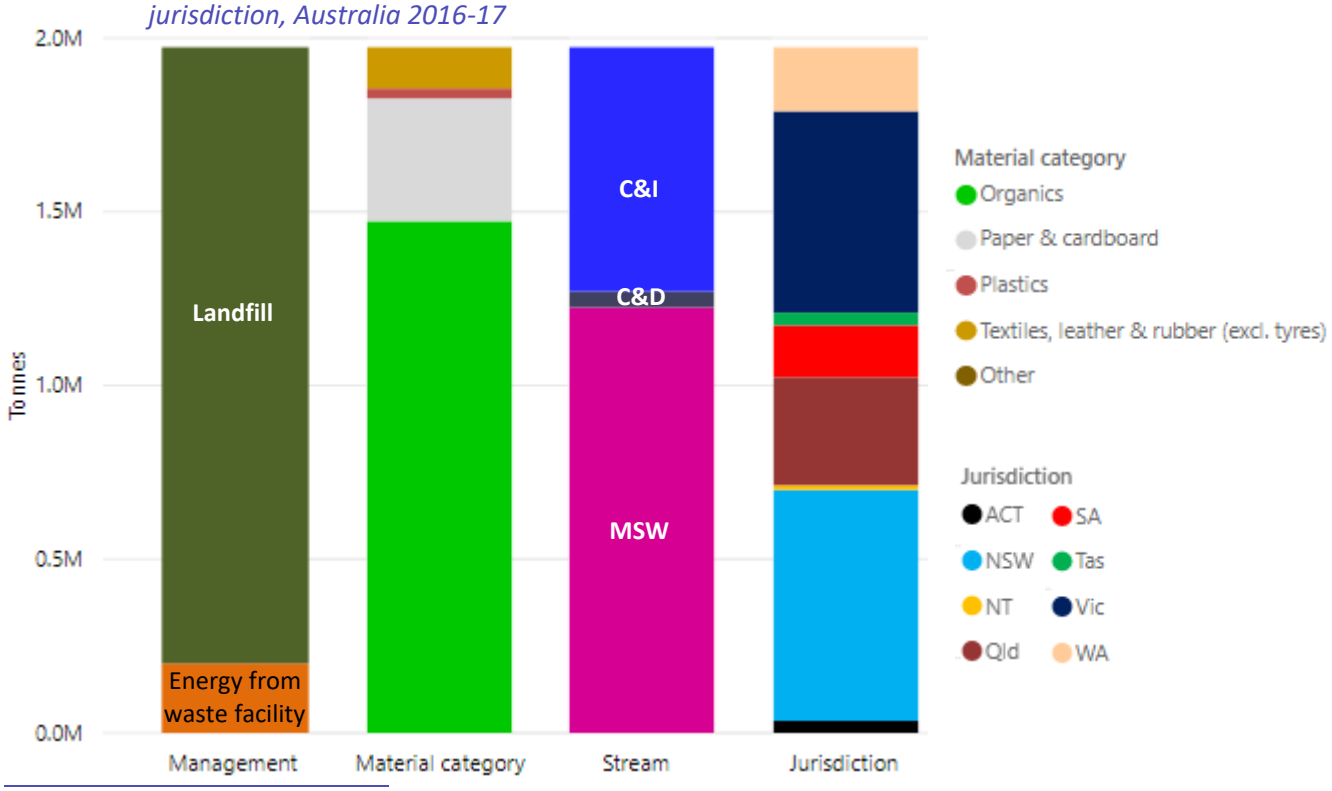
This section reports on the quantities of core waste materials[15] used for their energy value in Australia in 2016-17. The main ways waste is used for energy are:

- Collection of methane generated from the anaerobic decay of organic waste in large landfills. This is commonly used to generate electricity for sale into the grid.
- Production of 'processed-engineered fuels', typically from C&D and C&I waste, comprising timber, plastics and/or textiles[16]. These can be exported or used in cement kilns and other industrial furnaces, substituting for natural gas or coal.
- Use of high calorific value hazardous waste, such as oil-based paints and solvent, to fuel cement kilns[17] and export of some end-of-life tyres for use as a fuel[18].
- Anaerobic digestion of limited quantities of food waste.

4.1 Energy recovery in 2016-17

Figure 20 shows energy recovery from core waste by management method, material, stream and jurisdiction. About 1.97 million tonnes of waste was used for energy recovery, 90% through landfill gas collection. This methane was generated mainly from food, garden and paper and cardboard waste from the MSW and C&I waste streams. Landfill gas energy recovery occurs in all states and territories, roughly in proportion to population size.

Figure 20 Energy recovery from core waste by management method, material category, stream and jurisdiction, Australia 2016-17



[15] Excludes agriculture and forestry biomass used for generating energy, such as sugarcane bagasse and timber mill sawdust. Also excludes energy recovery from wastewater.

[16] Some of these materials may be overlooked in the data set as they can be derived from recycling residues.

[17] Not included in the charts in this section because of inadequate coding in state and territory hazardous waste data.

[18] Included with recycling data because the proportion used for energy recovery is unknown.

4.2 Trends in energy recovery

Figure 21 shows trends in energy recovery from waste. A marked fall is apparent over the past two years, attributable to declining reported energy recovery from landfill gas in NSW, SA, Tas and Vic. Factors that could be contributing to these declines include:

- reduced quantities of organics sent to landfill
- lower rainfall reducing degradation rates
- a switch in operator focus from energy generation to flaring[19]
- a data problem due to reduced local government reporting
- reduced landfill operator interest in collecting landfill gas.

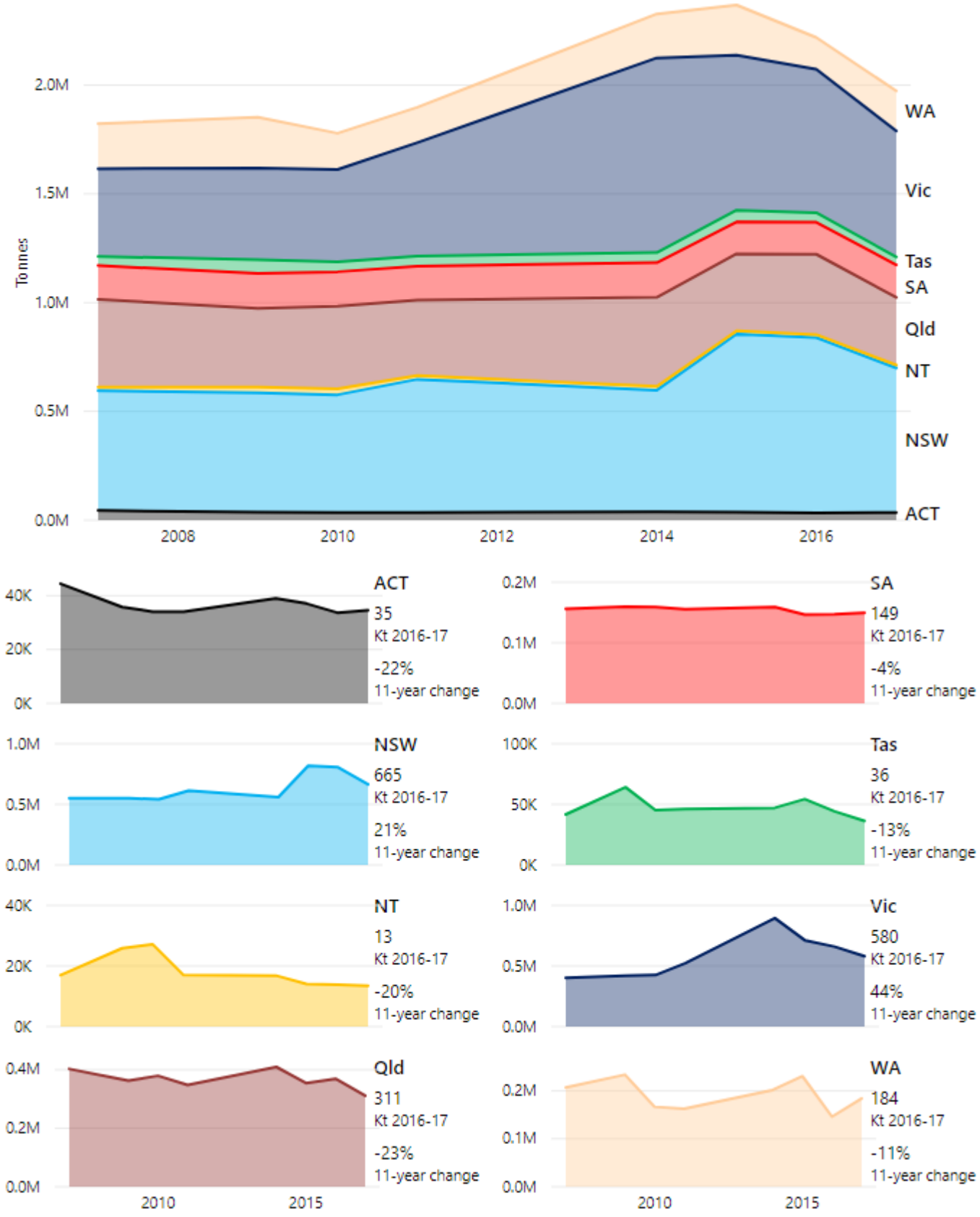
There is considerable interest within government and industry in expanding energy recovery from waste – see the discussion on waste technologies in Section 15.3.

Photo 4 Computers and lead acid batteries collected for reprocessing at a resource recovery centre in Canberra

Photo by Tom Worthington

[19] 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.

Figure 21 Trends in energy recovery from core waste by jurisdiction, Australia 2006-07 to 2016-17



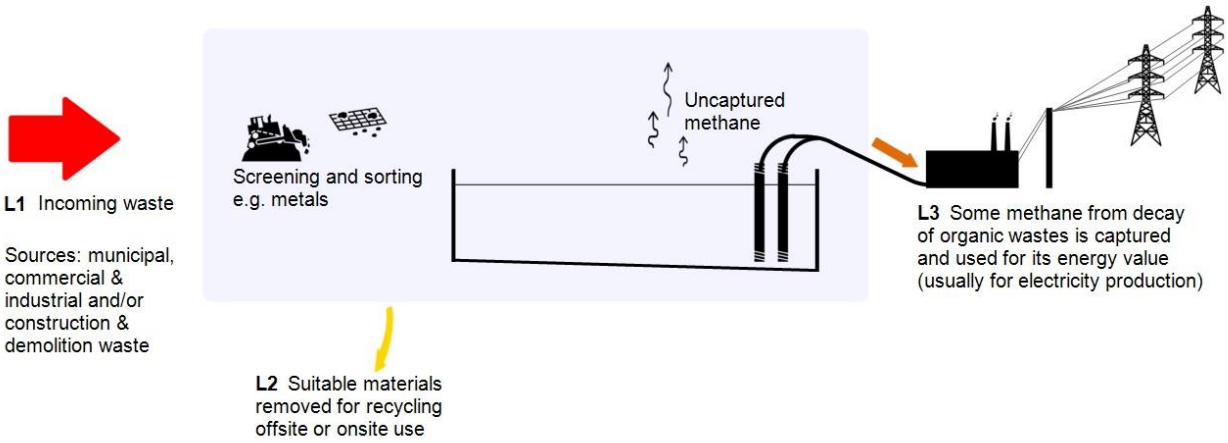
5. Disposal

This section reports on the quantities of waste materials disposed of in Australia in 2016-17. Disposal means allocation to a fate in which no use is made of the waste. Some 99.9% of core waste disposed of in Australia is in landfill. Most of the remainder is thermal destruction of medical and other waste.

5.1 What the data covers

In this report, not all waste taken to landfill is considered 'disposal'. Waste to landfill that is 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 22, 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.

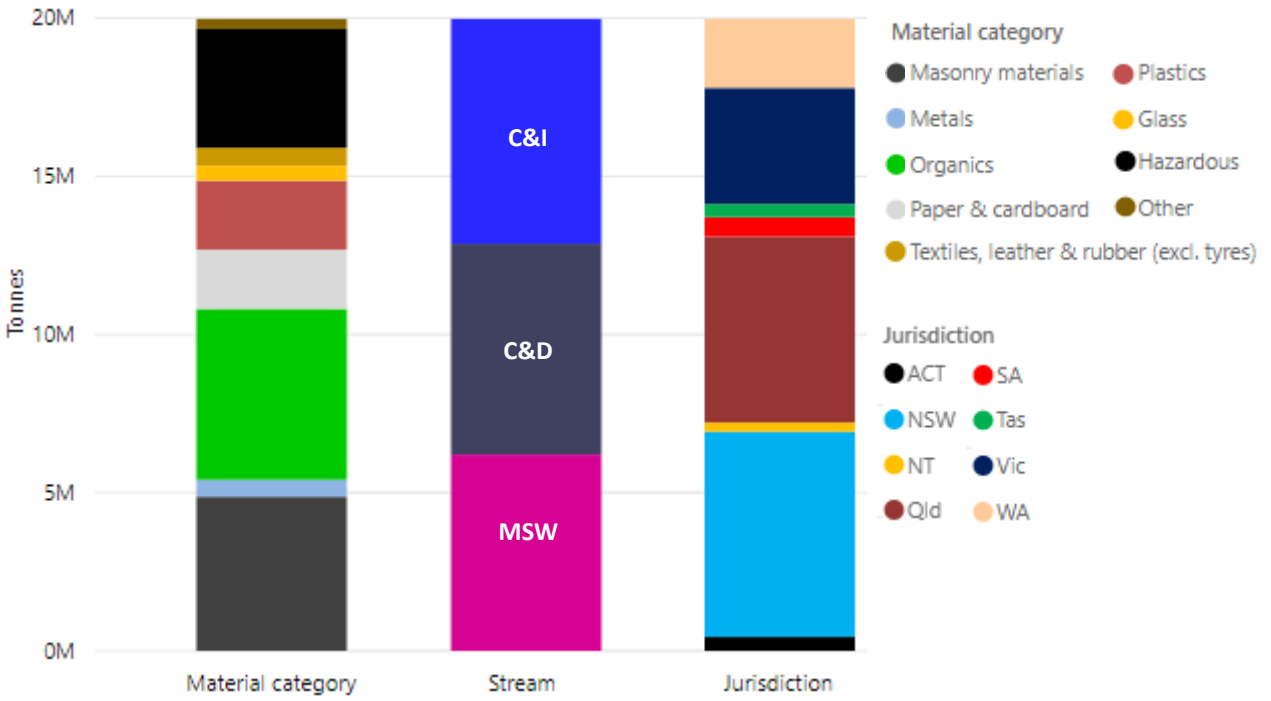
Figure 22 A generic landfill process, illustrating the data presented in this section



5.2 Waste disposal in 2016-17

Figure 23 (overleaf) shows the disposal of core waste by material category, stream and jurisdiction. Nearly 20 Mt of waste was disposed of, representing 37% of the 54 Mt of core waste generated. The biggest waste material components are organics, masonry materials and hazardous waste (mainly soils contaminated with hydrocarbons, heavy metals or asbestos). Organics are particularly problematic in landfills as they give rise to leachate, gas and odour and pest animal populations. Disposal from the C&I waste stream is slightly larger than from C&D waste stream, which is slightly larger than the MSW stream. Disposal by state and territory is roughly proportional to population.

Figure 23 Disposal of core waste by material category, stream and jurisdiction, Australia 2016-17



Supplementing the disposal data, Table 4 shows, for each state and territory, total waste to landfill (L1 minus L2 in Figure 22). A total of 21.7 Mt of core waste was deposited in landfill, comprising 40% of the 54 Mt generated.

Table 4 Core waste to landfill by jurisdiction, Australia 2016-17 (kt) and change since 2006-07

	ACT kt	NT kt	NSW kt	Qld kt	SA kt	Tas kt	Vic kt	WA kt	Austr. Mt
MSW	104	123	2,137	1,809	392	174	1,571	1,085	7.39
C&I waste	190	49	2,995	2,004	123	240	1,125	901	7.63
C&D waste	180	132	1,969	2,312	151	39	1,549	374	6.71
Total	**474**	**305**	**7,101**	**6,124**	**666**	**453**	**4,245**	**2,360**	**21.73**
% change since 2006-07	125%	-37%	14%	21%	-14%	-8%	-20%	-40%	-3%

Note: figures may not add exactly to the totals due to rounding

5.3 Trends in waste disposal

Figure 24 shows trends in the disposal of core waste and ash by source stream over the 11-year data set. Waste to disposal has declined by about 13% including ash and 4% excluding ash. Quantities of core C&I and C&D waste have remained fairly stable but MSW has declined by about 11% over the 11 years. When ash is included, C&I rates have fallen by 19%. On a per capita basis, disposal quantities have declined across all streams. This is due to stable or falling waste generation rates and increased recycling.

In Figure 25, disposal trends are shown by jurisdiction including only core waste (ash data by jurisdiction is not accurately known). Despite strong population growth, total disposal quantities have fallen slightly due to declining per capita rates of waste to landfill. The individual jurisdiction charts suggest varying results. ACT disposal quantities increased strongly over the last two years of the data set due to a program of forced demolition of about 1,000 houses contaminated with 'Mr Fluffy' asbestos insulation. The strong fall in WA waste disposal is associated with the C&D waste data issue discussed in Section 17.4. In most other jurisdictions the trend is fairly stable.

Figure 24 Trends in the disposal of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2016-17

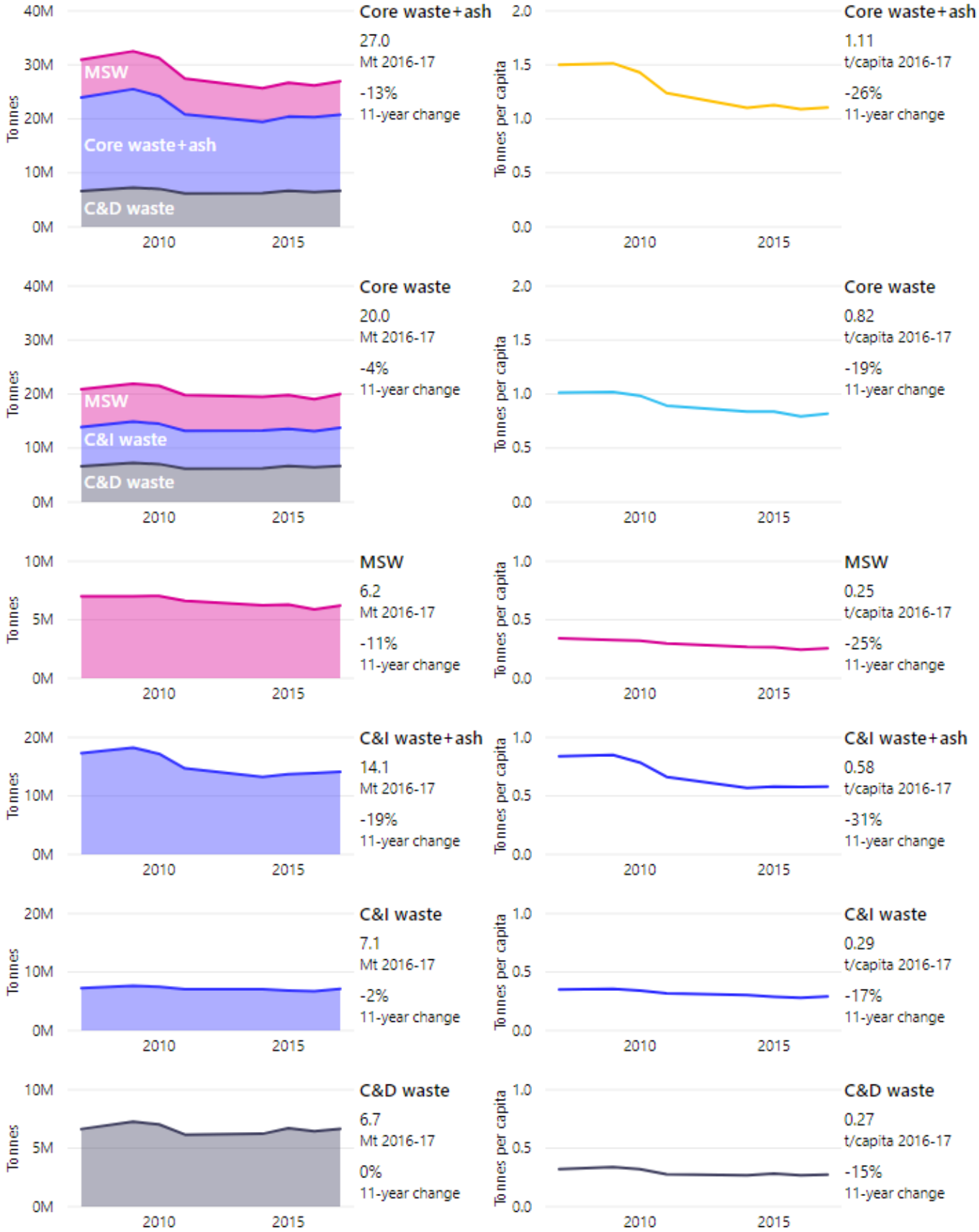
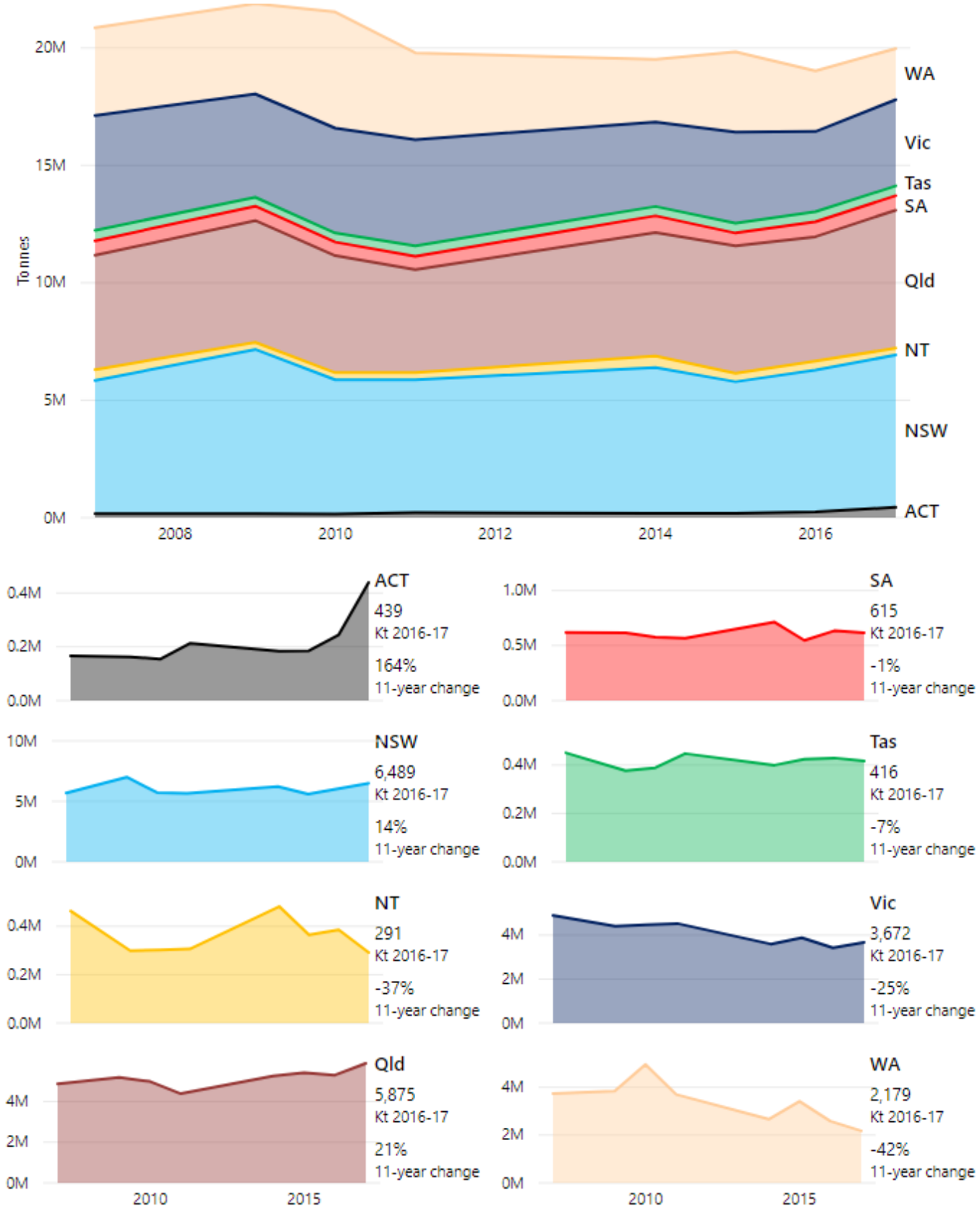


Figure 25 Trends in the disposal of core waste by jurisdiction, Australia 2006-07 to 2016-17



6. Resource recovery and recycling rates

This section assesses and compares resource recovery and recycling rates. It looks at these measures firstly for the eight states and territories, then 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.

6.1 Resource recovery and recycling rates, 2016-17

The headline national resource recovery rate in 2016-17 was 58%. The headline recycling rate was 55%.

These headline values include ash, but in the remainder of this section resource recovery and recycling rates exclude ash because the quantities are not accurately known for each state and territory. All the reported resource recovery and recycling rates also exclude hazardous waste sent for treatment, as this cannot be accurately allocated to recycling, energy recovery or disposal.

Figure 26 shows the estimated resource recovery and recycling rates for each state and territory. The rankings on both measures are identical. SA is the highest ranked jurisdiction, with a resource recovery rate of 82% and a recycling rate of 78%. Next, in order, are Vic, NSW[20], WA, ACT[21], Tas, Qld and NT. Across Australia, the resource recovery rate was 62% and the recycling rate was 58%.

Figure 26 Resource recovery and recycling rates of core waste by jurisdiction, 2016-17

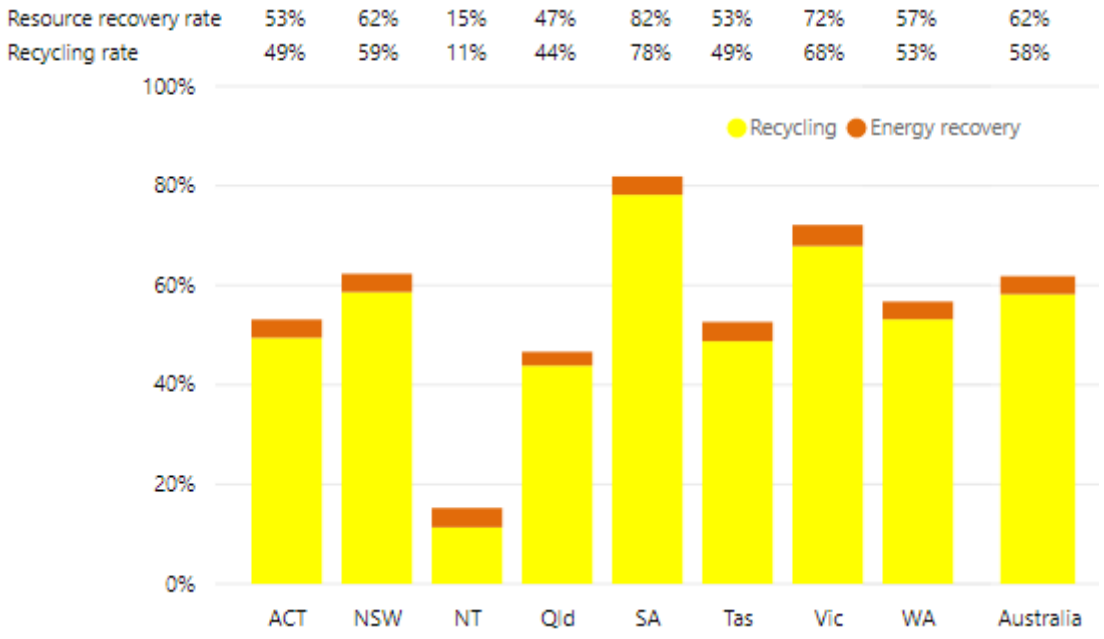
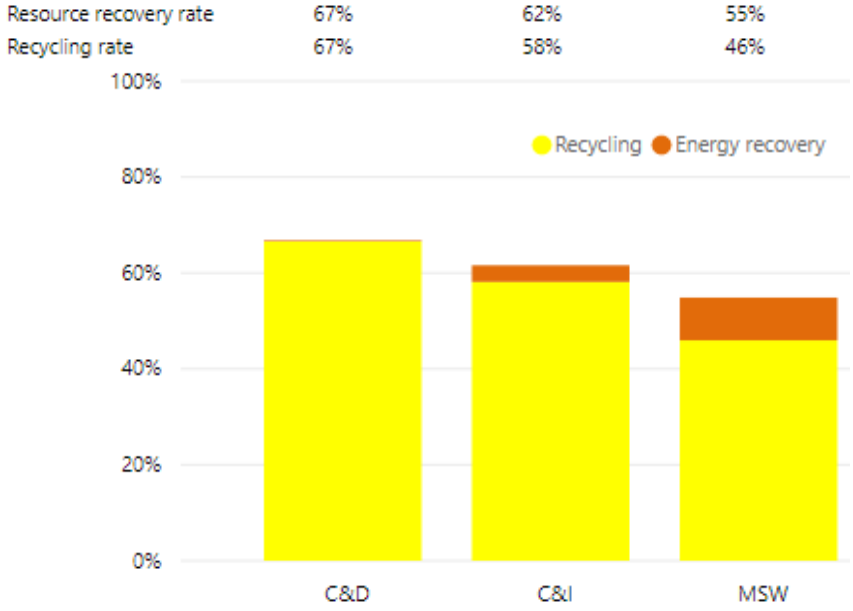


Figure 27 (overleaf) shows resource recovery and recycling rates by source stream. Recovery from the C&D waste stream is highest, followed by C&I waste and lastly MSW. Less than half of MSW is recycled.

[20] NSW recycling data for 2016-17 is an estimate only, extrapolated from 2014-15 data.

[21] Resource recovery and recycling rates in ACT were substantially lowered by the disposal of large quantities of asbestos contaminated waste from its 'Mr Fluffy' demolition program.

Figure 27 Resource recovery and recycling rates of core waste by source stream, Australia 2016-17

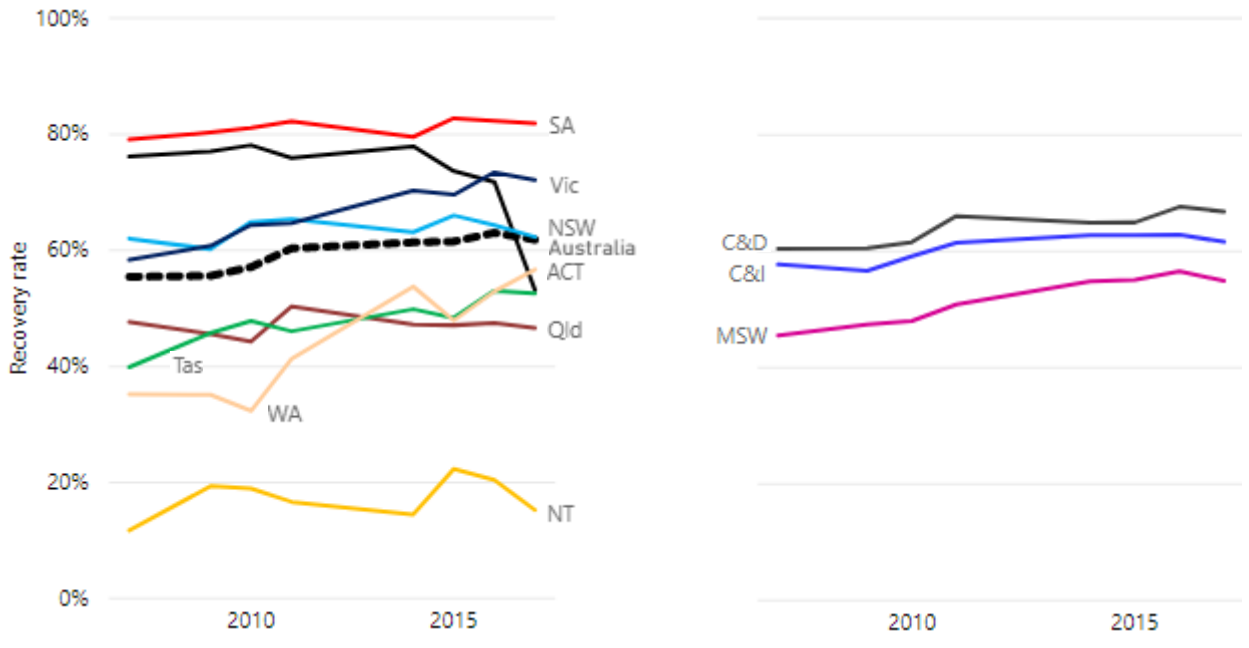


6.2 Trends in resource recovery rates

Figure 28 shows the trends in resource recovery rates by jurisdiction and by source stream over the 11 years from 2006-06 to 2016-17. In general, and across Australia altogether, the trend is to increased recovery rates. However, in recent years the recovery rates for Qld, NSW and Vic appear to have fallen slightly, noting that NSW recycling data for 2015-16 and 2016-17 is estimated. The falls are partly due to declining landfill gas recovery. The ACT recovery rate plummeted in 2016-17 due to the large quantities of demolition waste disposed of under its 'Mr Fluffy' asbestos program (see Section 5.3). Examined by source (on the right of Figure 28), recovery rate trends are increasing for all three streams.

Australia's resource recovery rate (excluding ash) rose from about 55% in 2006-07 to 62% in 2016-17. The 2016-17 value is unchanged from 2014-15 and slightly lower than 2015-16 but, given data uncertainties, these values are best considered unchanged.

Figure 28 Resource recovery rate trends of core waste by jurisdiction and stream, Australia 2006-07 to 2016-17



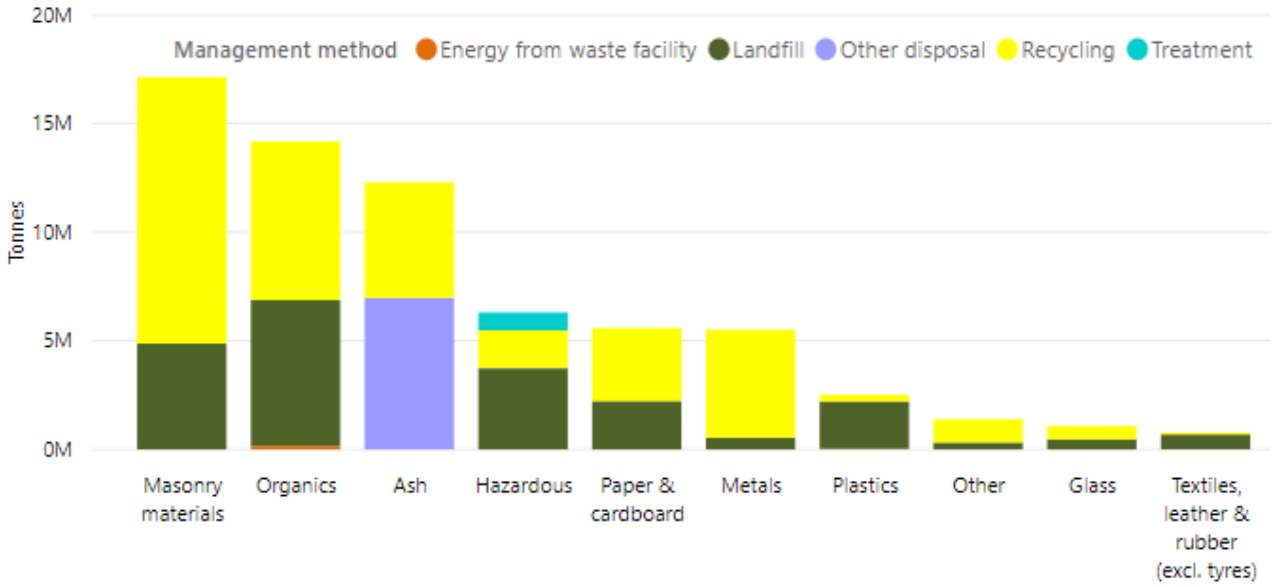
7. Waste materials analysis

This section reports on the status and trends of particular waste material categories, focusing mainly on the core waste. The status and trends in generation and management of key waste categories are examined in turn. The section closes with a comparison of resource recovery and recycling rates.

Figure 29 shows the generation and management methods of the core waste categories and ash generated in Australia in 2016-17. The largest categories were masonry materials, organics, ash and hazardous waste. Figure 30 (overleaf) shows the trends in generation and management for the most important categories.

In the following sections, key materials are discussed in turn. The discussion on the organics category is more detailed and covers a broader scope of wastes, so is examined last.

Figure 29 Generation and management method of core waste and ash material categories, Australia 2016-17



7.1 Masonry materials

In 2016-17 about 17.1 Mt, or 703 kg per capita, of waste masonry materials were generated. This category includes heavy waste types such as concrete, bricks and rubble. Masonry materials are recovered from most large demolition projects but less so from smaller projects. These often generate mixed loads of demolition waste that are sent directly to landfill.

Figure 30 (overleaf) shows the trend in masonry waste generation and management methods from 2006-07 to 2016-17. Waste generation increased by about 18% (15 to 17 Mt) while the recycling rate increased strongly from 61% to 72% (8.9 to 12.3 Mt).

There are good markets for recycled concrete aggregate for use as road base, aggregates and hardstand areas. The cement content in recycled concrete aggregate means that the aggregate 'packs down' well and forms a harder and more stable hardstand than pure virgin aggregate. There are also good markets for recycled bricks including for reuse in construction (when renovating older buildings to match the existing bricks) and when crushed into aggregate. Asbestos contamination risks need to be recognised and managed.

Figure 30 Trends in the generation and management methods of key material categories, Australia 2006-07 to 2016-17

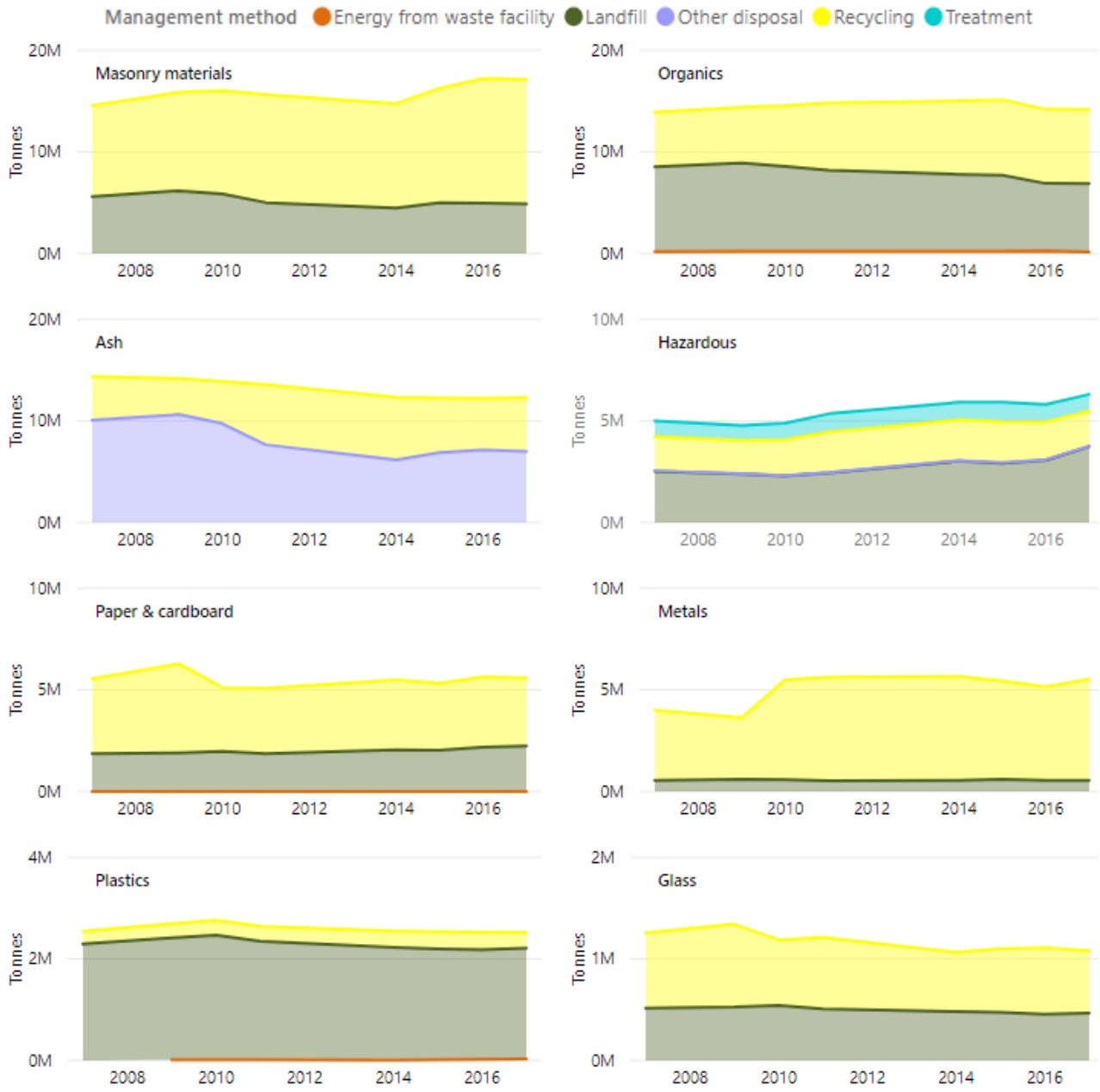


Photo 5 Demolition rubble awaiting crushing and recycling

Photo by Christine Wardle

7.2 Ash

Ash is a large waste stream, generated mostly by coal fired power stations, and mostly managed on the generating site outside the main waste management system. Australia generated some 12.3 Mt, or 504 kg per capita, in 2016-17. About 7.0 Mt was disposed on-site (normally backfilling the coal mine void at the power station) and around 5.3 Mt (43%) was recycled into products such as concrete, where the ash can substitute a portion of the cement content. Opportunities exist to recycle more ash, provided contamination issues are appropriately managed.

Figure 30 shows the trend in ash waste generation and management method from 2006-07 to 2016-17. Ash generation fell 14% over the period, reflecting the decline in coal-fired power generation in Australia, which fell from 187 to 162 terawatt hours per year over the same period (DoEE 2018). Australia's ash recycling rate increased significantly from 30% to 43% (4.3 to 5.3 Mt).

7.3 Hazardous waste

Hazardous waste comprised 6.3 Mt, or 259 kg per capita, of waste, 27% of which was recycled, 59% landfilled and 13% sent to a treatment facility[22]. The bulk of this category comprised contaminated soils, asbestos and tyres[23]. Treatment options are available to remove the hazards from some contaminated soils enabling reuse or recycling. Waste tyres have potential value as fuel or as an input to production processes, and there remains a significant opportunity to increase their recovery in Australia.

Figure 30 shows the trend in hazardous waste generation and management method from 2006-07 to 2016-17. The generation of hazardous waste increased by about 26% (5.0 to 6.3 Mt), while the recycling rate decreased from 34% to 27%. More than half the increase in the quantity of hazardous waste was due to greater quantities of material (mostly soil) contaminated with asbestos.

The cost of asbestos waste

The CIE (2017) estimated that in 2015 asbestos waste reduced quality of life in Australia by the equivalent of 5,394 disability-adjusted life years and reduced productivity by $42.5m.

7.4 Paper and cardboard

About 5.6 Mt of paper and cardboard waste was generated in 2016-17, or 229 kg per capita. About 60% was recycled and 40% was sent to landfill.

Figure 30 shows the trend in generation and management method of paper and cardboard. Generation was stable with an increase of around 1% over the period which equates to a per capita decrease of about 15%. This decline is partly caused by the digitisation of information. For example, industry analysis suggests that newspaper circulation has declined by about 10% per year over the last decade (IndustryEdge 2018).

The recycling rate decreased from 66% to 60% (3.7 to 3.4 Mt) with landfilling rates increasing from 34% to 40%.

[22] Due to the complex and highly varied treatment processes that occur in hazardous waste treatment facilities, the fate proportions are not readily calculable.

[23] Tyres are reported within hazardous waste because they pose a fire hazard and are a 'controlled waste' under the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure*.

Photo 6 Cardboard ready for baling and recycling

Photo by Christine Wardle

7.5 Metals

In 2016-17 about 5.5 Mt, or 226 kg per capita, of metal waste was generated. The recycling rate of 90% was higher than any other material category. Metal recycling is well-established in every state and territory but has suffered from unstable global prices, putting financial pressure on the scrap metals industry, which depends on export markets. At the time of writing prices are recovering. Some toxic metals, such as cadmium and cobalt, and rare and precious metals, such as gold and palladium, are still being landfilled in composite material products such as electronic waste. The tonnages are low but the potential environmental impacts and value of the lost resources are high.

Figure 30 shows the trend in metals waste generation and management method from 2006-07 to 2016-17. Waste generation increased by about 38% (4.0 to 5.5 Mt) and the recycling rate increased from 86% to 90% (3.5 Mt to 5.0 Mt).

7.6 Plastics

About 2.5 Mt or 103 kg per capita of plastic waste was generated in 2016-17. Just 12% was recycled with 87% sent to landfill and 1% sent to an energy from waste facility.

Figure 30 shows the trend in generation and management method of plastics from 2006-07 to 2016-17. Generation was stable over the period which, with a growing population, equates to a per capita decrease of 16%. 'Light-weighting' of packaging is a likely cause.

The plastics recycling rate remained relatively stable.

With recycling rates at just 12%, plastics may be 'low hanging fruit' for improving overall resource recovery rates. Where the value of plastics is too low for recycling, either in Australia or off-shore, processing into refuse-derived fuels offers an alternative. Like metals, plastics recycling has been affected

recently by low commodity values and a relatively strong Australian dollar. Despite the China restrictions, strong global markets remain for plastic waste that is well sorted by type and free of contamination. Australia's plastics recycling rates could be improved with greater on-shore investment in plastics sorting and cleaning equipment to enable either on-shore or off-shore recycling.

7.7 Glass

About 1.1 Mt or 44 kg per capita of glass waste was generated in 2016-17, with 57% being recycled.

Figure 30 shows the trend in generation and management method of glass from 2006-07 to 2016-17. Glass packaging is losing market share to plastic, resulting in a strong decline in glass waste. The quantity generated fell by about 14% or 180,000 tonnes between 2006-07 and 2016-17. Recycling rates have remained between 54% and 61%.

This recycling rate is reasonably good 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, although larger recycling plants now have technologies to deal with these small fractions.

Alternative markets for recycled glass, such as in road base, remain under-developed and under-utilised in Australia and there is a significant opportunity for expansion.

Photo 7 Crushed glass for use as a sand substitute in road base

Photo by Christine Wardle

7.8 Organics

In most of this report, including Figure 29 and Figure 30, the material category 'organics' refers to the core waste types of food, garden organics and timber. It excludes paper, cardboard, textiles, rubber and leather, and hazardous organics, which are discussed in separate core material categories.

In this section, however, organics are considered more broadly, covering the core organic wastes and also:

- organic wastes reported within the hazardous waste material category – mostly biosolids, grease trap sludge and waste from abattoirs and tanneries
- 'non-core' organic wastes from the agriculture and fisheries sectors, including manure, sugarcane bagasse, cotton gin trash and fisheries wastes.

Figure 31 shows 30 Mt of organic waste generation in 2016-17. Core organic materials from the MSW, C&I and C&D sectors made up about 46% (14 Mt or 581 kg per capita) and non-core organics from agriculture and fisheries made up the remainder. About 6.7 Mt of organic waste was deposited in landfill.

The most significant waste tonnages were livestock manure (33%), bagasse (20%), food organics (14%), garden organics (12%), timber (7%), other organics (6%), biosolids (5%), and food-derived hazardous waste (2%).

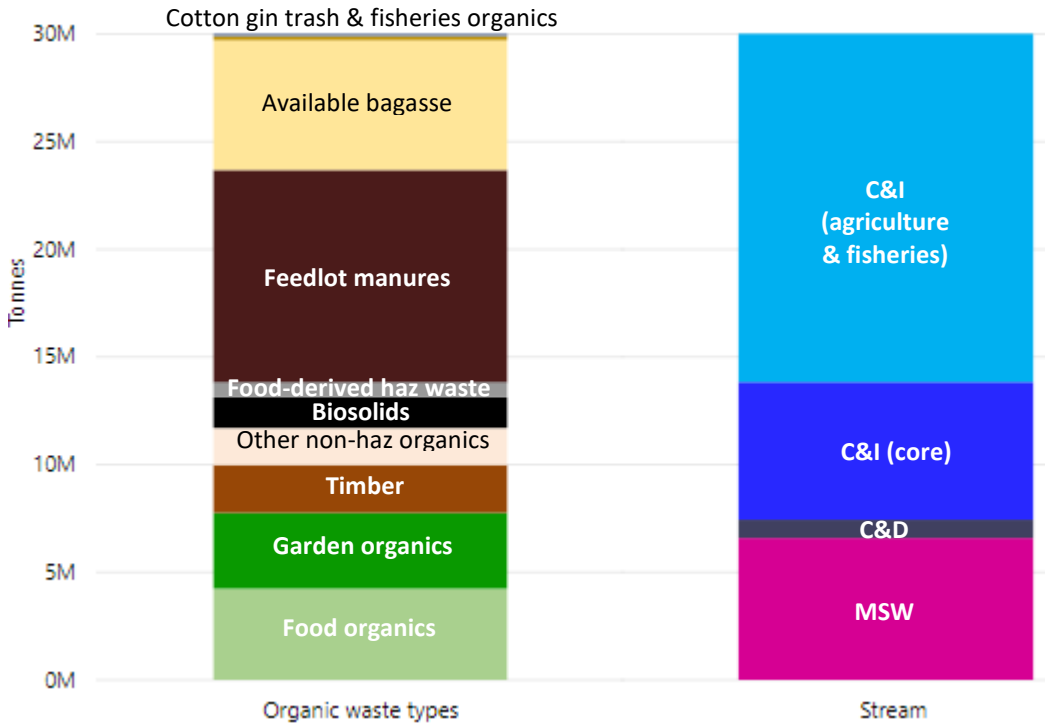
The trend in generation of organic waste is shown in Figure 30 for core waste only, for which trend data is available. Organic waste generation remained fairly stable over the 11-year period while Australia's population increased. Overall there was a reduction per capita of about 14%. The recycling rate increased from 39% to 52% (5.4 to 7.3 Mt).

Biosolids and contamination

The *National Waste Report 2016* categorised all biosolids as hazardous on the basis of their potential to contain hazardous contaminants and lack of data to demonstrate otherwise. Recent national biosolids data (PSD 2017) includes a breakdown by jurisdiction and contaminant grade, and in this report these have been adopted to better identify 'contaminated biosolids' as a small proportion of all biosolids.

However, the guidelines applied to characterise contamination levels cover a limited range of contaminants, including various heavy metals, organochlorine pesticides and PCBs. These represent a small portion of contaminant lists used for characterising hazardous wastes more generally, and exclude a range of chemical risks that are likely to apply to biosolids. For example, Gallen *et al.* (2016) measured PFOS contamination levels at 16 Australian wastewater treatment plants and found four with contamination levels exceeding European limits for their current uses (Australia has not yet set a biosolids-specific limit for PFOS). The proportion of biosolids reported here as contaminated is therefore likely to be an underestimate. This issue will be addressed further in the forthcoming *Hazardous Waste in Australia 2019* report.

Figure 31 Generation of organic waste by type and stream, Australia 2016-17



Almost all organics can be recycled via the composting process which generates products that improve soil productivity and health. Most compost is absorbed into the 'urban amenity' market, but agricultural markets are of increasing importance. Reducing and managing both gross and chemical contamination is the key issue to enabling higher rates of organics composting. Some organics, such as food waste, are suited to anerobic digestion processes, which generate electricity and produce a useful 'digestate' product

that can be used in compost and soil conditioner products. Significant opportunities remain to improve the recovery of organics via composting or anerobic digestion facilities.

Food waste

In this sub-section, based on the data available, food waste comprises:

1. the core food waste discarded from households and businesses
2. food-derived waste in the core 'hazardous waste' category – that is, grease trap sludge and wastes from abattoirs and tanneries.

This definition excludes food wastes generated on-farm, such as those in Photo 8, and in many upstream food processing operations. Data on these wastes are not readily available.

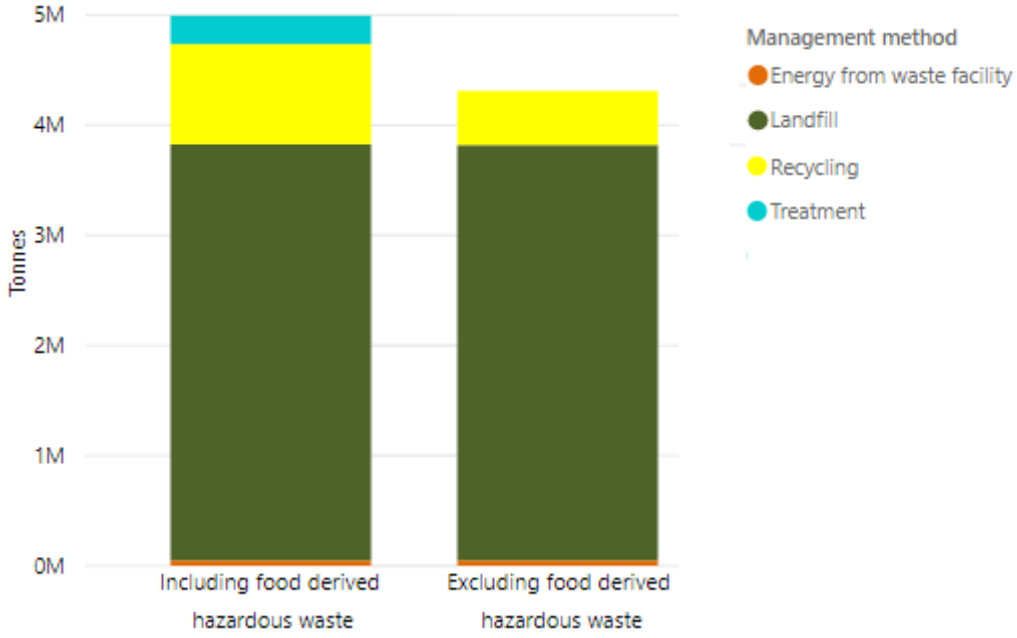
Photo 8 Farm waste like these bananas are not included in this data

From the War on Waste *TV series, used with permission from Lune Media*.

Figure 32 shows the generation and management methods of food waste. The bar on the left shows all recorded food waste data (1 and 2 above); the bar on the right shows only core non-hazardous food waste.

Including hazardous food waste, a total of 5.0 Mt of food waste was generated in 2016-17 with 76% going to landfill, about 18% recycled and 1% going to energy from waste facilities. Excluding the hazardous categories, 4.3 Mt of food waste was generated with 87% going to landfill, only 11% being recycled and around 1% going to energy from waste facilities. More local governments around Australia are beginning to collect food and garden waste in their organics kerbside bin collections, which should see an increase in food waste recovery in future years (see Section 10.1).

Figure 32 Generation of food waste by management method, Australia 2016-17



The National Food Waste Strategy

Food waste is acknowledged by all of Australia's governments as being important due to its impacts on the environment, economy and society.

In November 2017, the Australian Government launched a *National Food Waste Strategy* at the National Food Waste Summit in Melbourne. The strategy provides a framework to support collective action towards halving Australia's food waste by 2030, and aligns with the United Nation's Sustainable Development Goal 12.3 on food loss and waste.

Implementation of the strategy is supported by an initial $1.37 million investment over 24 months. $1 million of these funds has been provided by the Australian Government and the states and territories to Food Innovation Australia (FIAL). In 2019, FIAL will deliver an implementation plan that sets out the short and medium to long-term actions to support reductions in food waste, and a monitoring and evaluation framework to measure our progress towards achieving the 50% reduction target. By 2019, FIAL will have established an industry voluntary commitment program to engage business in food waste reduction activities.

The remaining $370,000 from the Department of the Environment and Energy's National Environmental Science Program is funding research into a National Food Waste Baseline and return on investment study for business, government and the not-for-profit sector.

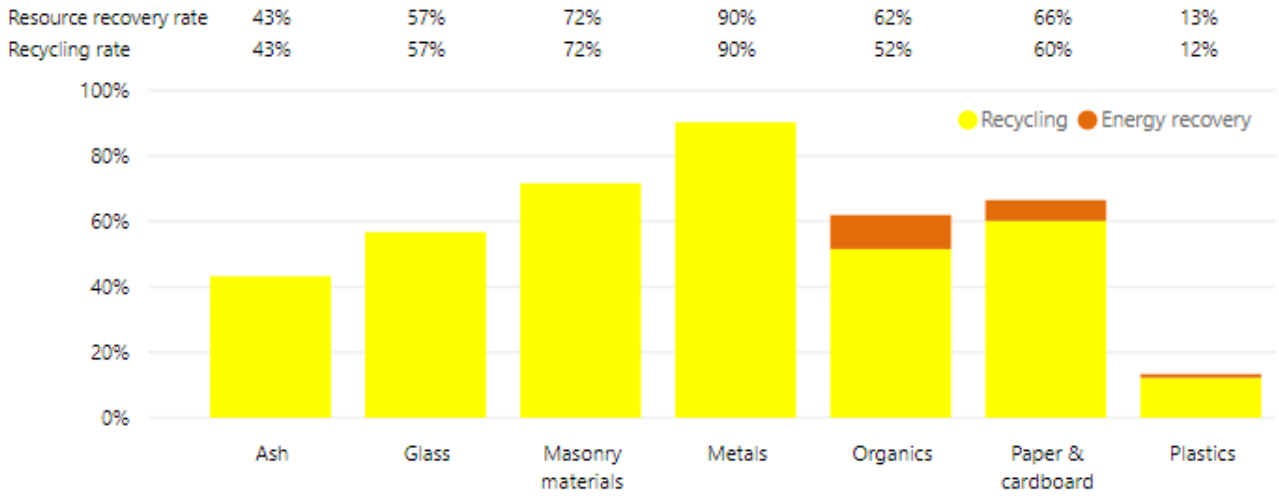
As the first report of its kind in Australia, the National Food Waste Baseline will quantify the amount of food waste generated across the supply and consumption chain, by sectors and food waste fates. The Australian Government's intent is for the report's findings to encourage Australians to avoid generation of food waste, reduce food waste to landfill, and encourage investment in the highest value treatment for all food waste fates, within the principles of the waste hierarchy with a circular economy approach.

The report will establish a baseline for food waste in 2016-17. The final report is expected to be published on the Department of the Environment and Energy's website in late 2018.

7.9 Resource recovery and recycling rates by material category, 2016-17

Figure 33 shows resource recovery and recycling rates for selected waste categories, remembering that 'resource recovery' includes materials used for generating energy. Material categories that are wholly or partly biologically sourced (organics, paper and cardboard, textiles, leather and rubber excluding tyres) all generate landfill methane that is partly captured, so their recovery rate exceeds their recycling rate. A small amount of plastic goes to energy recovery facilities. The materials with the highest recovery rates are, in order, metals, masonry, paper and cardboard, organics, glass, ash and plastics.

Figure 33 Resource recovery and recycling rates for core waste by material category, 2016-17



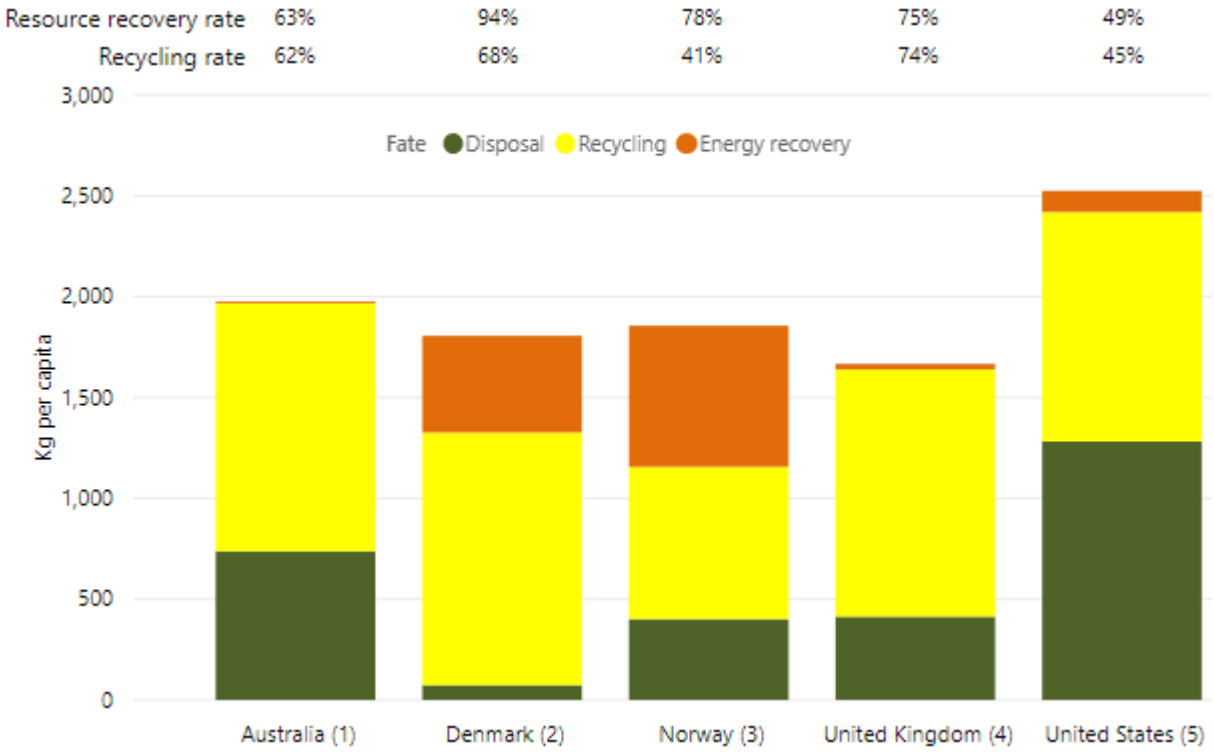
8. International comparisons

This section compares Australia's rates of waste generation, recycling and fate with various countries. It does this for most core waste and also MSW only. The countries compared were selected based on their data being available, recent and readily comparable with Australia.

8.1 Overall waste generation and fate

Figure 34 compares Australia's rates of waste generation, disposal, recycling and resource recovery with selected OECD nations. To ensure a consistent comparison, the Australian data excludes hazardous waste, ash and energy recovery from landfill gas.

Figure 34 Comparison of annual waste generation and fate per capita, Australia and selected OECD countries (excluding hazardous waste, ash and landfill gas energy recovery)



Figures are indicative only. Data is compiled for different years (2014 to 2016-17) and sources due to limitations on data availability. Data sources: 1 This project; 2 Danish EPA (2017); 3 2016 data from Statistics Norway (2018); 4 2014 data from Department for Environment Food & Rural Affairs (2018) Official statistics tables; 5 Based on 2015 data from US EPA (2017 & 2018).

Table 5 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.

Table 5 Descriptions of the waste sources included in the data compared in Figure 29

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).
Denmark	Includes waste from households, service sector, industry, building and construction, power, gas, and district heating supply, agriculture, hunting and forestry and other waste from C&I activities. Excludes soil, imports and exports.
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 bottom ash and fly ash, plastics, rubber, textiles, discarded vehicles, mixed waste and other. Excludes polluted soil, sludges, hazardous waste or radioactive waste.
United Kingdom	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 PCB.
United States	Includes household, commercial, business and institutional and C&D waste.

The rate at which the subject wastes were generated was between 1.7 and 2.0 t per capita per year for Australia, Denmark, Norway and the UK but the US was notably higher at 2.5 t per capita.

Disposal rates varied widely. Denmark disposed less than 100 kg per capita. Norway and the UK were similar, disposing around 400 kg per capita. Australia was significantly higher, disposing around 800 kg per capita and the US disposed by far the most, at around 1,300 kg per capita.

Corresponding to the varying disposal rates, energy recovery rates are very different. Norway and Denmark recovered energy from 700 and 500 kg of waste per capita respectively, reflecting their reliance on thermal energy from waste. The US recovered energy from around 100 kg of waste per capita. Australia was much lower, recovering energy from just 8 kg of waste per capita. There are currently no large-scale energy from waste facilities dedicated to core wastes in Australia.

Recycling rates across the selected jurisdictions were between 1.1 and 1.3 t per capita. Norway was notably lower at 0.8 t per capita. The UK had the highest recycling rate of the five countries at 74% [24] closely followed by Denmark at 68%. Australia's recycling rate of 62% was the next highest followed by the US at a much lower 45%. Norway had the lowest recycling rate of 41%, which may be linked to its high rates of energy recovery.

Recovery rates (recycling and energy recovery combined) were by far the highest in Denmark at 94%. Norway and the UK followed at 78% and 75% respectively. Australia's recovery rate for this scope of waste types was 63%. The US resource recovery rate was significantly lower at 49%.

[24] The UK figure is for 'recycling and other recovery' and includes reprocessing of organic materials (e.g. composting, anaerobic digestion, etc.)

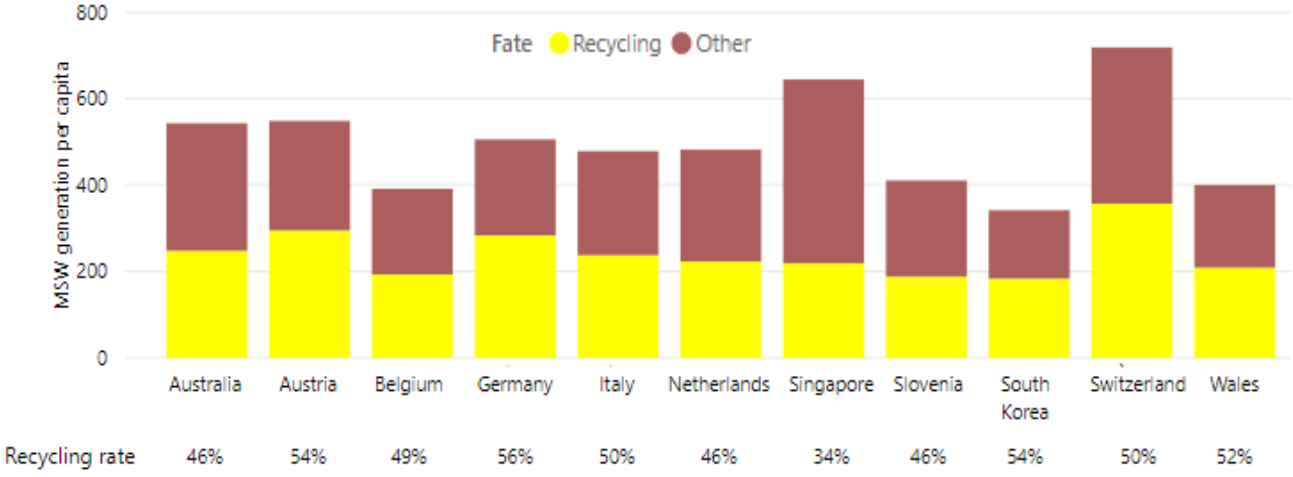
8.2 Municipal waste generation and fate

This subsection compares 2016-17 MSW generation and fate in Australia with selected countries. The data presented for all jurisdictions apart from Australia is sourced from Eunomia (2017), which attempts to report a consistent definition of MSW generation and recycling rate for a selection of developed countries for the 2016 reporting period[25]. It defines the recycling rate as the percentage of materials recycled, composted and digested divided by the MSW generated.

Australia's 2016-17 MSW data was adjusted to be as consistent as possible with the Eunomia definitions. This included removing all masonry materials from the MSW stream.

Figure 35 compares the adjusted per capita MSW generation in Australia with other nations as published in Eunomia (2017).

Figure 35 Comparison of MSW generation and recycling rates in selected countries



The average MSW waste generation across the reported countries was around 500 kg per capita. Australia's adjusted MSW waste generation was about 540 kg per capita or 9% higher than the average.

The average MSW recycling rate was about 50%. Australia's adjusted MSW recycling rate was about 45%.

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

[25] To obtain a consistent definition, Eunomia (2017) excluded C&D waste, C&I waste, incinerator bottom ash, contamination rejects within dry recycling and biowaste, wood waste that is incinerated rather than recycled.

9. Role of 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 of waste transport, storage, treatment and disposal operations. The policy frameworks in each state and territory differ, but there are common themes and some coordination through the Australian Government or direct discussions and sharing by states and territories. Common themes include ensuring waste is safely managed and that the waste hierarchy is implemented (see Figure 36).

Figure 36 The waste hierarchy expresses a preferential order to managing waste, and is embedded in state and territory policy frameworks

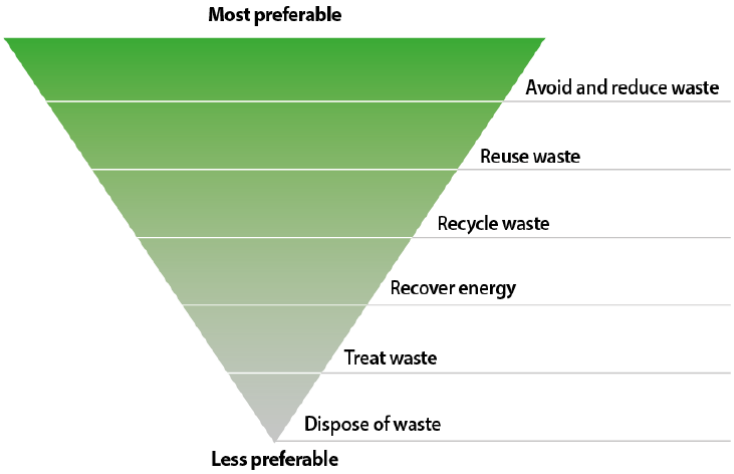


Table 6 (overleaf) summarises selected elements of state and territory policy frameworks, considering:

- Landfill levies – most jurisdictions require landfills to pay some amount to the state 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 document – most jurisdictions 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 6 specifies the strategy document and any targets within it.
- The table lists the status in each jurisdiction 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 single-use plastic bags?
  - does the jurisdiction operate a tracking system that requires 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 to this report. Their responses are set out following Table 6, providing perspectives on:

- data trends and the drivers of them
- major wins or initiatives, especially those other jurisdictions might be interested to follow
- policy developments
- current challenges and opportunities
- significant events.

Table 6 Summary of state and territory waste policy settings

	Landfill levy (2018-19)	Strategy document (including targets)	Other (please see table notes for key)		
ACT	MSW $96.05/t C&I $155.05/t Mixed C&I with >50% recyclable material $211.55/t (The dollar figures are prices rather than levy amounts, as ACT owns the landfill and 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 and recover waste resources for carbon sequestration. Recovery rate increases to over: • 85% by 2020 • 90% by 2025.	Container deposit scheme	✓	Introduced June 2018
			Landfill bans	✓	TVs & computers
			Single-use shopping bag ban	✓	Introduced Nov 2011
			Hazardous waste tracking	✗	
			Household chemical collections	✓	Free drop-off at two facilities
NSW	Metro area: • Waste $141.20/t • Virgin excavated natural material $127.08/t • Shredder floc $70.60/t Regional area: • Waste $81.30/t • Virgin excavated natural material $73.17/t • Shredder floc $40.65/t Coal washery rejects $14.80/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.	Container deposit scheme	✓	Introduced Dec 2017
			Landfill bans	✗	
			Single-use shopping bag ban	✗	
			Hazardous waste tracking	✓	
			Household chemical collections	✓	CleanOut events and Community Recycling Centres
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 shopping bag ban	✓	Introduced Sept 2011
			Hazardous waste tracking	✗	
			Household chemical collections	✗	

	Landfill levy (2018-19)	Strategy document (including targets)	Other (please see table notes for key)		
Qld	General waste: MSW, C&I, C&D (proposed) $70/t Regulated waste: • Category 1 $150/t • Category 2 $100/t Landfill levy proposed to be introduced 4 March 2019	*Waste—Everyone's responsibility: Queensland Waste Avoidance and Resource Productivity Strategy (2014–2024)* (under review at the time of writing) By 2024: • reduce waste per capita by 5% (to 1.8 tonnes per capita per year) • increase state average MSW recycling rate to 50% (from 33% in 2012-13) • increase C&I recycling rate to 55% (from 42%) • increase C&D recycling rate to 80% (from 61%) • reduce waste to landfill by 15% • improve management of problem wastes (specific targets to be developed).	Container deposit scheme	✓	Introduced 1 Nov 2018
			Landfill bans	✗	
			Single-use shopping bag ban	✓	Ban includes compostable and biodegradable bags
			Hazardous waste tracking	✓	
			Household chemical collections	✓	Drop-off availability subject to arrangements by individual councils
SA	Metro Adelaide: • Solid waste $100/t • Shredder floc $62/t Non-metro Adelaide: • Solid waste $50/t • Shredder floc $31/t No levy for packaged asbestos waste	*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 a range of hazardous, problematic and recyclable materials, including most e-waste
			Single-use shopping bag ban	✓	Introduced May 2009
			Hazardous waste tracking	✓	
			Household chemical collections	✓	Statewide household chemical drop-off
Tas	Voluntary levy adopted by regional waste groups at levels of $0 to $7.50/t	*The Tasmanian Waste and Resource Management Strategy* (2009) (under review at the time of writing) No numerical targets are included in the strategy	Container deposit scheme	✗	Under consideration
			Landfill bans	✗	-
			Single-use shopping bag ban	✓	Introduced Nov 2013
			Hazardous waste tracking	✗	Framework in place but not operational
			Household chemical collections	✓	Selected regional programs

	Landfill levy (2018-19)	Strategy document (including targets)	Other (please see table notes for key)		
Vic	Metro and regional: • MSW $64.30/t • C&I and C&D $64.30/t Rural: • MSW $32.22/t • C&I and C&D $56.36/t	*Statewide Waste and Resource Recovery Infrastructure Plan* (2016-2046) No numerical targets included in the plan	Container deposit scheme	✗	
			Landfill bans	✓	'Category A' prescribed industrial waste, paint, industrial transformers, grease trap waste, oil filters, whole tyres and large containers. E-waste ban from 1 July 2019.
	Prescribed industrial (hazardous) waste: • Category B $250/t • Category C $70/t • Asbestos $30/t		Single-use shopping bag ban	✓	To be introduced in 2019
			Hazardous waste tracking	✓	
			Household chemical collections	✓	Statewide program
WA	Putrescible $70/t Inert $105/m^3 $70/t approx.	*Western Australian Waste Strategy: Creating the Right Environment* (2012) Landfill diversion targets by 2020: • 65% for MSW in the metro region • 50% for MSW in regional centres • 70% for C&I across the state • 75% for C&D across the state.	Container deposit scheme	✓	To be introduced in 2020
			Landfill bans	✗	
			Single-use shopping bag ban	✓	Introduced July 2018
			Hazardous waste tracking	✓	
			Household chemical collections	✓	Eight metropolitan and five regional, permanent household chemical drop-off points

9.1 ACT perspective

A sustainable future is one of the ACT Government's strategic themes, as outlined in our plan to achieve zero greenhouse gas emissions by 2045. Our goal is to limit the risks posed by climate change, while ensuring Canberra remains one of the most liveable cities in the world.

Waste management is an important part of building a sustainable city. The ACT is one of the leading jurisdictions in Australia, with over 70% of our waste being used and recycled. However the recovery rate has plateaued over the last few years (excluding the loose fill asbestos insulation waste from Mr Fluffy houses).

Key waste management initiatives delivered in 2017-18 in the ACT are outlined below.

- The ACT Waste Feasibility Study submitted its findings to the Government in 2017. The recommendations include a Roadmap, which is designed to divert over 170,000 tonnes of waste from landfill and increase the ACT's resource recovery rate to 87% by 2025.
- The pilot of a green waste collection service commenced in April 2017, and the program is being progressively rolled out across the ACT. All suburbs will have access to the service by July 2019.
- The ACT Container Deposit Scheme commenced on 30 June 2018, encouraging the community to recycle while reducing litter and the number of containers going to landfill. Like other schemes operating around the country, people can return eligible beverage containers and receive a 10 cent refund.
- ACT NoWaste began administering the new *Waste Management and Resource Recovery Act 2016* (the Act), which commenced on 1 July 2017. The objects of the Act are to manage waste according to a hierarchy that minimises waste reduction and maximises reuse; promotes best practice waste management; supports innovation and investment; and promotes responsibility for waste reduction.

Some challenges were also encountered with the Chinese Government's tightening of conditions for the importation of recyclable waste products coming into effect mid-way through 2017-18. This impacted the Australian recycling sector. For the ACT, the major impact was reflected in reduced domestic prices for recyclable mixed paper and mixed plastics, which is a relatively small percentage of ACT waste that is recycled. The ACT Government was actively engaged in the national waste policy response through its representation at the Meeting of Environment Ministers.

In 2018-19 the ACT will continue to deliver its wide-ranging waste management agenda including:

- the Territory wide roll-out of green bins for garden organics
- the roll out of the container deposit scheme to reduce public litter and increase recycling
- developing options for a food and garden organics recycling solution and a food waste avoidance campaign, in line with the recommendations of the waste feasibility study
- continuing the licensing of ACT waste facilities and registration of waste transporters, in line with the *Waste Management and Resource Recovery Act*
- commencing the development of a robust information technology (IT) infrastructure to underpin the new waste regulatory framework
- issuing an updated Development Control Code for Best Practice Waste Management, and undertaking industry education and compliance
- developing a waste-to-energy policy for the ACT
- contributing to the national waste policy agenda.

9.2 New South Wales perspective

Focusing on reducing waste and supporting industry

NSW is focused on supporting a high performing and responsive waste industry, backed with an $802 million investment under Waste Less Recycle More (WLRM) to support a range of initiatives in waste management. WLRM is the largest waste and recycling funding program in Australia and is funded through the NSW waste levy. It began in 2012 with funding allocated to actions and programs to reduce waste, increase recycling, invest in infrastructure, reduce litter and tackle illegal dumping.

The NSW EPA has been developing, and transitioning to, a rigorous method of measuring recycling performance and waste generation. This new method will ensure the highest reliability and validity of NSW recycling performance and form a national benchmark for accurate waste and recycling data. NSW is committed to sharing its data quality and calculation framework, and to leading a national discussion around improving the quality of measuring recycling performance and waste generation. The EPA has leveraged its waste regulatory framework to prepare quality reliable recycling and waste generation data by:

- mandating data collection and the use of weighbridges for waste recovery facilities in New South Wales
- incentivising resource recovery and recycling by effectively applying the waste levy
- regulating strict stockpile limits on resource recovery facilities to ensure waste is managed appropriately and efficiently.

New reforms are tackling litter

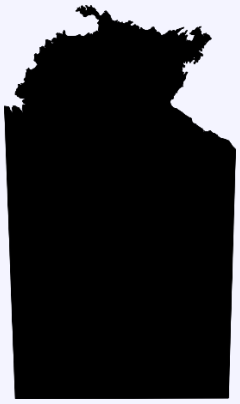
On 1 December 2017, the NSW Government introduced the largest litter reduction initiative in NSW, the Container Deposit Scheme, Return and Earn. The scheme allows people to receive a 10-cent refund when they deliver an eligible beverage container to a return point. As at October 2018, there are 680 return points across NSW with more than 750 million drink containers redeemed. There has been a 33 per cent reduction in Return and Earn eligible drink containers in the litter stream since November 2017 – the month before the scheme was introduced. Over the next 20 years, Return and Earn is expected to result in 1.6 billion fewer beverage containers littered, almost 11 billion fewer beverage containers ending up in landfill and 12.6 billion more beverage containers being recycled.

Improving the resilience of NSW recycling

In 2018 China began enforcing its National Sword policy, restricting the types of recyclable material it will accept, and its decision is presenting global challenges that are impacting recycling in NSW. In response, on 20 March 2018, the Minister for the Environment announced a one-off package of up to $47 million to support local government and industry respond to China's policy. The package funds a range of initiatives to ensure kerbside recycling continues and to promote industry innovation. The NSW EPA is also leading an inter-governmental Taskforce to find a longer-term response to China's policy, in partnership with industry and councils. The Taskforce is working towards innovating and improving recycling and recycling markets in NSW by:

- examining the use of recycled products in Government procurement
- developing a circular economy policy for NSW
- identifying opportunities to increase NSW's recycling capacity
- examining the need and options for longer term funding solutions.

9.3 Northern Territory perspective



The NT EPA continues to implement the 'Waste Management Strategy for the Northern Territory 2015-2022'. The Strategy provides a basis for understanding and improving the management of waste across the Territory, including reducing the generation of waste, increasing rates of resource recovery and minimising environmental impacts caused by waste.

Improving data collection, monitoring and analysis has been a focus in the Territory during 2017-18, with general improvement in timeliness and accuracy of reporting from licensed operators. The variations seen in the NT waste data is likely partly due to inconsistencies or inaccuracies in the data is collected and reported by licensees, and lack of timely reporting. Extreme weather events in the form of cyclones and flooding have also likely affected waste trends in the NT in the past few years. Tropical cyclones Lam and Nathan impacted the Arnhem land coast in February and March 2015 respectively, while Cyclone Marcus affected Darwin and surrounds during March 2018. Flooding (and the evacuation of the town) has occurred in Nauiyu (Daly River) in December 2015 and January 2018. Tracking and reporting of waste during emergency situations is challenging and the NT continues to refine its approach to emergency waste management. Improved reporting systems for waste disposed to landfill following emergency events will be a priority for 2018-19.

The development of an electronic waste tracking system, suitable for use by both industry and regulators, remains a priority. It is anticipated that significant progress will be made during 2018-19 on implementation of this system, and it will significantly improve the quality of data collected by providing a consistent approach.

Facilitating partnerships between industry and regional councils to improve access to waste management schemes (such as the container deposit and various product stewardship schemes) is also a current focus. Collaboration with regional councils is continuing, with the aim to improve waste segregation and management. Engaging with local community, local government and industry stakeholders through the NT Environment Grants program provides exciting opportunities to identify innovative approaches to waste management, especially in more remote communities.

9.4 Queensland perspective

Across 2016-17, Queensland generated 9.8 million tonnes of headline wastes (municipal solid waste, commercial and industrial waste and construction and demolition waste). This was a 7.1% increase on the amount generated in 2015-16. By comparison, Queensland's population grew by 1.3% over the same period.

Queensland increased its recycling effort for household and business wastes by almost 320,000 tonnes, resulting in close to 4.4 million tonnes of materials diverted away from landfill.

As its population grows and consumption increases, effective, fit-for-purpose waste avoidance and resource recovery pathways and solutions need to continue to be developed.

In 2018, the Queensland Government introduced reforms to combat plastic litter and improve recycling rates in Queensland, with the introduction of a container refund scheme, a ban on the supply of lightweight single-use plastic shopping bags and announcing the development of a new

comprehensive waste strategy, underpinned by a waste disposal levy. Under the scheme, people will receive a 10 cent refund for each eligible drink container they return to a container refund point. Alternatively, they may donate their 10 cent refund to a charity or community group.

The scheme will help tackle the problem of beverage container litter, which is largely associated with consumption in open air settings such as parks and beaches. At the same time, the scheme will improve Queensland's recycling performance, particularly in 44 local government areas that will enjoy recycling for the first time. Importantly, the scheme will enable our regional communities and businesses to share in the economic benefits the scheme will deliver.

The lightweight single-use plastic shopping bag ban will also significantly reduce the amount of plastic litter in the environment. To complement the ban, Queensland is working with retailers to adopt a voluntary phase-out of thicker single-use 'boutique'-style plastic shopping bags. 900 million of these bags are supplied annually by retailers across Australia.

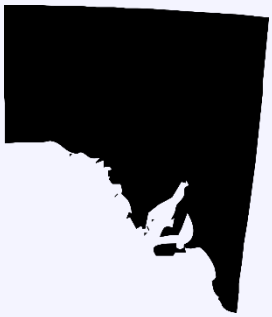
Plastic pollution is a growing problem and one that Queensland is confronting. In 2018, work continued on a plastic pollution reduction plan. Working with representatives from academia, science and research centres, environmental groups, industry sectors and local government, the reduction plan will identify and coordinate a strategic approach to reducing plastic pollution.

The centrepiece of the new waste strategy is the waste disposal levy. An avoidable charge, the waste disposal levy will be instrumental in changing waste management behaviour and practices in Queensland. It will reduce the incentive to dispose of waste to landfill, make material that is currently disposed of more attractive to be diverted as a vital feedstock for the state's biofutures industries and create new industries that manufacture products using recycled content.

The waste disposal levy will provide a much-needed source of funding for programs to support Queenslanders, local government, business and industry in reducing the amount of waste they generate and increase recycling, and for the development of new markets and products. The levy will also provide a disincentive to the practice of long-distance transport of waste for disposal in Queensland.

The Queensland Government will continue to introduce a range of initiatives for emerging priorities such as food and organic waste. Already a number of pilot projects are taking innovative approaches to divert these wastes away from landfill.

9.5 South Australian perspective



The SA waste management and resource recovery industry faces challenges as a result of the restrictions associated with China National Sword and associated increasing operating costs and distance to markets for recycled material.

Major developments and initiatives in SA include:

- China's National Sword Policy Response Package Initiative
  - infrastructure grants, loan fund, regional transport subsidy, market development grants, state-wide education campaign
- State Waste and Resource Recovery Infrastructure Plan
- disaster waste management planning – a Disaster Waste Management Capability Plan and Guidelines were completed and incorporated under the State Emergency Management Plan

- energy from waste discussion paper and summary of submissions released
- promoting the transition to a more circular economy in South Australia
- mass balance reporting with some companies volunteering their data in trials.

The SA Government has taken other actions towards improving certainty, innovation and growth in the waste and resource recovery sector and the broader green economy including:

- funding initiatives for local government waste and resource recovery infrastructure, waste education, new solutions for problematic wastes and to help recycle waste into more valuable commodities, accelerating new business opportunities and job creation in the resource recovery sector
- $0 levy for packaged asbestos waste to promote its safe and lawful disposal
- a levy for shredder floc currently at metropolitan Adelaide $62/tonne and non-metropolitan Adelaide $31/tonne.

Green Industries SA has the primary objectives to promote:

- waste management practices that, as far as possible, eliminate waste or its disposal to landfill
- innovation and business activity in the waste management, resource recovery and green industry sectors, recognising that these areas present a valuable opportunity to contribute to the state's economic growth.

Green Industries SA's role as an investor and catalyst for positive change through policy advocacy, has been central to discussions on how the affected sectors can adapt through longer-term structural adjustments to a more sustainable circular economy business model with increased local remanufacturing.

The *Environment Protection (Waste Reform) Amendment Act 2016* provides the necessary underpinning for the EPA to be able to better tackle illegal dumping and achieve a suite of waste reforms.

Significant waste management challenges exist in SA including:

- economies of scale, contamination and use of composite materials as packaging present challenges to remanufacturing locally and material exported for recovery
- waste promoted as 'product' and ensuring environmental risks are reliably tested to determine consistency of character and contaminant levels to support the use of only genuine recovered products, with materials that pose risks of harm being safely disposed as waste
- potentially reusable, low-risk 'fill materials' ending up at landfill due to uncertainty regarding testing and treatment and time-cost pressures
- clean up and management of illegal dumping on both public and private land continues to result in a significant cost to the EPA, local government and the SA community
- increasing amount of waste generation.

The greatest opportunities in waste management exist in diverting more material from waste currently destined for landfill, and new technology that can make marginal recycling viable.
The future should involve less waste generated per person, increased diversion of resources from landfill and a continued emphasis on recirculating material in the economy. Facilitating this requires:

- better harmonisation of waste practices and policies in place across all states and territories
- extended producer responsibility in place for a broad range of problematic wastes involving reliable long term, industry funded strategies

- prioritise waste avoidance and minimisation through product design (i.e. design products so waste is minimised, made to last and materials are more easily recoverable), efficient use and production, reuse and repair.

9.6 Tasmanian perspective

The Tasmanian Government has recently acted on some of Tasmania's most pressing waste issues by providing grants for controlled waste and tyre processing facilities, as well as supporting the rollout of a number of national stewardship schemes. In November 2017 the Government made changes to the regulation of waste tyre stockpiling. Storage of more than 100 tonnes of waste tyres is now regulated by EPA Tasmania as a "Level 2" activity under the *Environmental Management and Pollution Control Act 1994.*

In July 2018, partly in response to the Chinese import restrictions, the Minister for Environment convened a Waste and Resource Recovery Round Table. Participants discussed broad waste management priorities for Tasmania, including reducing packaging waste, working with industry leaders to boost consumer awareness and education, increasing recycling capacity, boosting demand through market development, and bringing focus to particular priority waste streams (organics, hazardous waste, industrial waste, and construction and demolition waste).

At the Round Table the Government committed to work with local government, industry and the community to develop a new waste strategy for Tasmania - the Waste Action Plan. Targeted consultation on the new strategy will occur in the latter part of 2018 and into early 2019 with public consultation to follow.

In 2017 the Tasmanian Government provided funding for an investigation into a model framework for a state-based Container Refund Scheme. The consultant's report on a potential CRS model was released in July 2018 and will be considered as part of the development of the Waste Action Plan. An internal EPA review of Tasmania's lightweight plastic shopping bag ban was carried out in 2017, which will also help to help to inform parts of the new waste strategy.

The Tasmanian Government is also rolling out a series of 2018 election commitments on littering, dumping and recycling. This includes:

- moving towards making Tasmania the cleanest and least-littered state by 2023
- developing a strategic collaborative program between land managers, councils and community corrections to clean up littering and dumping hotspots
- increasing penalties for littering and dumping
- improving litter and dumping reporting through the development of an app
- working with local government to improve resource recovery outcomes
- increasing funding to Keep Australia Beautiful – Tasmania.

9.7 Victorian perspective

In 2016-17, the volume of waste generated and recovered in Victoria remained relatively stable. Victoria's waste and resource recovery system managed 12.87 million tonnes of material – 1.1% more than the previous year. Approximately 4.25 million tonnes of waste were sent to landfill and 8.62 million tonnes (67%) of material were recovered for recycling.

The capacity of Victoria's resource recovery sector continues to grow, leading to greater recovery of valuable resources. For example, households recovered 17.6% more organic material in 2016-17 than the previous year. This is the result of expanded household organics collection and processing infrastructure and a growing market for recycled organic products, supported by the *Victorian Organics Resource Recovery Strategy*.

Like other Australian jurisdictions, Victoria's waste and resource recovery system has experienced significant challenges from recent disruptions in global recycling markets. In particular, our recycling system has faced major financial and operational challenges due to the sharp fall in commodity prices for mixed paper, plastic and cardboard.

To address these challenges, the Victorian Government released the *Recycling Industry Strategic Plan*. The actions included in the plan will support industry, minimise costs for households, and improve the resilience of Victoria's recycling sector. The plan commits to developing a circular economy policy by 2020, which will build on Victoria's existing waste and resource recovery strategies, with a focus on waste minimisation and sustainable production and consumption. The implementation of this plan is supported by a $37 million package that includes:

- boosting the Resource Recovery Infrastructure Fund, which leverages private investment in recycling infrastructure, to over $21 million
- delivering an education campaign to improve Victorians' understanding of household recycling
- expanding the existing market development program to identify new uses for priority waste materials
- leveraging government procurement to drive demand for recycled materials
- funding for the circular economy policy.

The plan includes a $13 million support package to help councils and industry in the short term, following China's recycling import restrictions.

Underpinning these investments, the Waste and Resource Recovery Planning Framework ensures Victoria has the right infrastructure to maximise recycling and safely manage residual waste. The *Statewide Waste and Resource Recovery Infrastructure Plan*, seven regional implementation plans and supporting strategies for organics, education and market development provide a long-term roadmap of waste and resource recovery infrastructure needs in Victoria.

The Victorian Government is committed to reducing the risk of fire at waste and resource recovery facilities in response to several recycling facility fires in 2016 and 2017. The new *Waste Management Policy (Combustible Recyclable and Waste Materials)* enables EPA to continuously monitor and regulate these sites to minimise the risk of fire. In August 2017, the government established the Resource Recovery Facilities Audit Taskforce to actively work with resource recovery facilities through inspections to improve their compliance with this policy. In response to this Taskforce's findings, the government released its *Action Plan: Managing fire risk at resource recovery facilities*.

The Victorian Government has banned electronic waste (or 'e-waste') from landfill and specified how e-waste must be managed. The new rules take effect on 1 July 2019. To support the rules, the government is rolling out an e-waste collection network that will provide the Victorian community with access to safe e-waste disposal points. This will be complemented by an education and communication campaign to increase community and industry awareness of e-waste and what to do with it.

In response to community concerns about increasing levels of plastic pollution and litter, the Victorian Government has also committed to banning single use lightweight plastic bags by the end of 2019.

9.8 Western Australian perspective

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 reflect increases to the waste levy over this period.

The construction and demolition (C&D) waste sector has been particularly responsive to these increases. The sector recently reported surpassing the Western Australian Waste Strategy C&D diversion target of 75% by 2020. This reported performance is impacted by growing stockpiles of processed and unprocessed C&D materials due to weak demand for recycled products.
The growing stockpiles of unprocessed C&D waste have had a distorting effect on Western Australia's waste generation and recycling statistics.

The Government is encouraging the use of recycled C&D products in civil projects such as road construction and is working with Main Roads to trial the use of 25,000 tonnes in major road projects.
The municipal sector has fallen well below the State's Waste Strategy diversion targets. Improvements to source separation and the adoption of organic recovery systems – including food organics and garden organics (FOGO) - are on the increase and will be key to increasing the amount of municipal waste diverted from landfill.

The State Government has committed over $9.5 million in funding through the Better Bins program to encourage local governments to implement source separated collection systems based on three bins. Encouragingly, local governments that have adopted the Better Bins preferred FOGO model are achieving amongst the highest waste diversion rates in the State.

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 expected to commence in 2020.

A Waste Taskforce was established with representatives from industry, local government, State and local government, and the community. The Taskforce was established to provide advice to the Minister for Environment on how to support and develop a sustainable and productive recycling sector in Western Australia.

Western Australia's new Waste Strategy

The Waste Authority, on behalf of the State Government, is reviewing the State's waste strategy to make Western Australia a low waste society in which human health and the environment are protected. The new strategy will include revised objectives and targets, with improved data collection and management to support monitoring and evaluation.

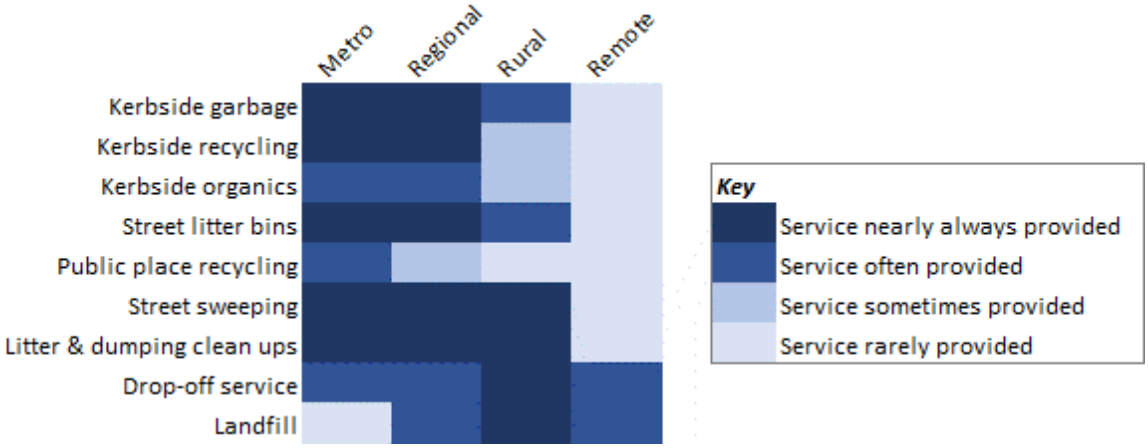
10. Local government waste management

This section addresses the critical role played by local governments in providing waste services to their communities. The data was mostly obtained from state government collations of council data. The section closes with a perspective from the Australian Local Government Association.

10.1 Local government services

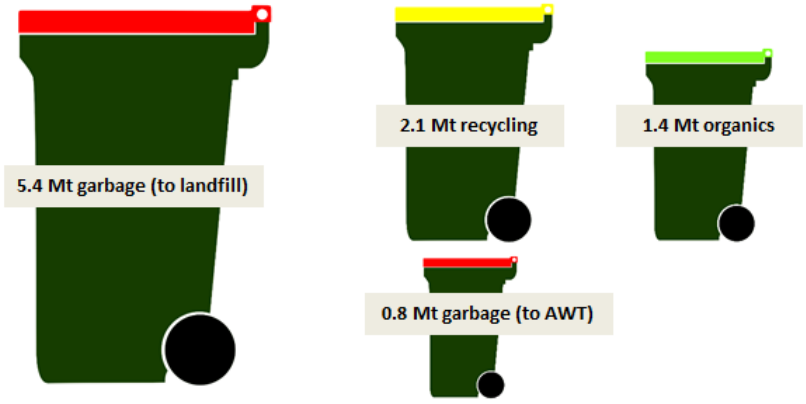
Local government waste services include kerbside collections, public place waste management and provision of recycling and disposal infrastructure. The services provided vary by local government and region type, as illustrated in Figure 37. Most of the data in this section is on kerbside services.

Figure 37 Local government waste services by region type



In 2016-17, local governments collected a total of around 9.7 Mt of residual waste from kerbside bin services. This quantity is broken down by service type in Figure 38. More than half of the bin contents collected by local governments was sent to landfill.

Figure 38 Waste collected by Australian local governments by service type[26], 2016-17



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 to ensure they are correctly used as people move between suburbs and states. Many local governments still use bin colours that are inconsistent with the standard.

[26] AWT stands for 'alternative waste technology'. See Table 9.

Figure 39 shows the proportions of Australian households provided with different types of kerbside service in 2016-17. About 95% had a kerbside garbage bin service, 91% had a recycling bin and 42% had an organics bin[27]. Those without a kerbside service usually have access to drop-off services.

Figure 39 Australian households' access to different type of kerbside service, 2016-17

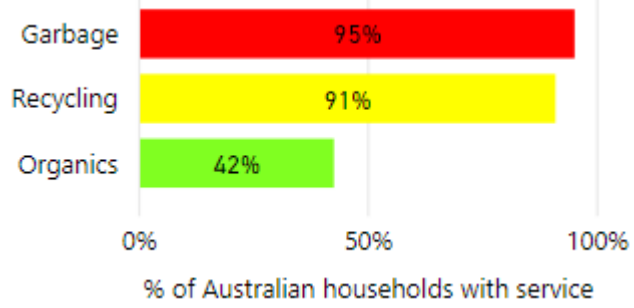


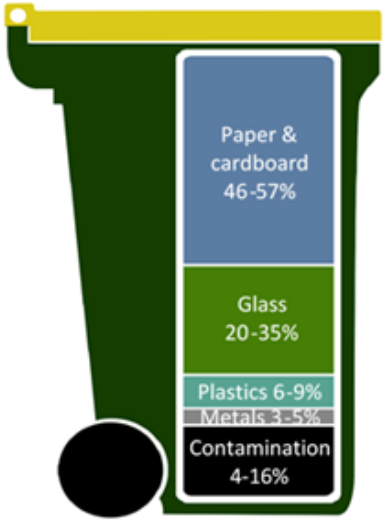
Table 7 shows the estimated kerbside service coverage by state and territory.

Table 7 Estimated proportions of households receiving kerbside services by jurisdiction, 2016-17

	ACT	NSW	NT	Qld	SA	Tas	Vic	WA
- garbage bin	100%	91%	73%	96%	100%	93%	96%	97%
sent to landfill	100%	66%	73%	92%	100%	93%	96%	69%
sent to alternative waste technology (AWT)	-	25%	-	4%	-	-	-	28%
-recycling bin	100%	89%	60%	86%	98%	93%	95%	92%
-organics bin	5%	60%	-	10%	92%	15%	56%	14%

In all states and territories except NT, more than 90% of households have a kerbside garbage service. For recycling, all ACT households have a kerbside service, SA has the second highest coverage at about 98%, followed by Vic at 95%, Tas at 93%, WA at 92%, NSW at 89% and NT at 60%. SA local governments provide an organics service to 92% of households, easily the highest proportion of any state or territory. Organics services are also popular in NSW and Vic but less so in other states and territories.

Figure 40 State and territory audit data on the composition of kerbside recycling bins (% by weight)



Kerbside recycling services

The types of materials accepted in kerbside recycling bins typically include glass packaging, metals (i.e. aluminium and steel cans), mixed paper and cardboard and plastic containers. However, there is some variation depending on the processing capacity at the receiving materials recovery facility.

An estimate of the average composition of a typical kerbside recycling bin is shown in Figure 40. Paper and cardboard make up the largest proportion by weight, but this proportion has declined in recent years as newspaper circulation has fallen.

Contamination rates in recycling bins typically range between 4-12% by weight, depending on the effort put into education and enforcement and the socio-economic characteristics of the area.

[27] Collated mainly from local government data. Likely to slightly overestimate because a small proportion of businesses are included that also receive a local government service.

Disposal rates from material recovery facilities are sometimes much higher than this due to the presence of bagged recyclables and glass fines, often attributable to breakage during bin collection and drop-off. Non-recyclable plastics are another major contaminant in recycling bins on a volume basis.

Kerbside organics services

Table 8 shows the numbers of local governments that provide kerbside organics services. Services vary – they may be universal or optional and may provide for collection of garden organics (GO) only or include both food organics and garden organics (FOGO). About 22% of Australian local governments offer a kerbside GO bin service and a further 16% provide some form of kerbside FOGO collection service. Several are trialling or planning to implement a FOGO service.

Table 8 Number of local governments with a kerbside organics bin collection service, July 2018

Jurisdiction	Number of local governments…			% of local governments…	
	with GO	with FOGO	trialling or planning FOGO	with GO	with FOGO
ACT	1	0	0	100%	0%
NSW	46	33	4	36%	26%
NT	0	0	0	0%	0%
Qld	10	1	0	13%	1%
SA	17	28	0	24%	40%
Tas	2	3	0	7%	10%
Vic	36	19	3	46%	24%
WA	9	4	1	7%	3%
Australia	**118**	**88**	**8**	**22%**	**16%**

Provision of organics services is highest in Victoria, with 70% of local governments. As Table 7 shows, however, this reaches only about 56% of households because services are sometimes taken up by only a fraction of households. SA has the second highest number of councils providing organics services (64%, comprising metropolitan councils) followed by NSW (60%). The ACT program is at the pilot stage in selected suburbs and is expected to be rolled out to the whole of ACT by mid-2019.

Uptake of FOGO is highest in SA, followed by NSW and Victoria. It should be noted that the performance of FOGO systems can differ greatly. Well promoted and carefully designed systems can capture about 70% of food waste, but in some local government areas participation rates are less than 4% of the population. The trend towards kerbside FOGO systems is expected to continue as in most cases it is cheaper to compost food waste than send it to landfill.

10.2 Australian Local Government Association perspective

The Australian Local Government Association (ALGA) was asked to contribute to this report, responding to four questions or prompts:

1. How would you describe the state of waste management in Australia in 2018?
2. What are the most significant challenges facing Australian waste management providers in 2018?
3. What are the greatest opportunities facing Australian waste management providers in 2018?
4. Where do you believe Australian waste management should aim to be in 10 years' time?

ALGA's response is set out on the following page.

Status of waste management

The Australian local government sector has long been at the coal-face of waste management, through kerbside collection services, processing, community education and landfill management.

Waste management is currently in a state of review and revision. Recent decisions impacting the export of waste materials for recycling to overseas processors have triggered a chain of discussions and re-negotiations between service providers and councils across the nation. But the impacts to date being felt at local levels are varied. Some areas continue to be unaffected (for now) but can see changes are on the way or needed, while others are already seeing impacts on their services and costs.

Our challenges

2018 has brought forth a range of new challenges for the local government sector, including balancing the rising costs of collection and processing services with meeting the expectations of communities and rate payers – all while continuing to encourage good waste management practices already occurring in most Australian households.

Key areas for focus in the local government sector are:

- decreasing quantities of waste going to landfill or stockpiled, such as through driving demand for recycled products
- supporting improved infrastructure capacities and capabilities at materials processing facilities
- keeping residents informed and encouraged to continue or improve good waste management practices.

Industry must also take greater responsibility for their end of life waste. Product design and packaging must ensure that products can be recycled, reused or composted. ALGA welcomes the Australian Packaging Covenant Organisation (APCO)'s commitment to achieve this by 2025.

Our opportunities

Many councils around the nation already have highly successful education campaigns, apps, websites, etc., as well as teams of very experienced people in the community who are ready and willing to contribute information and ideas to improve waste management in the coming years.

There are opportunities in learning from our local successes and sharing with others in other parts of the nation to scale-up successful initiatives, programs, platforms and management tools. This also means opportunities to improve our two-way communications – to not only share information with others about waste management services, advice, facilities, etc., but also about collecting ideas from local communities to feed into regional, state or national-scale approaches.

Waste management in 10 years

Waste management in 2028 should be a flourishing and economically viable industry, which contributes economically via more local jobs and increased demand for products made from recycled materials; environmentally through reduced quantities of waste going to landfill, and more waste re-entering the product-lifecycle following a circular economy model, and socially through acknowledging the good efforts and practices by Australian householders and local government service providers.

11. The waste and resource recovery sector

This section gives 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 Association of Australia (WMAA). These associations reflect on the current state of waste management in Australia, the most significant challenges and opportunities facing the sector, and where Australian waste management should aim to be in 10 years' time.

11.1 Sector overview

The Australian waste and resource recovery sector managed about 55 Mt of waste in 2016-17, including about 32 Mt through recycling and most of the rest through landfill. Based on a major report for the Department, the value of the sector's activities in 2014-15 was about $15.5 billion, comprising $12.6 billion from service provision and $2.9 billion from sale of recovered materials (CIE 2017). The value added by waste-related activities was $6.9 billion, accounting for 0.43% of Australian gross domestic product (GDP). The sector directly employed almost 50,000 people (full time equivalent terms), accounting for about 0.5% of total employment. About 20% of waste related activity was undertaken by local government.

After a long-term trend towards consolidation, a number of large businesses, including some transnationals, have come to dominate the market. Consolidation has brought efficiencies and higher levels of expertise, and reduced the risk of commercial failure. The large operators include Cleanaway, JJ Richards, Remondis, Suez and Veolia. Most of the large companies run collection operations for both commercial and domestic waste and often also own landfills and other waste infrastructure. Visy remains a major operator in recycling and paper and cardboard reprocessing. Cleanaway, with its recent purchase of Toxfree, is Australia's largest operator in hazardous waste management. Many smaller operators specialise in particular markets, such as composting or skip bin operation, or work in particular jurisdictions or regions. In metropolitan areas, collection businesses with small and medium-sized fleets provide competitive options for commercial and industrial waste sources.

Materials collected and sorted for recycling are often sold to operators who use both recycled and virgin materials, such as Alcoa (aluminium), Australian Paper or Sims Metals. Large quantities of metals, paper and cardboard and plastics are also exported (see Section 3.4).

11.2 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, for economies of scale, groups of local governments are tendering together and for longer (e.g. seven years or more). Services usually include a weekly garbage service and fortnightly recycling service, and often a regular or on-call organics service. Some councils extend their services to smaller businesses and institutions. Periodic or on-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, appliances, bikes and so on.

Large corporate waste generators often establish a relationship with a major waste and resource recovery company for national or regional services. Most other businesses engage service providers on short-term contracts or informal arrangements. In many instances, C&I recycling rates are lower than they could be because the cost of additional bins and collections is seen as prohibitive.

Hazardous wastes are typically managed by contractors having 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.

Lessons from the China crisis

The 2018 Chinese restrictions on import of wastes (see Section 15.1) drew attention to difficulties facing recyclers of domestic waste. Recyclers often bear all the risk if commodity prices fall, and may have limited options for stockpiling materials while new markets are sought. Rate caps can constrain local governments from renegotiating contracts. Governments are working on new model contracts.

11.3 Waste and resource recovery infrastructure

Table 9 (overleaf) describes the main types of waste and resource recovery infrastructure and those who operate them.

Local and regional government organisations that manage municipal kerbside collection contracts have an important role in establishing waste infrastructure. They offer large-scale and long-term contracts that often effectively underwrite the security of the waste infrastructure investment. This can apply to landfills, compost facilities, alternative waste technologies (AWTs) and other infrastructure.

Landfills remain the 'option of last resort' for most waste. The engineering and environmental management standards of landfills have improved markedly over the last few decades, driven by regulations and licence conditions. Most states and territories require similar standards of performance. However, landfills in some rural areas continue to operate at a low standard.

11.4 Regional variations

In metropolitan and larger urban centres, most waste infrastructure, including landfills, is privately owned. Businesses are usually serviced by private operators in a competitive environment. Local governments are responsible for collecting MSW and often 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, and covers costs through rates, service fees and gate fees at facilities. In most regional areas, local governments own and operate or contract out the operation of landfills, transfer stations and recycling centres. Local governments in these areas often provide waste and recycling services to many businesses. Waste management costs per capita and per tonne are typically higher in regional and remote areas. Larger landfill levies in some metropolitan areas can reduce the cost differential.

Table 9 Common waste management infrastructure types and functions

Facility type	Activity and function performed	Operators
Transfer stations/ resource recovery centres	Transfer stations allow small vehicles to drop off waste. Usually include a resource recovery centre that providing material-specific bins or areas for particular recyclables. Garbage is consolidated for transfer to landfill, improving safety by keeping small vehicles from operating landfill faces and improving transport efficiency.	• Local government and their contractors • Private businesses
Container deposit system drop points	Enable people to deliver and redeem eligible packaging. May be manually operated or automated 'reverse vending machines' that give credit for each item deposited.	• SA, NT, NSW, Qld governments • Local governments • Industry groups
Materials recovery facilities (MRFs)	Sort comingled recyclables and other materials, mostly from domestic recycling bins, into marketable grades of materials.	• Private businesses contracted to local government • Local government (few)
Composting facilities	Use a controlled, aerobic and naturally self-heating biological process to convert garden organics, food and other organic materials into soil conditioners, mulches and fertiliser products.	• Private businesses contracted to local government or providing farm and garden product supplies • Local government
Alternative waste treatment facilities (AWTs)	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 government
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 and plastics.	• Private businesses
Chemical/ physical treatment facilities	Accept a range of hazardous waste and treat it to reduce hazard.	• Private businesses
Landfills	Manage mixed residual waste. Usually engineered with a mixed clay and plastic lining, leachate collection and treatment, and (at larger sites) gas collection and combustion. Waste is compacted and covered daily. Landfills may be 'inert' (mainly demolition wastes), 'putrescible' (including household waste) or hazardous. Public access usually restricted to a resource recovery centre near the gate. Seen as the 'last resort' waste management option, but required into the long-term for asbestos, contaminated soils, waste processing residuals, disaster waste, etc.	• Private businesses (mainly urban areas) • Local government (mainly regional areas)

11.5 Australian Council of Recycling perspective

The year 2018 has been a pivotal one for the Australian recycling and resource recovery sector - literally.

As China has introduced new policies that significantly impact on the export of waste materials for recycling from Australia, the sector has needed to quickly pivot from one group of settings to another. From export-ready to self-reliant. From collection-oriented to production-oriented. From quantity to quality.

While the material previously going to China was a small proportion (around 30%) of a smaller sector (kerbside recycling), the Chinese prohibitions have given all recycling industry stakeholders reason to recalibrate our thinking and our activities. Indeed, we should not blame China - we should emulate China for taking policy decisions that aim to enhance domestic recycling capability.

ACOR modelling shows that 50% of the material recently exported to China could be retained in Australia with appropriate one-off investment, including from the more than $1 billion collected in waste disposal levies by various governments. An injection of around $150 million in better material recovery facilities, enhanced reprocessing facilities, community education and other measures would go a long way to developing a self-reliant, rebooted recycling system in Australia. That includes generating some 500 more jobs and reducing greenhouse gas emissions by the equivalent of 50,000 cars off the road.

Social research undertaken by ACOR shows the community expects political leadership when it comes to recycling. Over 85% of Australians support a national plan with aspects such as recycled content purchasing and producer requirements for the packaging supply chain. Ministers for the environment have in part responded and now we have before us the opportunity to develop a new National Plan for Recycling and the Circular Economy - the first such framework for nearly 10 years and a timely opportunity to take Australia's recycling performance higher than the middle of the international pack.

It's especially needed to enhance our comparatively immature approach to producer responsibility schemes where the unmitigated risks and unclaimed opportunities are growing. As one example, in a sector lacking a policy framework, battery consumption is growing by 300% per year and those batteries represent both an environmental and health and safety risk, but our recovery rate is around 3% as opposed to rates over 70% in Europe.

And while we navigate and respond to the immediate challenges, the Australian recycling industry – generating some 50,000 jobs and over $15 billion of value per year – also moves to the strategic horizon. Mega-trends like digitisation, robotification, urban densification and resource depletion are now emerging in the industry's service, product, investment and technology choices. From automated collection and processing to enhanced customer data provision to consumer activism around "end-of-life provenance" – these are but some of the key adjustments.

It is vital that there is a planned, coordinated and evidence-based approach to both the present and the future – if we truly want an Australian recycling system that delivers its optimal potential.

11.6 Australian Organics Recycling Association perspective

Status of waste management

The recycling of organics continues to steadily progress nationally with consistent efforts across the states in the drive to collect and divert higher levels of food waste from landfill in addition to their successful garden organics recycling. The implementation of municipal food and garden collection programs is increasing along with associated building and upgrading of commercial processing facilities.

Our challenges

The most significant challenge for the organics recycling industry are the significant costs of compliance to environmental regulation for processing facilities, financial guarantees and the continued development of markets for the recycled products. The market outcome of the combination of these factors, deters investment by small and medium enterprise in the sector, leaving only large operators as viable businesses.

Many agricultural wastes are over-classified in regulatory schemes and require capital intensive processing solutions even in remote rural environments where alternative protocols for using unprocessed manures are less stringent and less bio-secure. These regulatory realities deter processing into reusable products.

The collection of quality national data on the tonnages and volumes of the industry's contribution to a successful recycling rate is another challenge. This is being successfully and cooperatively taken up by state agencies across the country. While municipal data is well documented, the larger market is not, and regulated or licensed processing is only part of whole picture of recycled organics in Australia.

Our opportunities

The recent inclusion of 'compost' within definitions for Australian Carbon Credit Units, and first projects underway, will assist the push to use compost as a part of wider soil health and conservation efforts, which lead to building soil carbon and a long-term sequestration value. In this way there is an opportunity to sequester more carbon than we emit as a nation and to improve the water efficiency and productivity of our soils. AORA is working closely with Soils for Life in bringing this wider vision to agricultural Australia.

Waste management in 10 years

A transformation in the level of waste diversion to organics recycling will have taken place across the country, including the wide acceptance of compostable food service plastics, commercial source separation and strong municipal programs. Processors will have developed a market network of downstream processing, bringing urban and agricultural wastes together to maximise the quality and quantity of compost for soils. Compost use, soil health and soil carbon sequestration programs will become the norm in future farming.

11.7 National Waste and Recycling Industry Council perspective

Status of waste management

NWRIC

Australia is a global leader in economic and social progress. However this performance is not mirrored in waste and recycling. For example, many countries with lower wealth per capita achieve higher recycling rates – such as South Korea, Taiwan or Japan. Australia can stimulate employment and create social amenity via improved waste management and better recycling. The National Waste and Recycling Industry Council believes we could become a global leader.

Our challenges

We see four major challenges facing the waste and recycling sector in 2018. They are - resolving the recycling crisis created by the Chinese National Sword program, effective enforcement of regulations including data collection, medium to long term infrastructure planning and harmonisation and effective investment of landfill levies. These challenges are also opportunities – as below.

Our opportunities

- Improve enforcement of existing regulations via improved data collection, tracking and policing – this can be funded by landfill levies in some states.
- Put in place high quality infrastructure planning across Australia for waste and recycling assets – this should be done on 10 and 30 year timescales in every state and territory.
- Harmonise levies and levy enforcement, improve the mechanism of levy investment – the establishment of a national 'recycling bank' could help achieve this.

Waste management in 10 years

Waste and recycling data, regulation enforcement and licencing

- Where practical, all waste tonnes generated should be tracked source to sink. All tracked tonnes should go to licensed facilities. This will ensure fair, safe and sustainable outcomes for the whole industry.
- The Australian Bureau of Statistics (ABS) should collect high quality waste data on a national scale.
- All waste and recycling facilities in Australia should be licenced, irrespective of size. All waste transporters should be registered.

Infrastructure planning

- Every state and territory should have a 'Statewide Waste and Recycling Infrastructure' plan including dedicated and protected sites for landfills, energy recovery sites, composting sites and all forms of recycling. This plan should also provide for natural disaster waste.

Landfill levies

- Waste and recycling levies across Australia should be harmonised to prevent unnecessary interstate waste transfers. Levy avoidance should be minimal and rare.
- Levies should be invested in a manner which maximises their economic, social and environmental return. We believe the best way to do this is via a 'recycling bank' - similar to the Clean Energy Finance Corporation. This independent body will have dedicated outcomes to achieve from levy revenue in all jurisdictions.

11.8 Waste Management Association of Australia perspective

Status of waste management

In 2018 Australian industry continues to work hard to provide environmentally responsible and effective waste and resource management systems and services around almost all of Australia. Since 2016, with shows such as the ABC's *War on Waste*, there has been an increased public interest on what we as an industry do, which is only a good thing. China's enforcement of its National Sword policy in late 2017 has resulted in further public awareness, increased government attention, and greater focus on the need to develop markets in Australia for the materials that industry successfully diverts.

Our challenges

Australia lacks a 'level playing field' within which industry can operate. We need government at all levels to work with industry to implement the elements of successful waste and resource recovery policy. This does not necessarily mean that state landfill levies should be set at the same rate, for example, but rather that all states will have levies and other fundamental policy levers – strategic infrastructure planning, diversion targets, green public procurement, recycling content targets, levy reinvestment, proximity principle, market development, etc. Recently we have seen some state governments take their own action in response to China's National Sword and attempt to drive change in waste management and the industry. But the reality is that waste does not recognise state borders. In the absence of national policy levers, we will continue to simply go in circles. Further, waste management needs to be recognised as an essential industry to the community. That recognition will stimulate policy and legislation that protects and grows this important industry.

Our opportunities

Australia needs to actively work towards implementing policies that create a level playing field and nurture a 'circular economy' in Australia. What is a circular economy? Quite simply, it means acting in accordance with the waste management hierarchy (reduce, reuse, recycle) and keeping materials at their highest and best level of use for as long as possible. Recovering energy is a higher order outcome than burying material in landfill, but it is certainly not a replacement for recycling. Australia needs a sustainable recycling system decoupled from the global commodity market; a circular economy that will deliver jobs and investment. And whilst Australia is special, it is not unique. There is much we can learn from overseas experience in transitioning to a circular economy, and an obvious option is to follow the path of Europe.

Waste management in 10 years

The waste and resource industry will be viewed by all (community, industry, government) as an essential service that is integral to the lives of all Australians. A level playing field will provide commercial certainty, allowing the development of markets and infrastructure that meet community needs. Discussions about the industry will focus on the value we create. Our policy settings will compete with Europe to be the most effective in creating a circular economy, reducing carbon emissions and decreasing waste. Manufacturers, fast-moving consumer goods producers and all other sectors will compete to be the best in this field. Nirvana!

12. Product and packaging waste

This section presents information about product and packaging wastes. The quantities reported are a subset of those in the previous sections on waste generation, recycling and disposal, etc. The section opens with information from the various product stewardship programs, then presents data from container deposit systems, and closes with data on some other product waste.

12.1 Waste included in product stewardship programs

Product stewardship is an approach to managing the impacts of products and materials in which those involved in producing and selling products share responsibility for reducing their impact, throughout their lifecycle, on the environment, human health and safety. Typically, this involves industry working to ensure their product wastes are properly managed, often through financial support and achieving collection targets. The *Product Stewardship Act 2011* (PS Act) provides a basis for establishing product stewardship programs, which may be voluntary, co-regulatory (industry action underpinned by Australian Government regulation) or mandatory. No mandatory schemes have yet been established. Some product stewardship programs pre-date the PS Act.

Table 10 summarises Australian product stewardship schemes in 2016-17 and shows the tonnes of relevant product collected, as reported by the scheme organisation. In most cases the collected materials are recycled; in others they are sent for safe treatment and disposal. In some cases, many of the tonnes collected are not directly associated with the product stewardship scheme (e.g. tyres).

Table 10 National product stewardship schemes, 2016-17

Products covered	Product stewardship scheme	Start year	Scheme type	Tonnes of product collected	Est. capture rate [1]
Fluorescent lights	Fluorocycle	2010	Voluntary under the PS Act	906	-
Mobile phones and accessories	Mobile Muster	1998		79	69%
TVs and computers	National TV and Computer Recycling Scheme	2011	Co-regulatory under the PS Act	51,430	44%
Agricultural and veterinary chemicals	ChemClear	2003	Industry initiated and run	79	-
Agricultural & vet. chemical containers	drumMUSTER	1998		2,295	48%
Packaging [2]	Australian Packaging Covenant [3]	1999		3,714,000	67%
Paint	Paintback	2016		2,000	-
Tyres	Tyre Stewardship Scheme	2014		~45,000 [4]	-
Used oil	Product Stewardship for Oil	2000	Gov't initiated	257,800	-

1 The estimated capture rate is the tonnes collected divided by the total eligible for collection under the scheme
2 2015-16 data (2016-17 data unavailable)
3 Underpinned by the National Environment Protection (Used Packaging Materials) Measure 2011
4 This is the estimated quantity recycled. The scheme is not directly responsible for this amount.

The largest product stewardship program is the Australian Packaging Covenant. Its operator, APCO, works to improve the sustainability of the packaging industry and will be the key delivery

organisation in the recent commitment to ensure all packaging is recyclable or compostable by 2025. In 2015-16, around two-thirds of the packaging material consumed in Australia was recovered.

The second largest program is the Product Stewardship for Oil Scheme, which collected 286 ML (about 258 kt) of used oil in 2016-17. The program was established by the *Product Stewardship (Oil) Act 2000*, and applies an 8.5 cent levy on each litre of new oil, which is used to fund oil recycling. The collected oils include re-refined base oil (for use as lubricant or a hydraulic or transformer oil), other re-refined base oils and high-grade industrial burning oils (filtered, de-watered and de-mineralised).

The National Television and Computer Recycling Scheme is another large scheme, collecting over 50 kt of TVs, computers, printers and computer e-waste products in 2016-17, an increase of about 11% on the previous year. Around 96% of the collected materials were recycled, mostly overseas. The scheme has annual targets for the proportion of eligible products that must be collected. The targets peak at 80% in 2026-27.

12.2 Container deposit schemes

During 2016-17, CDS were operational in NT and SA[28] (see Section 15.2 for more detail). Between them, they collected 659 million containers. Table 11 presents data on the performance of the two schemes by material type, showing the proportion of the containers sold that were recovered under the scheme.

Table 11 2016-17 return rate by material type

Type of container	NT	SA
Aluminium containers	52%	89%
Glass containers	57%	85%
HDPE containers	28%	54%
LPB containers	39%	67%
PET containers	33%	66%
Steel containers	1%	-
Overall	**48%**	**80%**

The NT system, which was established in 2012, collected 72 million eligible containers, representing 48% of those sold. The SA recovery rate was much higher, totalling 587 million containers representing 80% of sales. The SA system is much more mature, having operated since 1977. In both systems, the return rates for aluminium and glass containers were the highest. Collected materials were shredded, crushed, pressed and bailed for domestic sale or export.

12.3 Other products

Electronic waste

Electronic waste[29] (or e-waste) is an increasingly significant issue as digitisation penetrates more and more aspects of society. Some e-waste contains heavy metals and other toxic substances while other wastes have resource value, particularly in metals recovery. 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 2016-17 about 485 kt of e-waste was generated in Australia, an increase of about 3.8% on the previous year. TVs and

[28] ACT, NSW and Qld have subsequently established CDS and a WA scheme is planned.

[29] Comprising anything operated by a plug or a battery

computers (discussed above) represented about a quarter of the total. About half the e-waste was recycled, mostly through metals recycling operations of white goods and similar. Smaller e-waste items were mostly landfilled.

Handheld batteries

Handheld batteries contain hazardous substances and also valuable metals that can be recovered. In 2012-13, an estimated 14.3 kt of handheld batteries were landfilled and about 403 tonnes were recovered in Australia. This 2.7% recovery rate is little changed since then. Overseas, many countries recycle much higher proportions of their waste batteries.

Expanded polystyrene

Expanded polystyrene is costly to transport and dispose due to its low density and bulky nature. In 2016-17, Australia consumed about 47 kt (about 2.4 million m^3) of expanded polystyrene (APC undated) and recovered about 29% (Envisage Works & SRU 2018).

Mattresses

Mattresses are a problem waste in landfills as they do not compact well. An estimated 1.6 to 1.8 million mattresses are disposed each year with more than half estimated to be landfilled (SSCEC 2018). Most components of mattresses can be recycled, including fabric, foam, husk, steel springs and timber. In the ACT almost 75% of waste mattresses are recycled.

Photo 9 Mattresses awaiting recycling

Photo by Christine Wardle

13. Litter and dumping

Litter and dumping are problems in many areas of Australia. In addition to damaging urban infrastructure and the environment, litter and dumped waste impose sizable clean-up costs on local government, parks and waterway managers and private land-owners. The fact that illegal disposal can be a cheap option is the main reason why waste management needs to be, and is, highly regulated.

Littering reduces urban amenity and pollutes land and waterways. An estimated 95% of Victorian beachside litter is from urban areas and carried to the sea by stormwater (VLAA 2013). Litter makes areas look dirty, encouraging more litter and dumping, and making people feel less safe and less happy. Litter can block drains resulting in localised flooding and infrastructure damage. Once in the environment, some forms of litter such as plastics, metals and glass will persist for decades and accumulate in the environment. There is currently concern about the impacts of the accumulation of plastics in the environment, and particularly their impact on aquatic and marine environments (see Section 15.4).

Annual litter surveys conducted by Keep Australia Beautiful (KAB) suggest a decline in the number of littered items, particularly cigarette butts and paper. This may reflect a decline in smoking and print media, as well as effective litter prevention and community engagement. The KAB (2017) litter survey of over 980 sites found the most common types of litter were cigarette packaging and butts, takeaway food packaging, drink containers, and other paper and plastic items.

Dumping – the intentional illegal disposal of waste loads – is a more serious waste crime than littering. In urban areas, dumping is often on vacant or pubic land and waterways at the edge of the city. There have also been examples of organised criminal activity in depositing waste in disused warehouses and similar, and incidents of fires at such dumps. Sometimes, poorly managed 'recycling' operations have effectively dumped waste on leased land, leaving a clean-up legacy for the landowner or the state.

States and territories were asked for data on the costs of cleaning up dumped waste. Qld reported cleaning up 8.5 kt at a cost of $18m. Vic reported 609 clean ups of 27.4 kt of dumped waste in 2016-17 at a cost of $12.5 million. No other jurisdictions were able to provide data. If costs elsewhere were similar per capita, Australia spent about $70 million cleaning up dumped waste in 2016-17 (excluding street sweeping).

Initiatives to combat litter and dumping

Litter and dumping are tackled at the state and local government level. All states and territories have anti-littering and dumping laws and penalties and most have teams dedicated to education and enforcement. Local governments, too, have by-laws against littering and dumping and staff tasked with pursuing offenders and promoting litter and dumping reduction initiatives. In NSW, regional illegal dumping squads specialise in combating and preventing illegal dumping.

A number of non-government and industry organisations, such as 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.

KAB data suggests that container deposit schemes in SA, NT and NSW have reduced littering of drink containers. NSW reports a 33% drop in drink containers eligible for deposits under its 'Return and Earn' container deposit scheme before and after the scheme was introduced (Minister for the Environment 2018). The impending establishment of CDS in other states and territories will extend that benefit.

Another method for reducing litter is to avoid using materials prone to becoming litter, such as plastic bags, plastic straws, balloons, microbeads and loose-fill polystyrene packing. Governments and communities across Australia are working to limit, restrict or ban many types of single-use plastics.

Photo 10 Criminal dumping of asbestos waste in a Victorian forest

Photo by Paul Randell

14. Liquid waste

This section provides an overview of liquid waste generation, management, treatment and fate in Australia in 2016-17. It reports on both non-hazardous liquid waste (sewage and trade waste) and hazardous liquid waste, which are included in earlier sections of this report. Liquid waste is included here following a recommendation from a previous assessment of liquid waste in Australia (Hyder Consulting 2011b). This section aims to illustrate and discuss the key waste flows between the 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 (hazardous and non-hazardous): 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 2017) 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 84 service providers including bulk water authorities, water utilities, and councils servicing most of the Australian population (more than 20 million). Another report prepared on commission to the Australia and New Zealand Biosolids Partnership (PSD 2017) provides data on biosolids generation.

To estimate quantities of effluent disposal, the following formula was applied:

> *Disposal (treated effluent outfall) (ML) = Total sewage collected (ML) - Total effluent recycled (ML) - Total biosolids generation (ML equivalent).*

Figure 41 (overleaf) provides an overview of liquid waste generation and fate in Australia in 2016-17. Liquid waste generation, management, treatment and fate are each discussed in the sections below.

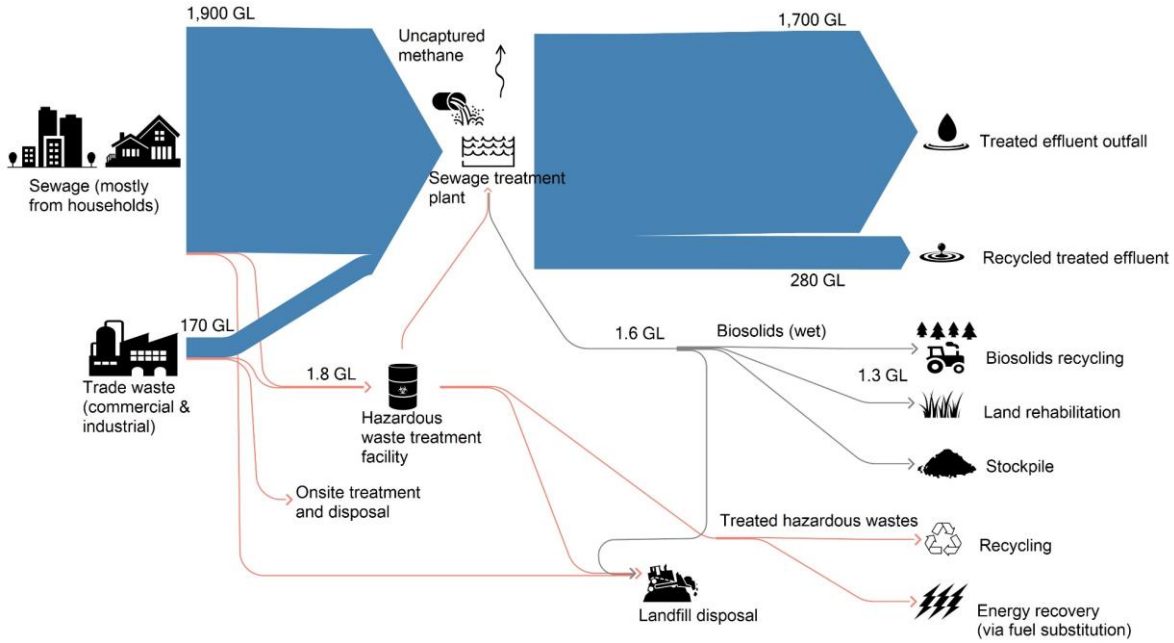
14.1 Liquid waste generation 2016-17

Household liquid waste generation

Sewage is the main liquid waste from households. In 2016-17, about 1,900 gigalitres (GL) of sewage was discharged to sewer, mostly from households.

Households also generate hazardous waste liquid when disposing of household chemicals through programs run in all states and territories except NT (see Table 6). Waste commonly collected in these programs includes oils, paints, pesticides and flammable liquids.

Figure 41 Overview of liquid waste generation and fate in Australia 2016-17



Liquids are also disposed of by households as part of food waste. Data is not available on the volumes of liquid food waste disposed via the sink in Australia, but this would form part of the overall sewage waste data included in Figure 41 above. The liquid content of 'solid' wasted food is included in the solid waste reporting earlier in this report. The liquid content varies, but most food waste is putrescible and generates liquid as it decomposes. When food waste is sent to landfill, this will ultimately contribute to landfill leachate.

Commercial and industrial liquid waste generation

Businesses and institutions all generate sewage, which contributes to the overall 1,900 GL quantity generated.

Some service industries and most manufacturing industries also dispose of trade waste to the sewerage system. Trade wastes are usually controlled by individual licence-type 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. Some of the service industry (such as hospitals, laboratories and vehicle repairers) and many manufacturers also generate hazardous liquid waste.

14.2 Liquid waste collection and movement

Liquid waste is collected and moved through:

- the sewerage pipe network
- commercial liquid waste transport vehicles
- 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 are gradually being replaced with separated systems. The sewerage system typically delivers the sewage to a sewerage 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. Where hazardous liquid waste is imported or exported overseas for reuse, recycling, treatment or disposal, the waste movement must be reported under Australia's commitment to the Basel Convention.

14.3 Liquid waste treatment

The two principal places of liquid waste treatment are:

- sewage treatment plants
- liquid waste treatment facilities (hazardous and non-hazardous).

Sewage treatment plants

BoM (2017) reports that in Australia in 2016-17 there were 673 sewage treatment plants operating to treat sewage and trade waste. Not all plants provide the same levels of treatment. The levels of sewage treatment are generally defined as primary, secondary, tertiary and/or advanced treatment.

The UN (2009) defines these treatment levels as follows:

- Primary treatment: 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 (BOD_5) 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%.
- Secondary treatment**:** Post-primary treatment of wastewater by a process generally involving biological or other treatment with a secondary settlement or other process, resulting in a BOD_5 removal of at least 70% and a chemical oxygen demand removal of at least 75%.
- Tertiary treatment of public wastewater: 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 BOD 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%
  - microbiological removal achieving a faecal coliform density less than 1,000 in 100 ml.

Based on the BoM (2017) supporting database, 36% of Australian wastewater was treated to secondary levels and 64% to tertiary levels.

The waste sent to sewage treatment plants has one of three fates:

1. Biosolids are formed from the treatment of tank bottom sludge from the sewage treatment plant process. PSD (2017) estimates that in 2016-17 Australia:
   - generated 1.6 GL (or around 1.6 Mt) of 'wet biosolids' which assumes a solids content of about 20%
   - recycled 83% of biosolids in direct land application in agriculture or in producing compost products
   - stockpiled, used in land rehabilitation, sent to landfill or discharged to the ocean 17% of biosolids.

   The extent of dewatering and/or drying of biosolids varies from facility to facility. This in turn affects the amount of liquid in biosolids. Biosolids represent perhaps the most significant flow from the liquid waste stream into the solid waste management system.
2. Treated effluent outfall, involving disposal of treated effluent to the ocean or a local water body. In 2016-17, about 1,700 GL of treated effluent was disposed to water bodies.
3. Recycled effluent, involving recycling of sewage that is treated to a suitable standard for the intended use, for example in irrigation. In 2016-17, BoM (2017) estimates that 280 GL of treated effluent was recycled.

Hazardous liquid waste treatment facilities

Large hazardous liquid waste treatment facilities are located in all states except ACT, NT and Tas, which export the bulk of hazardous liquid waste generated within their jurisdiction to other states for treatment. In 2016-17, about 1.8 GL (or 1.8 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 and there is great variation in the services they provide. Some specialise in treating one type of commonly occurring liquid waste that is readily reused or recycled (e.g. waste oils and lubricants). Other large facilities are able to receive an extensive and complex range of liquid, solid and 'sludge state' wastes and accept the bulk of Australian hazardous liquid waste.

Put simply, hazardous liquid waste facilities manage this range of liquid waste by:

- treatment of the particular hazard characteristics to enable recycling, energy recovery or disposal to sewer or landfill, and/or
- chemically immobilising the hazardous component of the liquid waste (often by the addition of a binding agent such as lime) to solidify the waste and enable disposal to a hazardous solid waste landfill.

After biosolids, hazardous waste treatment facilities are the main interface between solid and liquid waste management systems. They generate solid waste when:

- hazardous liquid waste is solidified
- 'sludge state' waste is treated to remove liquids.

Due to the complex and highly varied treatment processes in hazardous liquid waste treatment facilities, the fate of the 1.8 Mt of waste sent to these facilities cannot be numerically described.

15. Current and emerging challenges

Waste management is always changing in response to community demand, government policy, technological development and market circumstances. This section reviews some of the challenges faced by the waste sector. Firstly, it addresses the major recent issues arising from China's restrictions on the export of recycled commodities. It then considers some government policy and program issues of increasing significance, followed by challenges relating to waste and its processing. Several environmental concerns of growing community importance are then examined.

The section closes with a contribution from the Boomerang Alliance, representing environmental groups with a particular concern about waste.

15.1 Restrictions on the export of waste materials

China's 2017 and 2018 announcements restricting imports of particular types and grades of waste materials for recycling has been a major development for the waste and resource recovery sector. Many processors of domestic recyclables had come to rely on exporting low-grade mixed materials to China and other countries with lower labour and environmental compliance costs. China decided that the environmental costs of importing these materials from Australia, USA, Europe and other countries were too high, and established policies restricting the allowable levels of contaminants in waste material loads to 0.5%. Its restrictions had global consequences, rapidly leading to reduced prices for sorted waste commodities and causing market blockages, stockpiling and some instability in the provision of recycling collection and processing services.

Various state governments responded with assistance funding to local governments and recyclers, as well as programs supporting innovation, market development and processing infrastructure to clean and increase the value of recyclables. There has been an increased recognition of the benefits of on-shore recycling, tying in with the notion of the circular economy (discussed below).

The export data presented in Section 3.4 shows the quantity and value of waste-derived exports in 2017-18 was higher than the previous year, with exports to Indonesia, Vietnam, India, Malaysia and Thailand increasing as those to China declined. This suggests that the Australian market, broadly, has overcome the problems caused by the Chinese restrictions. However, many companies have been forced to absorb financial losses and remain financially stricken, and many local governments and ratepayers have faced higher costs.

The Chinese restrictions have been closely watched by other major importers of waste materials, and this year Malaysia, Thailand and Vietnam have each announced tighter controls over imports of waste materials. It is likely that export markets for waste materials for recycling will become more constrained globally, and Australia will need to increase on-shore recycling of the major export commodities of metals, paper and cardboard and plastics.

15.2 Government policies and programs

National harmonisation of waste policy

Waste has traditionally been managed locally, and most waste policy and regulation is developed by states and territories. Increasingly, however, waste is moving across borders and national industries are facing waste management issues in multiple jurisdictions. With support from the states and territories, the Australian Government is spearheading efforts to harmonise policy and regulation to

ensure rational and efficient management. An updated *National Waste Policy* is to be released with this publication. Consistent national data and reporting is part of this effort. Harmonisation in the hazardous waste area is particularly important, since many of the markets for processing these materials are national.

The circular economy

A concept gaining currency in waste policy is the circular economy[30], which envisages keeping products, components, and materials at their highest utility and value at all times. This contrasts with the 'take, make and dispose' economic model, which relies on plentiful, cheap and easily accessible materials and energy. Several states and territories are developing waste policy within a circular economy framework.

Infrastructure planning

Australian states and territories have been developing and renewing waste strategies for decades but there has been a more recent shift in focus towards plans and strategies aiming to ensure adequate infrastructure is provided. SA and Vic released comprehensive infrastructure strategies in 2018, and waste and resource recovery groups in Victoria have produced regionally-specific strategies. NSW consulted on a draft infrastructure strategy in late 2017. In other states, infrastructure plans are less current, e.g. NT 2015 and Tas 2009. The Australian Government has undertaken work assessing infrastructure for the management of hazardous waste.

There are infrastructure incentive funding programs in NSW, NT, SA and Vic, and Qld has announced its intention to provide significant incentives funded by the introduction of the landfill levy (Helen Lewis Research 2018).

An increasing emphasis of infrastructure planning is the adequacy of resource recovery infrastructure and the need to protect suitable sites from conflicting neighbourhood development. This particularly relates to the future management of organics, C&D waste, hazardous waste and potential energy from waste facilities.

In some areas, the closure of small landfills is reducing options for disposing of asbestos.

Product stewardship

Product stewardship is one area where national leadership is required. Product stewardship agreements[31] can reduce waste and improve its management through shared responsibility, including with manufacturers. Sometimes a levy on initial purchases is used to fund the changes needed. The performance of current product stewardship arrangements is summarised in Section 12.1. The Australian Government is considering a number of other products for stewardship arrangements, namely: plastic microbeads and products containing them; batteries; photovoltaic systems; electrical and electronic products; and plastic oil containers.

Container deposit schemes

A current area of rapid policy development is CDS. A CDS has been in place in SA since 1977 but until recently all other states and territories, supported by the packaging and beverage industries, preferred to focus on local government collection systems. CDS were established in NT in 2013, NSW in 2017, ACT in mid-2018 and Qld in November 2018, and is scheduled to start in WA in 2020. Tas is

[30] See https://www.ellenmacarthurfoundation.org/circular-economy.

[31] See https://www.environment.gov.au/protection/national-waste-policy/product-stewardship.

also considering introducing a CDS. Litter surveys and anecdotal reports suggest CDS reduces litter and improves recycling in regional and remote communities.

Environmental groups have long advocated for CDS and see its proliferation as a victory that will reduce litter, improve recovery and raise awareness about the costs and value of recycling.

Food and garden organics recovery

Across Australia, food and garden organics make up about half of kerbside garbage and a quarter of commercial garbage. Food and garden organics in landfills generate the greenhouse gas methane, produce liquid leachate that can pollute groundwater, create odour, sustain pest animals and create unstable landforms. About 43% of Australian local governments have introduced kerbside organics services that, combined with smaller volume garbage bins, have seen the proportion of garden organics in garbage fall markedly. Mostly, these materials are composted and used as soil conditioners in urban markets.

Increasingly, organic collection and processing systems are being modified to also accept food waste. These combined food organics and garden organics services can result in significant reductions in domestic waste to landfill and production of more nutrient-rich products, so long as participation rates are good and contamination is kept low. This requires effective community education and is helped when kitchen bins and compostable bags are provided. Environmental regulators also often require a higher standard of processing technology because of greater odour risks. NSW and Victoria require most licensed facilities accepting food waste to use in-vessel or covered aerated composting technologies.

Local government uptake of FOGO is discussed further in Section 10.1. Another method for recovering food waste is AWTs, which are discussed under ‘waste technologies’ below.

Reducing greenhouse gas emissions

Carbon policy has been a major issue for the solid waste sector for over a decade, primarily due to emission of methane from the anaerobic decay of organic waste in landfills. The industry is strongly engaged with the Australian Government’s Emissions Reduction Fund, which incentivises activities that reduce landfill emissions, including burning landfill gas, processing organic waste through alternative technologies or diverting organic material for composting. Between 1990 and 2016, emissions from solid waste declined by 43%. The 2016 data puts emissions from solid waste disposal at about 8.7 Mt of carbon dioxide equivalent, or 1.6% of Australia’s greenhouse gas emissions[32]. A 2018 decision by the Emissions Reduction Assurance Committee means that landfill gas collection operations will be unable to receive credits under the Emissions Reduction Fund after their standard seven-year contracts expire. The impact on gas recovery rates is yet to be seen. Landfills will still be able to earn saleable ‘large-scale generation certificates’ for producing renewable power.

Removal of PFAS contaminated soils

Per- and poly-fluoroalkyl substances (PFAS) are a recently recognised hazardous material that was present in firefighting foams until recent years. Health impacts on humans have not been definitely proven (DoH 2018) but PFAS can bioaccumulate and adverse effects have been demonstrated in animals. Very large volumes of soil are known to be contaminated with PFAS, particularly where firefighting foams are widely used, such as defence sites, airports and fire training facilities.

[32] See http://ageis.climatechange.gov.au/. Emissions from solid waste were 15.3 Mt carbon dioxide equivalent in 1990 and 8.7 Mt in 2016. Emissions from all sources were 533 Mt in 2014.

Governments are investigating appropriate responses and management solutions. This issue will be further explored in the forthcoming *Hazardous Waste in Australia 2019* report.

15.3 Changes to waste and its processing

Compositional changes

Changes in consumer behaviour and the ways goods are delivered are changing waste streams. A reduction in consumption of printed media and the size of print media publications has reduced volumes of paper in domestic waste. The replacement of many rigid packaging formats with soft plastics has seen a decline in the proportion of glass, rigid plastic and paperboard and an increase in the volume of low density and low-value or harder-to-recycle soft plastics in waste and recycling streams. The implications of these changes are reduced quantities and value of comingled recyclables per capita and a growing need for effective recycling of soft plastics.

Waste technologies

In comparison with many countries, particularly in western Europe, Australia continues to rely on relatively basic waste technologies. Some 95% of our residual wastes are sent to landfill, most composting occurs in open windrow systems and most hazardous waste is treated using relatively simple processes. There are ongoing efforts to boost the sophistication of waste technologies in Australia, but these are inevitably weighed against cost increases.

Some processing of residual wastes is occurring in AWTs in Sydney and Perth where landfill capacity is more constrained. Facilities such as the Global Renewables UR-3R plant accept mixed municipal waste and are able to recover recyclables and process the residuals into an organic soil conditioner. In general, such facilities are financially competitive with landfill only where there is a shortage of local landfill capacity or a large levy applies on disposal of waste to landfill.

Another technological approach that is increasingly discussed, particularly in urban areas facing landfill constraints, is energy from waste. Apart from use of landfill gas, energy from waste is not well developed in Australia[33]. Technologies include:

- traditional mass-burn incineration, which is common in Europe and Japan
- pyrolysis and gasification, in which waste is heated in low or no oxygen environments to produce a synthetic gas that is subsequently burned for energy production
- anaerobic digestion of organic waste in tanks or ponds to generate methane that is subsequently burned for energy production
- processing materials into ‘refuse derived fuels’ for use in cement kilns and other industrial furnaces, either in Australia or overseas.

At the time of writing, several proposals are at various stages of development for large-scale incineration facilities to receive municipal wastes, including two each in Vic and WA. NSW recently declined another large-scale proposal. The energy harvested would be a mix of biological materials (food, garden, timber, paper and natural textiles) and fossil sources (plastics and synthetic textiles). Based on typical household waste composition in Australia, about half the energy collected would be from biological sources and half from fossil sources. Incineration of this waste would result in greenhouse gas emissions at about half the rate of bituminous coal per unit power generated. The calorific value of municipal waste, before drying, would be about 40% of coal.

[33] Although there is extensive energy generation from agricultural and forestry biomass such as sugar cane bagasse.

A key challenge for energy from waste proponents is overcoming concerns about emissions and the risk that recycling would be undermined. The case for energy from waste is stronger where it is demonstrated to be an option of last resort above landfill, but below higher options on the waste hierarchy (see Figure 36) of avoidance and reduction, reuse and recycling.

15.4 Growing environmental and community concerns

Waste fires

Waste fires can arise across all stages of the waste management chain including waste collection, transport, transfer stations, recycling and disposal at landfill (Fattal *et al.* 2016). Flammable waste materials include tyres, plastics, timber, garden waste, oils, solvents and paper. Several recent fires in waste stockpiles have required days of firefighting effort and required local evacuations. Extinguishing landfill fires can require extensive digging out of material. Where this does not happen, landfill fires have been known to smoulder for months or years.

Common sources of combustion include cigarette butts (the most common cause of bin fires), adding smouldering waste to a pile, spontaneous combustion of composting organics and arson. A more recent – and worrying – ignition source is lithium ion batteries, which can combust when fractured, for example by landfill compaction machinery. In some rural areas, deliberate burning of accumulated waste remains a working practice.

The effects of waste fires can include direct risk to people and property, creation of noxious fumes, toxic run-off into the environment, disruption to the waste management system, and costs in fighting the fire and replacing damaged property.

Data on waste fires is not well collated. Melbourne's Metropolitan Fire and Emergency Services Board provided a list of 62 significant fires attributable to waste in 2016-17. When smaller bin fires are included, the numbers are much higher. Fattal *et al.* (2016) reported annual totals of 5,652 waste-related fires in NSW and 1,003 in SA.

Restricting waste stockpiling is one of the main methods of managing risk of major fires.

Stockpiles and their management

Waste stockpiling has come to prominence due to fires and fire risks in stockpiled materials and abandoned waste dumps that required state intervention to clean up. The problems are often associated with recycling operations that run into trouble. The Chinese restrictions on the import of recycled commodities, for example, led to some large stockpiles of flammable materials while businesses worked to find new markets. In some cases, large quantities of waste have been stockpiled by operators who lack the capacity or investment needed to process or sell the materials. In still other cases, stockpiles are created by criminal activity.

Significant stockpiles of tyres, plastics, paper, demolition rubble and timber have been abandoned or inadequately managed in recent years.

The states have responded in various ways. NSW has introduced strict conditions on waste management facilities on the size and management of stockpiles, and Vic recently released its *Waste Management Policy (Combustible Recyclable and Waste Material)*. However, some resource recovery industries such as timber mulching, C&D masonry crushing, and composting facilities argue that they need to stockpile materials to meet large supply contracts or manage seasonal variation in supply and demand.

Food wastage

Food production and distribution is financially and environmentally expensive, using fertilisers, water, agricultural chemicals and energy, and if it is landfilled, food waste generates the potent greenhouse gas methane. The economic cost of food wastage in Australia is estimated at more than $20 billion per year (SARDI 2015). The *National Food Waste Strategy* (Australian Government 2017) targets a halving of Australia's food waste by 2030. More detail is provided in Section 7.8.

Plastic litter

Community concern about plastic litter has been galvanised by news about the 'Great Pacific Garbage Patch', photos of dead birds with stomachs full of plastic (see below) and the startling claim that by 2050 there is likely to be more plastic in the ocean than fish (WEF *et al.* 2016). There is also concern about tiny plastic microparticles entering food chains, derived from tyres, road markings, paint, clothing fibres, cosmetics and the degradation of larger items.

High-profile media coverage and political lobbying for bans on single use plastic bags and drinking straws have seen Qld, Vic and WA follow ACT, SA, NT and Tas in introducing legislation to ban single use bags, and major retailers nationally phase out single use bags. Some major food chains are also phasing out single use plastic straws. Australian governments are also working with cosmetic companies to phase out their use of microbeads.

Research suggests that 10 rivers, mostly in Asia, may be the source of 88% to 95% of the global load of plastic introduced to the ocean (Schmidt *et al.* 2017).

Photo 11 A dead bird and the plastic that was inside it

From The Ocean Cleaner (theoceancleaner.org.au). Used with permission.

15.5 Boomerang Alliance perspective

The Boomerang Alliance brings together almost 50 environmental, community and other groups who are passionate about stemming waste and litter. They were invited to contribute to this report, responding to the same questions and prompts as ALGA and the four waste industry associations:

1. How would you describe the state of waste management in Australia in 2018?
2. What are the most significant challenges facing Australian waste management providers in 2018?
3. What are the greatest opportunities facing Australian waste management providers in 2018?
4. Where do you believe Australian waste management should aim to be in 10 years' time?

The Boomerang Alliance response is set out below.

Status of waste management

We are at the crossroads. In retrospect we stagnated with most waste management until China correctly told us it was too contaminated for genuine recycling - we should have been pushing much harder towards the circular economy and comprehensive product stewardship.

Our challenges

What do we do next? Revert to landfill and waste to energy, eating up resources - or embrace genuine sustainability that will benefit future generations? The most useful route is for example to have all packaging reused, composted or recycled by 2025; food waste to decline; and a broad-based attack on single use plastics.

Our opportunities

Adjusting to the new market circumstances and working with government to respond to the community's demand for expansive and enduring recycling and thus create economic growth and obtain a renewed social licence to operate.

Waste management in 10 years

In ten years' time we should be well into the new recycling paradigm, having bypassed fuzzy commitments and aspirations. Our economy and society should be comprehensively achieving 'recycled', 'reused' or 'composted' for a whole range of materials. The calls for landfill and mixed waste to energy should be distant memories. In 10 years' time we should have a Circular Economy Plan well underway with ambitious mandatory waste reduction targets set for identified problematic wastes. Such plans require strategic interventions throughout a product lifecycle to avoid and minimise resource use or manage discarded materials as secondary resources.

16. Influences on waste generation and management

This section discusses six factors that influence Australia's waste generation and management as presented in this report:

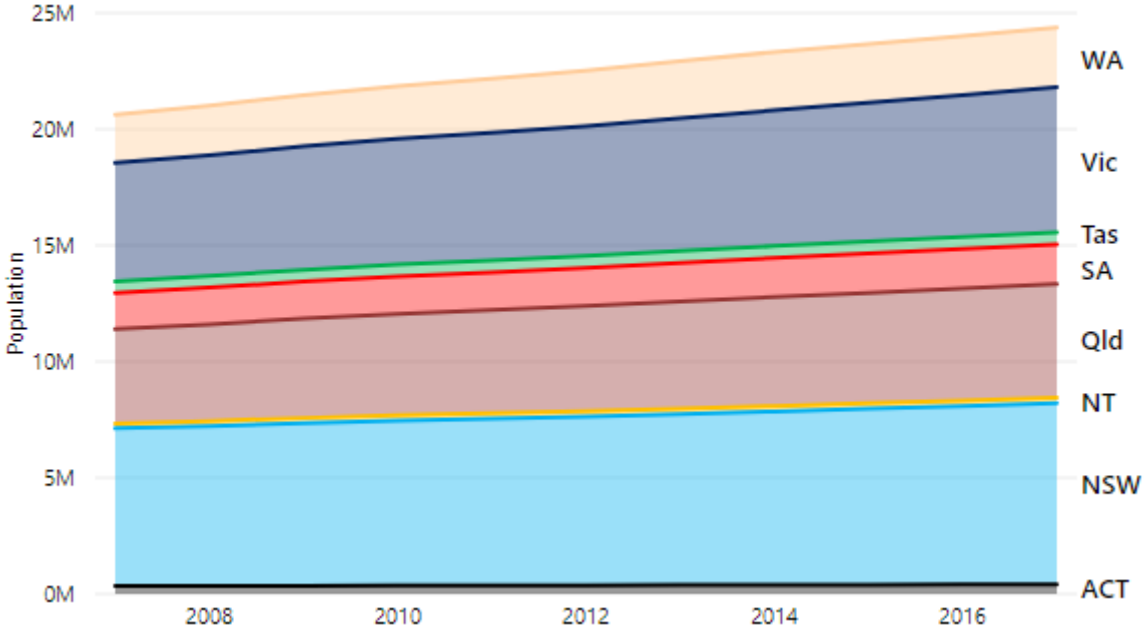
- population growth
- economic growth
- technological change
- access to recycling markets
- waste policy
- carbon policy.

The section concludes with a discussion on how waste generation and management might change into the future.

16.1 Population growth

Waste generation is linked to population size. Other things being equal, more population means more waste. Figure 42 shows Australia's population by state and territory in each of the 11 years for which national waste data is presented in this report. Overall, population grew by 18% from 20.6 to 24.4 million, an average of 1.7% per year. The fastest growing state was WA, which grew by an average of 2.1% per year, and the slowest was Tas, which grew by 0.5% per year. The three biggest states—NSW, Vic and Qld—represent more than three-quarters of Australia's population.

Figure 42 Australian population by state and territory, 2006-07 to 2016-17



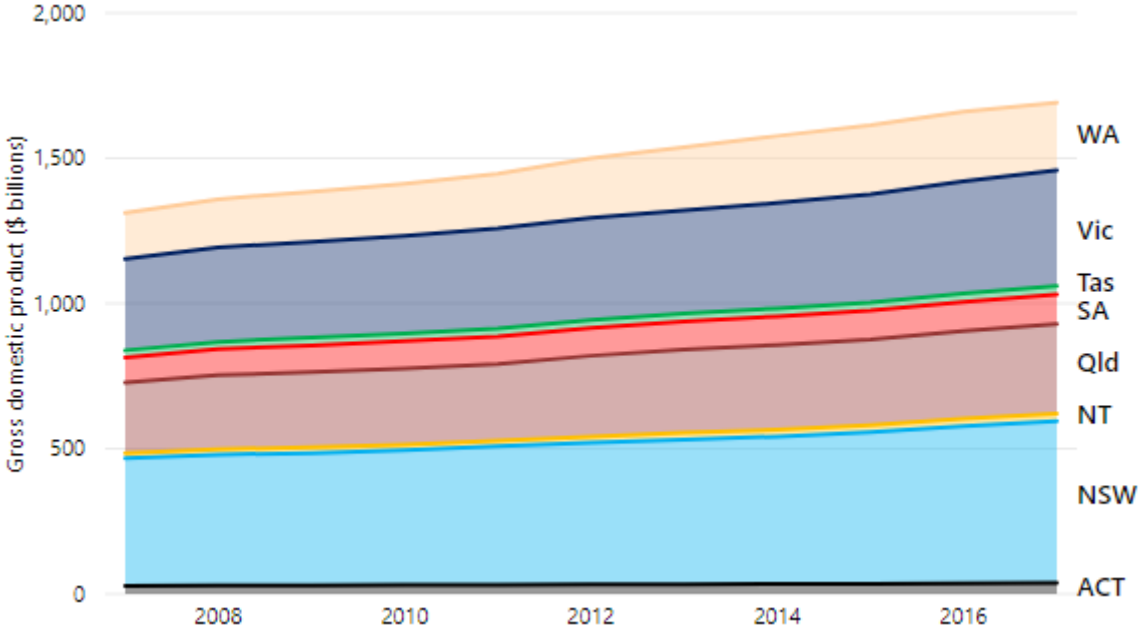
16.2 Economic growth

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.

Figure 43 shows gross state product (GSP) for each state and territory in each year for the period of the report. Overall, the combined GSP grew by 29%, an average of 2.6% per year. The fastest growing state was WA, which grew by an average of 3.9% per year, and the slowest was Tas, which grew by 1.5% per year.

Much of our economic growth can be attributed to population growth but, for all states and territories, the economy grew faster than population over the 11-year period. In other words, the average amount of economic activity per capita increased.

Figure 43 Australian economic activity by state and territory (GSP), 2006-07 to 2016-17



16.3 Technological change

Technological change is affecting waste types and quantities. The shift from paper to digital communications is greatly reducing paper wastage. High strength but light weight packaging is also decreasing the weight of our recycling bins. And while the quantity of e-waste items is growing strongly, the weight of these wastes is rising more slowly[34] because items are getting lighter.

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

Technological change also affects waste management. In MRFs, in particular, robotic and optical sorting equipment is improving recovery.

[34] Estimated at 3.8% per year at present – see Section 12.3

16.4 Access to recycling markets

Recycling is often not viable 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 tend to have lower recycling rates when they have large remote populations or lack ready access to the major markets.

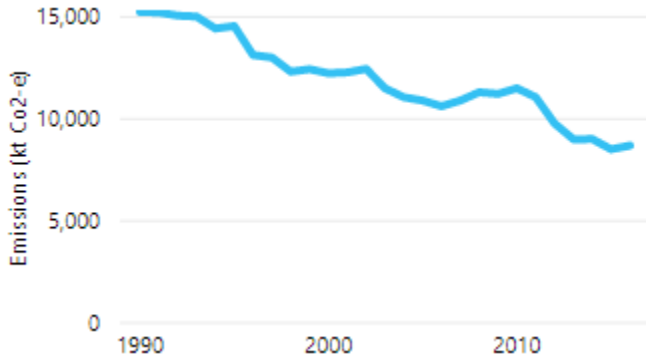
16.5 Waste policy

Waste management is strongly influenced by government regulation and policy, mostly at the state and territory level. Waste generation is also affected by policy, albeit to a lesser extent. State and territory waste policy is discussed in Section 9.

16.6 Carbon policy

When organic waste decays in the anaerobic environment of a landfill, the greenhouse gas methane is formed. Methane emissions can be reduced by capturing the gas for energy recovery or flaring. Between 2006-07 and 2015-16, methane emissions from landfills fell by 20%, continuing a declining trend since 1990 (see Figure 44). The decline is nearly all due to increased landfill gas capture, and can be attributed to carbon policy initiatives, mostly at the national level.

Figure 44 Greenhouse gas emissions from landfills, 1989-90 to 2015-16



Source: Australian Greenhouse Emissions Information System (http://ageis.climatechange.gov.au/)

16.7 The future of waste generation and management

Given these influences and current trends, how can we expect waste quantities and their management to change into the future?

Examination of the waste generation trends in Figure 11 suggests waste quantities are likely to continue increasing slowly despite slight falls in the tonnes of waste generated per capita. Domestic waste, however, may level off in absolute terms. This is a measurement by weight – as packaging gets lighter, weight could decline while volume increases. Large projects and programs could increase waste, as has been seen in the asbestos demolition programs in ACT. Large quantities of PFAS contaminated soils could find their way into landfills over the coming decades.

The long-term trend in waste management is towards increasing levels of recycling and, driven by public demand and government policy, there is little reason to imagine this will change. Of course, for some materials the cost of recycling is high and the benefits are low. However, there are plenty of wastes for which resource recovery can be significantly increased to the benefit of the community, including food waste, skip bin materials and e-waste. The high cost of energy is likely to drive the development of energy from waste facilities, particularly in areas with limited landfill airspace. As well as potential mass-burn operations, there may be a market for facilities using niche, high-calorific waste streams such as timber, textiles and hard-to-recycle plastics.

17. Method

This section summarises the method, main assumptions and main data problems and adjustments used for collating the data presented in this report.

Appendix B provides a set of proposed principles for use in the development of a potential future national standard for waste data and reporting. Much of the content in Appendix B proposes principles that aim to resolve issues that are noted in this section.

17.1 Data sources

Within the *National Waste Reporting Tool 2016-17*, states and territories were asked to provide the following data to contribute to the core data set:

- tonnes of landfill waste, disaggregated by source stream where known
- imports and exports of landfill waste 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 were asked for additional data to support other sections of this report, including data on local government waste management, product waste and litter and dumping.

Further input to the core data set was obtained from a range of sources as shown in Table 12.

Table 12 Contributions to the core data set from sources other than the states and territories

Data	Source and comments
Hazardous waste	State and territory data previously provided to the Australian Government for use in the annual report to the Basel Convention
Average composition of C&I recycling	Encycle Consulting & SRU Consulting (2013)
Plastics recycling	Envisage Works and SRU (2018)
Factors for back-calculating waste associated with energy recovery from landfill gas	*National Greenhouse and Energy Reporting (Measurement) Determination 2008* as amended
Methane recovered from landfills for energy generation by state and territory	Australian Government Department of the Environment and Energy
Population & economic data	ABS (2017, 2018)

17.2 Assumptions

Assumptions were needed to fill data gaps so that a complete national picture could be developed. These are described in the *National Waste Reporting Tool 2016-17*, which was endorsed by the states and territories, and is released with this report. The methods for gap-filling often included assuming that proportions or rates in a jurisdiction, time period, area or waste stream were similar to those in another, or had particular values. Specific significant assumptions for non-hazardous waste included that:

- the proportional change in waste generation per capita in each waste stream (MSW, C&I and C&D) between 2014-15 and 2016-17 in NSW was the same as the rest of Australia combined
- the proportional split of recyclables by material and stream in NSW in 2016-17 were the same as in 2014-15
- the composition of each waste stream (MSW, C&I and C&D) to landfill in the ACT, NSW, SA and Vic is as determined by each jurisdiction through their own landfill audits
- the composition of each waste stream in NT, Qld, Tas and WA is based on national average figures calculated by assuming (a) the organic fraction and proportions are equal to those set out in the NGER (Measurement) Determination 5.11, and (b) the inert proportions are equal to the population-weighted average calculated from ACT, NSW, SA and Vic
- the mass of waste associated with energy recovery from landfill gas can be reasonably estimated using NGER default values applied to non-hazardous wastes, as described below.

Specific assumptions for hazardous waste are given in the *National Waste Reporting Tool 2016-17* in the worksheet 'Other national data'. They include that:

- The proportions of each hazardous waste type sent to disposal, recycling, energy recovery, treatment or storage in each state or territory are equal to either:
  - the proportion of that waste type sent to that fate in 2016-17 where known and calculable or
  - the weighted average of that waste type sent to that fate in 2014-15 as recorded in NSW, Qld, Vic and WA waste tracking systems (considered the best estimate).
- Some hazardous waste recorded in tracking systems is double-counted because it is sent to more than one facility before reaching its final fate. This proportion needs to be subtracted from the total to derive waste generation. The proportion to be subtracted is estimated by reference to the proportions sent to short-term storage in Qld and Vic in 2016-17. This amounts to 12% of hazardous waste arisings recorded in tracking systems.
- Hazardous wastes, including biosolids, are assumed to be sourced from the C&I stream except N120 contaminated soils and N220 asbestos, of which 72% and 54% respectively are assumed to be sourced from C&D waste. This is based on data from SA and Vic, which run tracking systems that cover these wastes and record waste fate.

17.3 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. In the Australian Government method used in this report, this is considered a form of energy recovery. The national waste data set 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 Department's NGER system, plus data from smaller jurisdictions where the Department 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.

17.4 Significant data gaps and quality issues

Table 13 describes the main data problems and how they are dealt with in the report.

Table 13 Main data problems and how they were dealt with

Type of issue	Details	Adjustments and rationale
Data unavailable	No data on NSW recycling data 2016-17	Extrapolated from 2014-15 data assuming NSW change in waste per capita is equal to the change in other parts of Australia. Required for a complete national data set.
	No data on Qld hazardous waste data 2016-17	Extrapolated from 2015-16 data 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
Unrecorded waste	About 100 kt of WA C&D waste was deposited at recycling operations in 2016-17 but not processed. This is excluded from WA data.	None. Incorporating this data could lead to double-counting when it is processed in a subsequent year, distorted recovery rates in a subsequent year, and/or the need to track waste vintage. (See discussion in Appendix B.)
	Some tens of thousands of tonnes of unprocessed Vic C&D waste was deposited at a site outside Geelong in 2016-17. This is excluded from Vic data.	As above. Reasonable quantity estimates are also unavailable.
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 C&D recyclables sent to Qld • SA recyclables sent to Vic	ACT recycling quantities were deducted from NSW recycling data and estimates (all years). For others, data was not identifiable and quantifiable. No adjustment made.

Type of issue	Details	Adjustments and rationale
	Organic hazardous waste may be included in both tracking system and compost industry data.	For several states the relevant data did not match up. No adjustment made.
	WA 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 WA landfill data (all years).
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 • Vic landfill waste sent to levy-free landfills in rural NSW • ACT landfill waste sent to levy-free landfills in NSW.	Corrected when identified. Data on NSW landfill waste to Qld in recent years was collected by Qld, allowing reallocation to NSW. Vic landfill transfers to NSW were estimated and reallocated to Vic (recent years). ACT landfill transfers to NSW could not be quantified so no adjustment was made.
Misallocated stream	Some MSW may be included in C&I or vice-versa, e.g. transfer station waste all counted as MSW.	None
Ambiguity over the fate 'recycling'	Waste is allocated to 'recycling' if recorded in state and territory data, either because it was received at a recycling facility or entered a recycling process. However, some of this material may have: • not been processed • been processed then stockpiled on-site • been processed but then stockpiled off-site.	None. Data on these quantities is not available. However, the quantities are generally relatively small. NSW regulates and restricts stockpile sizes.

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Appendix A Chart data

Chart data

(The abbreviation 'CAGR' means average annual growth rate.)

Data table for Figure 1 Waste generation by material category and stream, Australia 2016-17 (core waste + ash)

Million tonnes

Material category	Mt	Stream	Mt
Masonry materials	17.1	MSW	13.8
Metals	5.5	C&D	20.4
Organics	14.2	C&I core	20.4
Paper & cardboard	5.6	C&I (electricity generation)	12.3
Plastics	2.5	**Total**	**66.8**
Glass	1.1		
Textiles, leather & rubber (excl. tyres)	0.8		
Hazardous	6.3		
Other	1.4		
Total core wastes	**54.5**		
Ash	12.3		

Data table for Figure 2 Trend in the generation of core waste plus ash by stream in total (left) and per capita (right), Australia 2006-07 to 2016-17

Million tonnes

Core + ash	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	16.9	18.5	18.4	18.4	17.9	19.4	20.1	20.4	1.9%
C&I	33.1	33.3	34.0	33.9	33.3	32.9	32.3	32.7	-0.1%
MSW	12.9	13.3	13.5	13.5	13.8	14.0	13.5	13.8	0.7%
Total	**62.9**	**65.1**	**65.9**	**65.8**	**65.1**	**66.3**	**66.0**	**66.8**	**0.6%**

per capita

	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Core waste + ash	3.05	3.03	3.02	2.97	2.79	2.80	2.75	2.74	-1.1%

Data for Figure 3 Trend in the recycling (left) and disposal (right) of core waste plus ash by stream, Australia 2006-07 to 2016-17

Million tonnes

Recycling	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	10.1	11.1	11.3	12.1	11.5	12.4	13.5	13.6	3.0%
C&I	14.4	13.6	15.3	17.7	18.4	17.4	16.9	17.2	1.8%
MSW	4.8	5.3	5.5	5.8	6.3	6.4	6.3	6.3	2.7%
Total	**29.4**	**30.0**	**32.1**	**35.5**	**36.2**	**36.3**	**36.7**	**37.0**	**2.3%**

Million tonnes

Disposal	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	6.6	7.3	7.0	6.2	6.2	6.7	6.4	6.7	0.0%
C&I	17.3	18.2	17.2	14.7	13.2	13.7	13.9	14.1	-2.0%
MSW	7.0	7.0	7.0	6.6	6.2	6.3	5.9	6.2	-1.2%
Total	**30.9**	**32.5**	**31.3**	**27.4**	**25.7**	**26.7**	**26.2**	**27.0**	**-1.4%**

Data table for Figure 4 Resource recovery and recycling rates of core waste by jurisdiction, 2016-17

Jurisdiction	Energy recovery rate	Recycling rate	Total recovery rate
ACT	4%	49%	53%
NSW	4%	59%	63%
NT	4%	11%	15%
Qld	3%	44%	47%
SA	4%	78%	82%
Tas	4%	49%	53%
Vic	4%	68%	72%
WA	4%	53%	57%
Australia	4%	58%	62%

Data for Figure 5 Exports of waste materials for recycling by type from Australia to all destinations, 2006-07 to 2017-18

Kilotonnes

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	CAGR
Metals	1,575	2,011	1,981	1,852	1,874	2,432	2,401	2,695	2,466	1,965	2,141	2,447	4.1%
Plastics	100	129	249	207	233	290	259	268	256	226	215	220	7.4%
Paper, card	1,105	1,332	1,265	1,497	1,384	1,466	1,567	1,497	1,497	1,535	1,453	1,324	1.7%
Other	84	197	137	111	255	306	296	309	326	327	400	315	12.7%
Total	**2,864**	**3,669**	**3,632**	**3,666**	**3,746**	**4,494**	**4,523**	**4,768**	**4,545**	**4,053**	**4,209**	**4,306**	**3.8%**

Data table for Figure 6Figure 6 Generation and management method of core waste and ash material categories, Australia 2016-17

Kilotonnes

Material category	Recycling	Other disposal	Landfill	Treatment	Energy from waste facility
Masonry materials	12,266		4,871		
Organics	7,299		6,710		162
Ash	5,314	6,983			
Metals	4,982		538		
Hazardous	1,729	24	3,731	822	
Paper & cardboard	3,361		2,230		0
Plastics	306		2,182		28
Other	1,072		319		0
Textiles, leather & rubber (excl. tyres)	88		679		9
Glass	612		467		
Total	**37,030**	**7,006**	**21,726**	**822**	**200**

Data table for Figure 10 Waste generation by material category and stream, Australia 2016-17

Million tonnes

Material category	Mt	Stream	Mt
Masonry materials	17.1	MSW	13.8
Metals	5.5	C&D	20.4
Organics	14.2	C&I core	20.4
Paper & cardboard	5.6	C&I (electricity generation)	12.3
Plastics	2.5	C&I (agriculture & fisheries)	16.2
Glass	1.1	C&I (mining)	1.8
Textiles, leather & rubber (excl. tyres)	0.8	C&I (mineral processing)	28.8
Hazardous	6.3	**Total**	113.6
Other	1.4		
Total core wastes	**54.5**		
Ash	12.3		

Data table for Figure 11 Trends in the generation of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2016-17

Million tonnes

Core + ash	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	16.9	18.5	18.4	18.4	17.9	19.4	20.1	20.4	1.9%
C&I	33.1	33.3	34.0	33.9	33.3	32.9	32.3	32.7	-0.1%
MSW	12.9	13.3	13.5	13.5	13.8	14.0	13.5	13.8	0.7%
Total	**62.9**	**65.1**	**65.9**	**65.8**	**65.1**	**66.3**	**66.0**	**66.8**	**0.6%**

Million tonnes

Core	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	16.9	18.5	18.4	18.4	17.9	19.4	20.1	20.4	1.9%
C&I	18.8	19.2	20.1	20.3	21.0	20.7	20.1	20.4	0.8%
MSW	12.9	13.3	13.5	13.5	13.8	14.0	13.5	13.8	0.7%
Total	**48.6**	**51.0**	**52.0**	**52.2**	**52.7**	**54.1**	**53.8**	**54.5**	**1.2%**

Tonnes per capita

	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Core waste + ash	3.05	3.03	3.02	2.97	2.79	2.80	2.75	2.74	-1.1%
Core waste	2.35	2.37	2.38	2.35	2.26	2.28	2.24	2.23	-0.5%
MSW	0.62	0.62	0.62	0.61	0.59	0.59	0.56	0.56	1.0%
C&I core + ash	1.61	1.55	1.55	1.53	1.43	1.39	1.35	1.34	-1.8%
C&I core	0.91	0.89	0.92	0.92	0.90	0.87	0.84	0.84	-0.9%
C&D	0.82	0.86	0.84	0.83	0.77	0.82	0.84	0.84	0.2%

Data table for Figure 12 Trends in the generation of core waste by jurisdiction, Australia 2006-07 to 2016-17

Kilotonnes

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
ACT	704	716	710	892	841	711	873	941	2.9%
NSW	15,863	18,490	17,374	17,484	17,908	17,690	17,948	18,086	1.3%
NT	528	374	377	371	567	474	487	347	-4.1%
Qld	9,586	9,763	9,181	9,113	10,265	10,596	10,322	11,245	1.6%
SA	3,115	3,320	3,321	3,830	3,898	3,811	4,068	4,034	2.6%
Tas	831	787	844	924	900	931	1,066	938	1.2%
Vic	12,088	11,519	12,855	13,167	12,459	13,153	13,341	13,714	1.3%
WA	5,829	5,992	7,388	6,399	5,906	6,694	5,668	5,182	-1.2%
Total	**48,545**	**50,960**	**52,049**	**52,178**	**52,744**	**54,060**	**53,774**	**54,487**	**1.2%**

Data table for Figure 14 Recycling of core waste by material category, jurisdiction and stream, Australia 2016-17

Kilotonnes

Material category	Kilotonnes	Stream	Kilotonnes	Jurisdiction	Kilotonnes
Masonry materials	12,266	MSW	6,319	ACT	465
Metals	4,982	C&D	13,556	NSW	10,603
Organics	7,299	C&I core	11,841	NT	39
Paper & cardboard	3,361	**Total**	**31,715**	Qld	4,932
Plastics	306			SA	3,154
Glass	612			Tas	458
Textiles, leather & rubber (excl. tyres)	88			Vic	9,310
Hazardous	1,729			WA	2,754
Other	1,072			**Total**	**31,715**
Total	**31,715**				

Data table for Figure 15 Trends in the recycling of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2016-17

Million tonnes

Core + ash	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	10.1	11.1	11.3	12.1	11.5	12.4	13.5	13.6	3.0%
C&I	14.4	13.6	15.3	17.7	18.4	17.4	16.9	17.2	1.8%
MSW	4.8	5.3	5.5	5.8	6.3	6.4	6.3	6.3	2.7%
Total	**29.4**	**30.0**	**32.1**	**35.5**	**36.2**	**36.3**	**36.7**	**37.0**	**2.3%**

Million tonnes

Core	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	10.1	11.1	11.3	12.1	11.5	12.4	13.5	13.6	3.0%
C&I	10.1	10.1	11.2	11.7	12.2	12.1	11.9	11.8	1.6%
MSW	4.8	5.3	5.5	5.8	6.3	6.4	6.3	6.3	2.7%
Total	**25.1**	**26.5**	**27.9**	**29.6**	**30.0**	**30.9**	**31.7**	**31.7**	**2.4%**

Tonnes per capita

	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Core waste + ash	1.42	1.40	1.47	1.60	1.55	1.53	1.53	1.52	0.6%
Core waste	1.22	1.23	1.28	1.33	1.29	1.31	1.32	1.30	0.7%
MSW	0.23	0.25	0.25	0.26	0.27	0.27	0.26	0.26	1.0%
C&I core + ash	0.70	0.63	0.70	0.80	0.79	0.74	0.71	0.70	0.1%
C&I core	0.49	0.47	0.51	0.53	0.52	0.51	0.49	0.49	-0.1%
C&D	0.49	0.52	0.51	0.54	0.49	0.53	0.56	0.56	1.3%

Data table for Figure 16 Trends in the recycling of core waste by jurisdiction, Australia 2006-07 to 2016-17

Kilotonnes

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
ACT	492	516	520	643	616	487	593	465	-0.6%
NSW	9,291	10,583	10,731	10,814	10,743	10,860	10,741	10,603	1.3%
NT	45	47	44	45	65	92	86	39	-1.3%
Qld	4,162	4,087	3,685	4,238	4,437	4,635	4,535	4,932	1.7%
SA	2,308	2,507	2,534	2,993	2,942	3,008	3,203	3,154	3.2%
Tas	290	296	358	380	402	396	521	458	4.7%
Vic	6,655	6,578	7,848	7,990	7,865	8,440	9,137	9,310	3.4%
WA	1,846	1,870	2,223	2,481	2,972	2,976	2,854	2,754	4.1%
Total	**25,089**	**26,483**	**27,943**	**29,584**	**30,043**	**30,892**	**31,671**	**31,715**	**2.4%**

Data table for Figure 17 Comparison of core waste recycling and exports of waste materials for recycling from Australia to all destinations by material category, 2016-17

Kilotonnes

Material category	Recycling	Waste materials for recycling export
Masonry materials	12,266	
Metals	4,982	2,141
Organics	7,299	
Paper & cardboard	3,361	1,453
Plastics	306	215
Glass	612	
Textiles, leather & rubber (excl. tyres)	88	
Hazardous	1,729	
Other	1,072	
Total of others		400
Total	31,715	4,209

Data table for Figure 18 Exports of waste materials for recycling by type from Australia to all destinations, 2006-07 to 2017-18

Kilotonnes

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	CAGR
Metals	1,575	2,011	1,981	1,852	1,874	2,432	2,401	2,695	2,466	1,965	2,141	2,447	4.1%
Plastics	100	129	249	207	233	290	259	268	256	226	215	220	7.4%
Paper, card	1,105	1,332	1,265	1,497	1,384	1,466	1,567	1,497	1,497	1,535	1,453	1,324	1.7%
Other	84	197	137	111	255	306	296	309	326	327	400	315	12.7%
Total	**2,864**	**3,669**	**3,632**	**3,666**	**3,746**	**4,494**	**4,523**	**4,768**	**4,545**	**4,053**	**4,209**	**4,306**	**3.8%**

Data table for Figure 19 Exports of waste materials for recycling by type from Australia to China, 2006-07 to 2017-18

Kilotonnes

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	CAGR
Metals	255	471	846	580	459	558	432	236	232	174	203	156	-4.4%
Plastics	94	113	190	137	141	155	138	108	130	144	125	27	-10.7%
Paper, card	648	910	916	1,173	1,060	1,108	1,188	1,067	938	996	920	562	-1.3%
Other	2	18	1	1	2	11	3	2	2	2	3	3	2.2%
Total	**999**	**1,512**	**1,953**	**1,891**	**1,663**	**1,833**	**1,760**	**1,414**	**1,301**	**1,316**	**1,251**	**748**	**-2.6%**

Data table for Figure 20 Energy recovery from core waste by management method, material category, stream and jurisdiction, Australia 2016-17

Kilotonnes

Management	Kt	Material category/type	Kt	Steam	Kt	Jurisdiction	Kt
Energy from waste facility	200	Organics	1,473	MSW	1,225	ACT	35
Landfill	1,773	Paper & cardboard	354	C&D	46	NSW	665
	1,973	Plastics	28	C&I core	703	NT	13
		Textiles, leather & rubber (excl. tyres)	119	**Total**	**1,973**	Qld	311
		Other	0			SA	149
Total		**Total**	**1,973**			Tas	36
						Vic	580
						WA	184
						Total	**1,973**

Data table for Figure 21 Trends in energy recovery from core waste by jurisdiction, Australia 2006-07 to 2016-17

Kilotonnes

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
ACT	44	36	34	34	39	37	34	35	-2.5%
NSW	550	550	542	613	559	819	806	665	1.9%
NT	17	26	27	17	17	14	14	13	-2.3%
Qld	403	362	379	348	410	355	369	311	-2.6%
SA	156	160	159	155	159	147	147	149	-0.4%
Tas	42	64	45	46	47	54	44	36	-1.4%
Vic	403	421	425	522	895	712	659	580	3.7%
WA	207	234	167	163	202	231	146	184	-1.2%
Total	**1,822**	**1,852**	**1,778**	**1,898**	**2,327**	**2,368**	**2,219**	**1,973**	**0.8%**

Data table for Figure 23 Disposal of core waste by material category, stream and jurisdiction, Australia 2016-17

Kilotonnes

Material category	Kt	Stream	Kt	Jurisdiction	Kt
Masonry materials	4,871	MSW	6,208	ACT	439
Metals	538	C&D	6,660	NSW	6,489
Organics	5,399	C&I core	7,109	NT	291
Paper & cardboard	1,876	**Total**	**19,976**	Qld	5,875
Plastics	2,182			SA	615
Glass	467			Tas	416
Textiles, leather & rubber (excl. tyres)	570			Vic	3,672
Hazardous	3,754			WA	2,179
Other	319			**Total**	**19,976**
Total	**19,976**				

Data table for Figure 24 Trends in the disposal of core waste (plus ash where shown) by stream in total (left) and per capita (right), Australia 2006-07 to 2016-17

Million tonnes

Core + ash	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	6.63	7.26	7.03	6.15	6.22	6.70	6.43	6.66	0.0%
C&I	17.31	18.25	17.19	14.68	13.21	13.72	13.86	14.09	-2.0%
MSW	7.01	7.01	7.04	6.61	6.25	6.29	5.88	6.21	-1.2%
Total	**30.95**	**32.52**	**31.26**	**27.45**	**25.68**	**26.71**	**26.17**	**26.96**	**-1.4%**

Million tonnes

Core	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	6.63	7.26	7.03	6.15	6.22	6.70	6.43	6.66	0.0%
C&I	7.23	7.62	7.46	7.03	7.04	6.84	6.71	7.11	-0.2%
MSW	7.01	7.01	7.04	6.61	6.25	6.29	5.88	6.21	-1.2%
Total	**20.88**	**21.89**	**21.53**	**19.80**	**19.51**	**19.83**	**19.03**	**19.98**	**-0.4%**

Tonnes per capita

	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Core waste + ash	1.50	1.51	1.43	1.24	1.10	1.13	1.09	1.11	-3.0%
Core waste	1.01	1.02	0.99	0.89	0.84	0.84	0.79	0.82	-2.1%
MSW	0.34	0.33	0.32	0.30	0.27	0.27	0.25	0.25	-2.8%
C&I core + ash	0.84	0.85	0.79	0.66	0.57	0.58	0.58	0.58	-3.7%
C&I core	0.35	0.35	0.34	0.32	0.30	0.29	0.28	0.29	-1.8%
C&D	0.32	0.34	0.32	0.28	0.27	0.28	0.27	0.27	-1.6%

Data table for Figure 25 Trends in the disposal of core waste by jurisdiction, Australia 2006-07 to 2016-17

Kilotonnes

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	
ACT	166	163	154	213	184	185	245	439	10.2%
NSW	5,674	7,000	5,716	5,657	6,214	5,602	6,035	6,489	1.4%
NT	463	299	303	306	482	364	385	291	-4.5%
Qld	4,866	5,189	4,984	4,384	5,260	5,421	5,297	5,875	1.9%
SA	619	615	577	567	713	547	634	615	-0.1%
Tas	450	376	389	447	399	424	429	416	-0.8%
Vic	4,887	4,403	4,461	4,525	3,592	3,876	3,417	3,672	-2.8%
WA	3,734	3,845	4,951	3,698	2,664	3,414	2,585	2,179	-5.2%
Total	**20,860**	**21,890**	**21,535**	**19,797**	**19,508**	**19,833**	**19,028**	**19,976**	**-0.4%**

Data table for Figure 26 Resource recovery and recycling rates of core waste by jurisdiction, 2016-17

Jurisdiction	Energy recovery rate	Recycling rate	Total recovery rate
ACT	4%	49%	53%
NSW	4%	59%	62%
NT	4%	11%	15%
Qld	3%	44%	47%
SA	4%	78%	82%
Tas	4%	49%	53%
Vic	4%	68%	72%
WA	4%	53%	57%
Australia	4%	58%	62%

Data table for Figure 27 Resource recovery and recycling rates of core waste by source stream, Australia 2016-17

Jurisdiction	Energy recovery rate	Recycling rate	Total recovery rate
C&D	0%	67%	67%
C&I	3%	58%	61%
MSW	9%	46%	55%

Data table for Figure 28 Resource recovery rate trends of core waste by jurisdiction and stream, Australia 2006-07 to 2016-17

Jurisdiction	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
ACT	76%	77%	78%	76%	78%	74%	72%	53%	-3.5%
NSW	62%	60%	65%	65%	63%	66%	64%	62%	0.0%
NT	12%	19%	19%	17%	14%	22%	20%	15%	2.3%
Qld	48%	46%	44%	50%	47%	47%	48%	47%	-0.2%
SA	79%	80%	81%	82%	80%	83%	82%	82%	0.4%
Tas	40%	46%	48%	46%	50%	48%	53%	53%	2.9%
Vic	58%	61%	64%	65%	70%	70%	73%	72%	2.2%
WA	35%	35%	32%	41%	54%	48%	53%	57%	5.0%
Australia	55%	56%	57%	60%	61%	62%	63%	62%	1.2%

Stream	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
C&D	60%	60%	62%	66%	65%	65%	68%	67%	1.1%
C&I	58%	57%	59%	61%	63%	63%	63%	62%	0.7%
MSW	46%	47%	48%	51%	55%	55%	57%	55%	1.8%

Data table for Figure 29 Generation and management method of core waste and ash material categories, Australia 2016-17

Kilotonnes

Material category	Recycling	Other disposal	Landfill	Treatment	Energy from waste facility
Masonry materials	12,266		4,871		
Organics	7,299		6,710		162
Ash	5,314	6,983			
Metals	4,982		538		
Hazardous	1,729	24	3,731	822	
Paper & cardboard	3,361		2,230		0
Plastics	306		2,182		28
Other	1,072		319		0
Textiles, leather & rubber (excl. tyres)	88		679		9
Glass	612		467		
Total	**37,030**	**7,006**	**21,726**	**822**	**200**

Data for Figure 30 Trends in the generation and management methods of key material categories, Australia 2006-07 to 2016-17

Kilotonnes

Masonry material Management	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Recycling	8,935	9,687	10,151	10,626	10,278	11,228	12,271	12,266	3.2%
Other disposal									
Landfill	5,614	6,180	5,869	5,018	4,470	5,016	4,950	4,871	-1.4%
Treatment									
Energy from waste facility									
Total	**14,549**	**15,867**	**16,020**	**15,645**	**14,749**	**16,244**	**17,221**	**17,137**	**1.7%**

Kilotonnes

Organics Management	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Recycling	5,374	5,479	5,978	6,620	7,224	7,440	7,294	7,299	3.1%
Other disposal									
Landfill	8,363	8,698	8,334	7,988	7,569	7,477	6,626	6,710	-2.2%
Treatment									
Energy from waste facility	188	221	221	221	230	214	273	162	-1.5%
Total	**13,926**	**14,398**	**14,533**	**14,829**	**15,023**	**15,130**	**14,194**	**14,171**	**0.2%**

Kilotonnes

Ash Management	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Recycling	4,277	3,528	4,155	5,930	6,143	5,365	5,056	5,314	2.2%
Other disposal	10,074	10,627	9,724	7,651	6,173	6,874	7,144	6,983	-3.6%
Landfill									
Treatment									
Energy from waste facility									
Total	**14,351**	**14,154**	**13,879**	**13,581**	**12,316**	**12,240**	**12,200**	**12,297**	**-1.5%**

Kilotonnes

Hazardous Management	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Recycling	1,674	1,632	1,770	1,985	1,999	1,999	1,863	1,729	0.3%
Other disposal	28	24	26	26	26	35	25	24	-1.5%
Landfill	2,519	2,383	2,291	2,438	3,024	2,919	3,064	3,731	4.0%
Treatment	774	735	793	899	867	966	857	822	0.6%
Energy from waste facility									
Total	**4,995**	**4,774**	**4,880**	**5,348**	**5,915**	**5,920**	**5,809**	**6,305**	**2.4%**

Kilotonnes

Paper and cardboard Management	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Recycling	3,680	4,380	3,132	3,210	3,436	3,290	3,460	3,361	-0.9%
Other disposal									
Landfill	1,866	1,899	1,973	1,868	2,045	2,035	2,186	2,230	1.8%
Treatment									
Energy from waste facility									
Total	**5,546**	**6,279**	**5,105**	**5,078**	**5,481**	**5,325**	**5,646**	**5,591**	**0.1%**

Kilotonnes

Metals Management	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Recycling	3,460	3,026	4,907	5,092	5,106	4,832	4,598	4,982	3.7%
Other disposal									
Landfill	541	600	573	524	551	599	547	538	-0.1%
Treatment									
Energy from waste facility									
Total	**4,001**	**3,625**	**5,481**	**5,615**	**5,657**	**5,431**	**5,145**	**5,520**	**3.3%**

Kilotonnes

Plastics Management	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Recycling	254	278	294	292	326	334	345	306	1.9%
Other disposal									
Landfill	2,290	2,397	2,451	2,331	2,216	2,182	2,160	2,182	-0.5%
Treatment									
Energy from waste facility		17	17	17	8	17	22	28	
Total	**2,544**	**2,692**	**2,761**	**2,640**	**2,549**	**2,533**	**2,527**	**2,516**	**-0.1%**

Kilotonnes

Glass Management	2007	2009	2010	2011	2014	2015	2016	2017	CAGR
Recycling	739	815	644	702	584	625	653	612	-1.9%
Other disposal									
Landfill	515	525	541	508	482	473	456	467	-1.0%
Treatment									
Energy from waste facility									
Total	**1,254**	**1,341**	**1,186**	**1,210**	**1,066**	**1,099**	**1,109**	**1,079**	**-1.5%**

Data for Figure 31 Generation of organic waste by type and stream, Australia 2016-17

Kilotonnes

Material category	Tonnes	Stream	Tonnes
Food organics	4,242	MSW	6,593
Garden organics	3,521	C&D	846
Timber	2,222	C&I core	6,396
Other organics	1,719	C&I (Agriculture & fisheries)	16,180
Biosolids (non-contaminated)	1,420	**Total**	**30,015**
Food-derived hazardous wastes	682		
Other hazardous organic wastes	6		
Biosolids (contaminated)	24		
Manure	9,849		
Bagasse (available)	6,033		
Cotton Gin Trash	184		
Fisheries organics	114		
Total	**30,015**		

Data for Figure 32 Generation of food waste by management method, Australia 2016-17

Kilotonnes

Management	Incl. food derived hazardous waste	Excl. food derived hazardous waste
Energy from waste facility	50	50
Landfill	3,777	3,770
Other disposal	0	
Recycling	910	491
Treatment	256	
Total	**4,993**	**4,311**

Data for Figure 33 Resource recovery and recycling rates for core waste by material category, 2016-17

Material category	Energy recovery rate	Recycling rate	Recovery rate
Ash	0%	43%	43%
Glass	0%	57%	57%
Masonry materials	0%	72%	72%
Metals	0%	90%	90%
Organics	10%	52%	62%
Paper & cardboard	6%	60%	66%
Plastics	1%	12%	13%

Data for Figure 34 Comparison of annual waste generation and fate per capita, Australia and selected OECD countries (excluding hazardous waste, ash and landfill gas energy recovery)

Kg per capita

Country	Disposal	Recycling	Energy recovery	Generation
Australia	738	1,230	8.16	1,976
Denmark	74	1,253	479	1,806
Norway	401	755	700	1,856
United Kingdom	414	1,227	26	1,667
United States	1,283	1,138	105	2,525

Data for Figure 35 Comparison of MSW generation and recycling rates in selected countries

Kg per capita

Country	MSW recycling per capita	MSW unknown management per capita
Australia	248	295
Austria	295	253
Belgium	193	198
Germany	284	222
Italy	238	241
Netherlands	223	259
Singapore	219	426
Slovenia	188	223
South Korea	184	158
Switzerland	357	362
Wales	209	192

Data for Figure 42 Australian population by state and territory, 2006-07 to 2016-17

Thousands ('000)

Juris.	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CAGR
ACT	338	344	351	358	365	372	380	387	393	400	406	1.8%
NSW	6,786	6,884	7,002	7,102	7,180	7,262	7,358	7,462	7,573	7,681	7,798	1.4%
NT	211	217	223	228	230	233	239	243	243	244	245	1.5%
Qld	4,056	4,160	4,276	4,367	4,437	4,519	4,611	4,689	4,753	4,813	4,884	1.9%
SA	1,561	1,578	1,598	1,619	1,632	1,647	1,663	1,678	1,694	1,707	1,717	1.0%
Tas	492	496	502	506	510	512	512	513	514	516	519	0.5%
Vic	5,104	5,200	5,313	5,419	5,496	5,593	5,712	5,838	5,966	6,098	6,244	2.0%
WA	2,077	2,135	2,209	2,264	2,319	2,386	2,463	2,508	2,533	2,551	2,568	2.1%

Data for Figure 43 Australian economic activity by state and territory (GSP), 2006-07 to 2016-17

Millions of dollars

Juris.	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CAGR
ACT	27	29	30	30	31	33	33	34	35	36	38	3.2%
NSW	439	451	456	465	477	489	498	508	522	542	558	2.4%
NT	18	18	20	19	20	21	23	24	24	24	25	3.4%
Qld	243	255	258	262	264	278	286	292	296	303	309	2.4%
SA	86	90	93	94	95	96	97	98	99	100	102	1.7%
Tas	25	26	26	26	27	27	27	28	28	28	29	1.5%
Vic	314	325	330	336	345	352	355	363	373	386	399	2.4%
WA	158	166	172	180	188	206	218	231	237	240	233	3.9%

Data for Figure 44 Greenhouse gas emissions from landfills, 1989-90 to 2015-16

Year	Emissions (kt CO2-e)
1990	15,240
1991	15,220
1992	15,063
1993	15,018
1994	14,432
1995	14,550
1996	13,130
1997	13,011
1998	12,317
1999	12,437
2000	12,238
2001	12,281
2002	12,453
2003	11,502
2004	11,062
2005	10,900
2006	10,623
2007	10,902
2008	11,307
2009	11,229
2010	11,502
2011	11,064
2012	9,775
2013	9,001
2014	9,012
2015	8,510
2016	8,694

Appendix B Principles for waste data and reporting

Principles for waste data and reporting

A major challenge in national waste reporting is reconciling data from jurisdictions and industries that has been compiled using different concepts, definitions and methods. These differences can also be problematic for regulators and waste companies dealing with cross-border issues.

The benefits of national uniformity in this area are widely recognised, but change can be expensive – the concepts, definitions and methods used by a state or territory may be embedded in licences or regulations, as well as long-standing protocols and trend reporting. Harmonisation therefore requires time and a willingness to incur short-term costs for long-term national benefit.

The Department of the Environment and Energy has expressed a readiness to progress harmonisation by helping to establish national standards for waste data and reporting. In the area of hazardous waste, it developed and maintains the *Australian hazardous waste data and reporting standard*[35] as a reference for states and territories undertaking regulatory and other reviews.

For broader waste reporting, there has been significant investment in producing a standardised national tool and dataset with standard reporting parameters. But there is no clear national standard, in a single document, for states and territories to apply in their waste and recycling data requirements, collection, collation and reporting.

This Appendix is intended to provide a set of possible principles as a starting point for discussions over a future national standard for data and reporting in relation to non-hazardous waste. The proposed principles build upon:

- the National Waste Classification System, which was developed in the 1990s but not widely implemented
- the Hyder Consulting (2011a) 'method report' and its subsequent refinements in national waste reporting
- the Australian hazardous waste data and reporting standard
- a decade of practice in liaising with jurisdictions and industry and merging their data to a common platform.

The content covers:

- definitions of key terms
- a proposed core data set for waste reporting
- proposed methods for classifying waste by source stream
- proposals for waste measurement, indicators and reporting.

It is not suggested that the content included here encompasses the full scope of what the envisaged standard should contain. For example, a broader set of definitions would be needed.

[35] See https://www.environment.gov.au/system/files/resources/8b5088bd-fd7b-493f-bdc1-f1512cbc2bc4/files/aus-hazwaste-data-reporting-standard-2017-revision.pdf

Definitions

The table below defines some key terms required for consistent national waste reporting. Terms are grouped by subject matter (via shaded rows).

Term	Definition
Waste	Materials or products that are unwanted or have been discarded, rejected or abandoned. Includes materials or products that are recycled, converted to energy, or disposed. Materials and products that are reused (for their original or another purpose without reprocessing) are not waste because they remain in use.
Solid waste	Waste that: 1. can have an angle of repose of greater than 5 degrees above horizontal, or 2. does not become free-flowing at or below 60 degrees Celsius or when it is transported, or 3. is generally capable of being picked up by a spade or shovel.
Municipal solid waste (MSW)	Waste produced by households and council facilities.
Commercial and industrial (C&I) waste	Waste that is produced by institutions and businesses, including offices, schools, restaurants, retail and wholesale businesses, and industries such as manufacturing.
Construction and demolition (C&D) waste	Waste produced by demolition and building activities, including road and rail construction and maintenance and excavation of land associated with construction activities.
Source stream	Either MSW, C&I or C&D.
Waste management	The activities through which a waste is dealt with, in infrastructure approved to receive it.
Energy recovery facility	A facility that captures, on average, more than 20% of the embodied energy in the waste it receives for beneficial use.
Storage	Accumulation of wastes in approved infrastructure such that materials are readily retrievable.
Short-term storage	Storage where there is a plan or a reasonable expectation that wastes will be stored for less than 10 years.
Long-term storage	Storage where there is a plan and a reasonable expectation that wastes will be stored for more than 10 years.
Fate	The ultimate destination of waste within the management system. The fates of waste are recycling, energy recovery, disposal and long-term storage.
Recycling	A waste fate 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. For data reporting purposes, recycling: • excludes materials in stockpiles of unprocessed waste materials • includes all materials processed for recycling, whether they are quickly sold or used, or stockpiled for later sale or use • excludes residuals that are sent to landfill or otherwise disposed of.
Disposal	A waste fate in which no material or resource recovery use is made of the waste. Includes disposal to landfill and to incineration without energy recovery.
Energy recovery	A waste fate in which a substantial portion of the embodied energy in a waste is recovered.

Term	Definition
Resource recovery	Making use of a waste material. For data reporting purposes, the quantity of waste to resource recovery is the sum of the quantities to recycling and energy recovery.
Reuse	Reallocation of products or materials to a new owner or purpose without reprocessing or remanufacture, but potentially with some repair (e.g. repair of pallets for resale).
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 tip shop).
Treatment	The removal, reduction or immobilisation of hazardous characteristics to enable the waste to be sent to its final fate or further treatment.
Waste generation	The process of producing waste. For data reporting purposes, waste generation is the sum of the quantities of wastes taken to waste management facilities or added to on-site stockpiles.
Waste diversion	The redirection of waste from a disposal facility to a recycling or energy recovery facility.
Waste management industry	Businesses that undertake collection, storage and/or management of wastes, excluding the wastewater treatment industry.
Primary production	The conversion of natural resources into primary products, usually for use as raw materials by other industries.
Mixed material waste	Waste comprised of more than one category of waste material.

The core data set for waste reporting

1. Waste reporting should include a core data set that is tracked over time and from which the primary indicators of waste performance are derived. The core waste data set should be defined with reference to types of source stream, management and waste category and type.
2. The core waste source streams are MSW, C&I and C&D waste.
3. A core set of waste categories and types is proposed, comprising solid and liquid hazardous waste that is managed by the waste management industry, as listed in Table 14.
4. The core waste data set excludes
   - uncontaminated soil ('clean fill') and rock.
   - waste generated by the main processes of primary production (e.g. bark and sawdust from forestry operation, agricultural manures, mining and mineral processing wastes) except when they are managed by the waste industry[36]
   - pre-consumer waste that is recycled on-site as part of a manufacturing process
   - waste used for producing energy where the energy production process is on the site where most of the waste was generated.
5. Where available and of interest, data on other waste may be sought and reported where known, but outside the core data set. Non-core data may include ash, mining and mineral processing waste, and food waste using a broader definition than in the core data set.
6. In support of jurisdictional waste reporting, the core waste categories and types should inform requirements for waste facility data recording and reporting, and waste audits.

[36] Waste ancillary to primary production, such as mining staff waste or discarded tyres, should be included.

Table 14 A proposed core set of waste categories and types

	Waste category	Waste type
Materials	Masonry materials	Asphalt
		Bricks
		Concrete
		Rubble (incl. non-haz. foundry sands)
		Plasterboard & cement sheeting
	Metals	Steel
		Aluminium
		Non-ferrous metals (ex. aluminium)
	Organics	Food organics
		Garden organics
		Timber
		Other organics
		Biosolids (non-contaminated)
	Paper & cardboard	Cardboard
		Liquid paperboard
		Newsprint & magazines
		Office paper
	Plastics	Polyethylene terephthalate (PET)
		High density polyethylene (HDPE)
		Polyvinyl chloride (PVC)
		Low density polyethylene (LDPE)
		Polypropylene (PP)
		Polystyrene (PS)
		Other plastics
	Glass	Glass
	Textiles, leather and rubber (excl. tyres)	Textiles
		Leather & rubber (excl. tyres)
	Mixed material waste	E-waste
		Residuals from metals recycling facilities (shredder floc)
		Residuals from materials recovery facilities
		Residuals from mechanical biological treatment facilities
		Residuals from pulp mills
		Disaster waste
		Quarantine waste
	Hazardous waste	Waste listed in Schedule A of the *National Environment Protection (Movement of Controlled Waste Between States and Territories) Measure*, including liquid hazardous wastes, reported in accordance with the *Australian hazardous waste data and reporting standard*
	Other	Other unclassified materials

7. The average composition of mixed material waste should be estimated and published. This would enable conversion of the associated tonnes to material categories and types (i.e. the first seven categories in the list), allowing material-specific recovery rates to be estimated.

8. The core waste management methods are:
   - recycling
   - energy recovery
   - landfills
   - other disposal
   - treatment

- short-term storage
- long-term storage.

9. The fates of waste include:
   - Resource recovery, including recycling and energy recovery
   - Disposal, including landfill, thermal destruction, discharge to water body
   - Long-term storage, including long-term on-site storage (regulator approved) and long-term isolation.

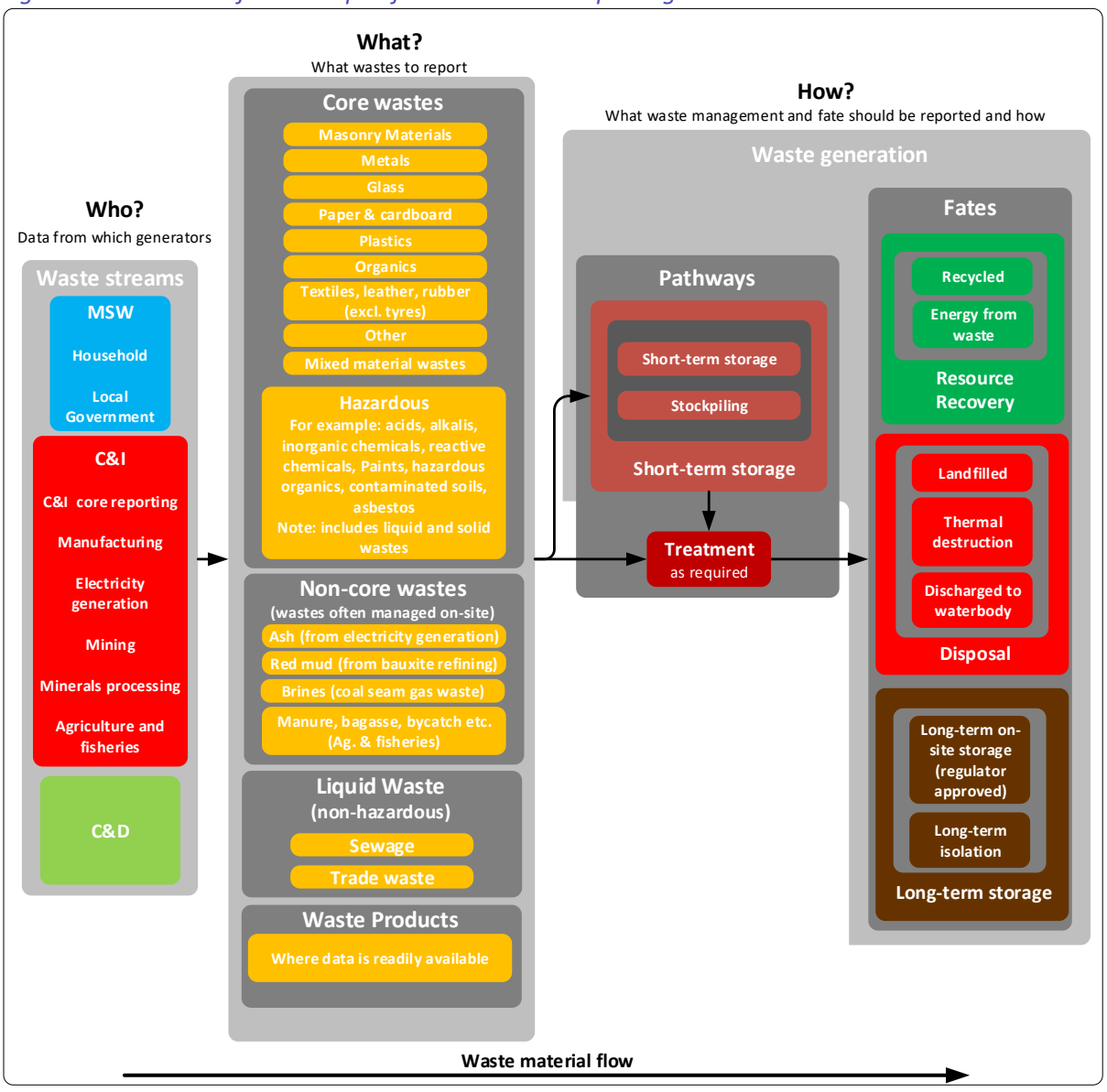
   Note: waste management method and waste fate may differ. For example: waste managed via recycling may include contaminants that are subsequently disposed of; short-term storage is a management type but not a fate; the fates of waste sent to treatment facilities are not presently known.

   Waste reuse may also be reported where the data is readily available, e.g. from tip shops.

   Materials and products that are reused (for their original or another purpose without reprocessing) are not waste because they remain in use. This definition of waste sets the broad scope of current national reporting.

Figure 45 provides an overview of the potential scope of future national waste reports.

Figure 45 Potential future scope of national waste reporting



Classifying waste by source stream

10. Subject to the subsequent points in this section, waste loads should be classified by stream as follows:
    - containing primarily MSW – classify as MSW
    - containing primarily masonry materials – classify as C&D waste
    - containing primarily C&I – classify as C&I waste.
11. Some waste collection processes that focus on MSW also collect some C&I waste (e.g. small businesses serviced by council collections). Similarly some waste collection processes that focus on C&I waste also collect some MSW (e.g. mixed-use high-rise buildings serviced by commercial collections). Based on the method above, these are to be recorded as wholly arising from the main stream. However, if the overall proportion of MSW included in the C&I stream or the overall proportion of C&I included in the MSW stream is estimated to exceed 5%, steps should be taken to quantify the amount and to adjust the overall data accordingly.
12. CDL returns should be classified as MSW except when there is strong evidence they are derived from commercial activity.
13. Residuals from waste processing operations and transfer stations should be classified according to the source stream from which most of its waste originates. For material recovery facilities, transfer stations and alternative waste treatment facilities, residuals would mostly be classified as MSW.
14. Waste loads in skip bins should be classified by stream as follows:
    - self-haul by a resident – classify as MSW
    - containing primarily masonry materials – classify as C&D waste
    - all others – classify as C&I waste.
15. Waste generated as a result of natural disasters should be classified as C&D waste.

Waste measurement, indicators and reporting

16. Core waste data should be measured or estimated over the whole jurisdiction.
17. The aim should be to count waste once only in the jurisdiction it was generated. Efforts should be made to avoid double-counting.
18. The primary measure for waste reporting is ‘wet weight’ tonnage.
19. A nationally agreed list of waste densities should be developed and used for converting volume measures to weight. (Hazardous waste densities are already published in the *Australian hazardous waste data and reporting standard*.)
20. Data should be collected from:
    - all major waste management facilities
    - major waste generators that manage waste via on-site storage
    - ad-hoc facilities (such as construction sites undertaking on-site processing for offsite use) where the waste quantities collectively managed are significant.
21. Data on the jurisdiction of origin should be collected. Where practicable, waste facilities should record the jurisdiction of origin of incoming loads.
22. Significant data gaps should be filled through research and best estimates based on transparent logic applied consistently over time. Methods for filling significant data gaps may be developed and documented in a future national standard to ensure jurisdictions use similar approaches.

23. Jurisdictions should require disposal facilities to record and report data on single material loads by type (currently undertaken successfully by NSW, which captures about 30% of its landfill data from single-load reports, providing the best data nationally on landfill composition).

24. In collecting data from the recycling industry, jurisdictions should collect data on:
    a) (primary focus) the quantity of material entering the recycling process, i.e. net of any contamination disposed of (this ensures all material is counted, and is counted once only)
    b) the quantity of material received at the facility, so that increments to any stockpiles of unprocessed material are measured
    c) the quantity of recyclables removed from the site, including from stockpiles
    d) the markets for recyclables based on a set of broad market categories defined to protect commercial confidentiality.

25. Audits commissioned with the intention of providing a representative compositional understanding of a waste stream and fate should apply waste categories that ensure the proportion of residual materials in the category 'other' (or similar) are less than 5% of the total.

26. Jurisdictional waste reporting should include, but not necessarily be limited to, the primary indicators of waste performance that are listed in Table 15.

Table 15 Primary indicators of jurisdictional waste performance

Indicator	Units	Definition
Waste generation per person in a given financial year	kg per capita	The quantity of core waste to core waste management types in the given year (excluding waste removed from short-term storage) divided by population. Absolute tonnages and population numbers used should also be specified.
Recycling rate in a given financial year	%	*Option 1*: The quantity of core waste to the fate 'recycling' in the given year divided by waste generated[1] in that year.[2] *Option 2*: The quantity of core waste to the fate 'recycling' in the given year that were generated[1] in that year, divided by waste generated[1] in that year.[2]
Recovery rate in a given financial year	%	As above, but including both 'recycling' and 'energy recovery' fates in the numerator.

1 Waste removed from short-term storage to other facilities would be excluded from this amount.

2 These two options differ in how they deal with waste sent to short-term storage in one year and recycled in a subsequent year (e.g. unprocessed C&D waste stockpiled by a recycler who goes bankrupt).

Under Option 1, this waste would be included in the denominator in the first year and the numerator in the subsequent year. This approach would depress the recycling and recovery rate calculations in the first year and boost them in the subsequent year. Theoretically the recycling and recovery rates in the subsequent year could exceed 100%.

Under Option 2, this waste would be included in the denominator in the first year but would not be included in the numerator in the subsequent year. Instead, a separate indicator, 'drawdown of waste stockpiles', could be reported to maintain a correct mass balance.

Selection of the best option needs to be discussed and agreed by the states and territories.

27. If recovery rates are to be calculated for a short-lived material type or product (e.g. packaging waste), the quantity of that material or product consumed can be used as the denominator instead of the quantity of the waste generated.

Appendix C Method changes since the National Waste Report 2016

Method changes since the National Waste Report 2016

Between the publication of the National Waste Report 2016 and this report, the Department of the Environment and Energy sponsored an improvements program to research, propose and decide upon changes to national waste reporting methods. This work culminated in a report titled '*Improving national waste data and reporting*', which is available on the Department's website. The main changes are summarised in Table 16.

Table 16 Summary of method changes since the National Waste Report 2016

Change	Explanation and comment
The scope is expanded to include: local government waste management; product and packaging waste; tip shop sales; litter and dumped waste; liquid waste; wastes from mining, mineral processing and agriculture; the Australian waste sector; waste fires; and disaster waste.	Intended to add depth. Requested by several stakeholders. The available data was limited in some cases e.g. tip shops.
Restructure of reporting framework to include separate sections on waste generation, recycling, energy recovery and disposal. (In the previous version these were reported together in sections on each jurisdiction.)	Follows overseas precedent and responded to stakeholder comment. Allows more nuanced discussion on these important concepts. Allows different wastes to be included depending on the level of information available.
Inclusion of more data on the fate of recyclables, including exports.	Responded to stakeholder comment and public interest associated with the 'recycling crisis'.
Additional contributions from the Australian Local Government Association, National Waste and Recycling Industry Council and the Boomerang Alliance.	Intended to add depth.
More detail on uncertainties.	Requested by various stakeholders.
Improved data collation and warehousing by transforming the eight years of national data to a flat database, to be publicly accessible via the Department website using Microsoft Power BI.	Requested by various stakeholders. Will allow users to generate their own charts and analyses.
Improved visualisations using Power BI functionality and 'Sankey' infographics.	Some stakeholders thought the NWR 2016 packed too much information into charts. Infographics were widely requested.

Appendix D A history of national waste reporting

A history of national waste reporting

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 correspond to that in 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 the differences between these reports meant that 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 work on developing 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 see how their data had been transformed. Subsequently, a procedural document describing the whole process and a revised method was developed (REC and BE 2015). This was agreed to by all the 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 to be consistent with the agreed approach, producing, in four separate tools, a historical record back to 2006-07. It was initially intended that the Department would develop a national waste data system for storing and querying the national data record over time, but this did not receive budgetary approval.

The *NWR 2016*, released last year, covered two data years (2013-14 and 2014-15) and presented trends back to 2006-07[37]. The national waste profiles for the six annual versions of the tool were compiled to show trends.

For this report, data was collected for 2015-16 and 2016-17, again using the Excel tool. Rather than producing a master Excel workbook for showing trends, the data for all eight years in the set was compiled into a single flat database for analysis and presentation using Microsoft PowerBI. It is understood the Department will publish the database online with automated access via PowerBI so that users can do their own analyses.

It is understood that the Department will continue to prepare the NWR every two years.

[37] Waste quantities for 2007-08, 2011-12 and 2012-13 were interpolated as data was not collected in those years.