SA organics sector analysis

Summary

This project was delivered by Rawtec in partnership with RMCG, BDO EconSearch, Lifecycles and Carbon Clarity.

Acknowledgement of country

We acknowledge and respect the Traditional Custodians whose ancestral lands we live and work upon and we pay our respects to their Elders past and present.

We acknowledge and respect their deep spiritual connection and the relationship that Aboriginal and Torres Strait Islanders have to Country. We also pay our respects to the cultural authority of Aboriginal and Torres Strait Islander people and their nations in South Australia, as well as those across Australia.

Contents

Acronyms & abbreviations

AD	anaerobic digestion
BSF	black soldier fly
CO_2e	carbon dioxide equivalent
C&I	commercial and industrial
e	equivalent
FTE	full-time equivalent
GISA	Green Industries SA
GSP	Gross State Product
ha	hectares
kL	kilolitres
ML	megalitres
RISE	regional industry structure and employment
RO	recycled organics
SA	South Australia
SOC	soil organic carbon
tpa	tonnes per annum
WWTP	wastewater treatment plant
yr	year

Preface

Green Industries SA has a strategic priority to recover and process food and organic waste.

This analysis of the organics sector, the first such study in South Australia, sought to measure the South Australian organics processing sector's current economic and environmental contribution and its capacity to support further transition to a circular economy and potential new opportunities.

A circular economy is one in which economic activity drives society-wide benefits, building economic, natural and social capital. It is an alternative to the current take-make-waste extractive industrial model and is based on three principles:

- Designing out waste and pollution
- Keeping products and materials in use
- Regenerating natural systems

The circular model makes a distinction between the technical (non-renewable) cycle and the biological cycle. In the biological cycle, food systems are designed such that organic carbon and nutrients are fed back into the environment, safely regenerating natural systems, like soil.

South Australia's organics reprocessing sector is highly circular. Of the estimated 1.35 million tonnes of discarded organics materials managed in South Australia annually, 83% is prevented from entering landfill and is transformed into valuable products.

The sector is a significant contributor to South Australia's economy, supporting local industries and jobs, and delivering additional economic benefits to its partners through the application of recycled organics which improves soil health and farm productivity. Recycling organics also contributes to reducing the State's environmental impact through lower greenhouse gas emissions and water savings.

South Australia's leading position in the recovery and processing of organics, including an advanced composting industry with demand for products, has been achieved through sustained focus to establish widespread source separation systems and provision of support for investment in processing infrastructure and developing markets for quality compost outputs, including new products such as specialised composts and fertilisers.

Green Industries SA (formerly Zero Waste SA) has supported an infant industry to become a demand driven and highly productive sector of the South Australian economy. Helped by direct and indirect support, the South Australian composting industry has established its products in the consumer market place.

An estimated

1,350,000 tonnes

of discarded organics are managed in SA each year

607,600 tpa

received by composting facilities that is turned into compost, mulch, and other products

The organics sector is highly circular with

83% of materials diverted from landfill

Collecting, transporting, processing, and managing organics provides

1,261 FTE jobs in SA

In SA, sector contributes

$189 millon

to gross state product (GSP), including **$90 million** to household income

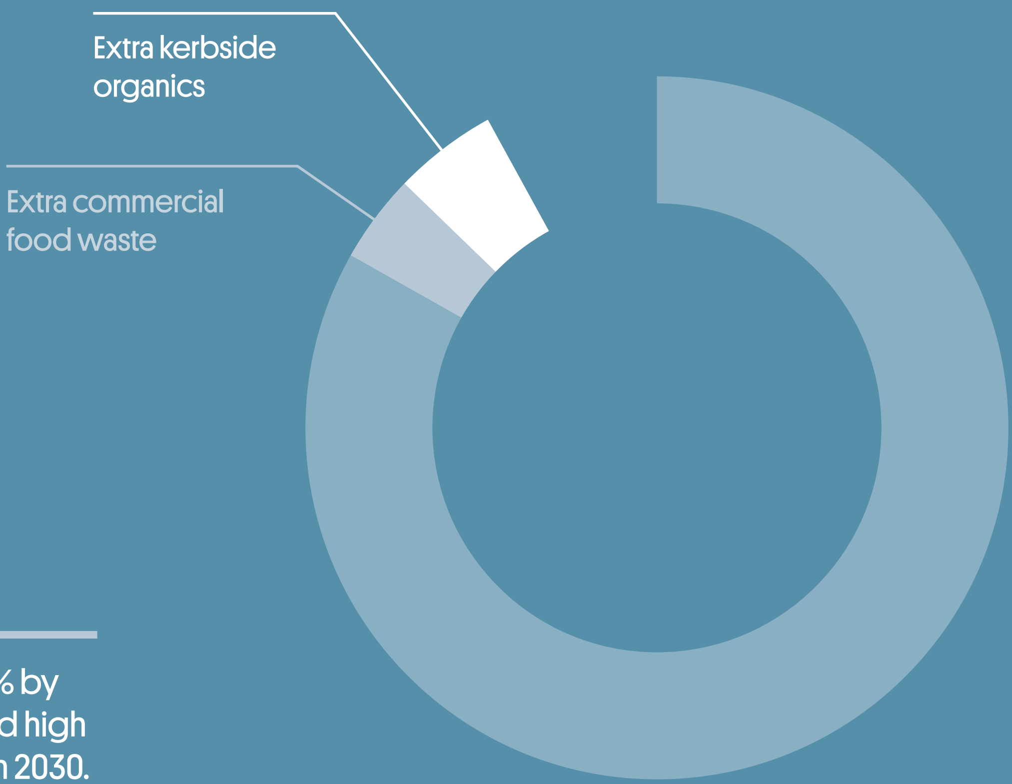
Using recycled organic products (Australian Standard mulch and compost) provides soil health benefits thus maintaining or improving productivity. The flow-on impacts of improved productivity contribute a further

$190 million

to GSP to SA's economy.

If SA increases kerbside organics (food and garden) diversion to 75% and increases commercial food waste diversion to 60% by 2030, circularity of the sector can rise from 83% to

92%



Organics diversion (% by weight) for combined high diversion scenarios in 2030.

1 Introduction

A circular economy is a self-sustaining system. It is fuelled by renewable energy and keeps material resources circulating for as long as possible at their highest value.

South Australia's organics sector recirculates organic materials through the economy. For example, Adelaide's householders can put their food and garden waste in their kerbside-collected green bins. Councils take the material from these bins to a commercial facility where it is turned into compost. The compost is then used by farmers to improve soil health, returning carbon and nutrients to the soil, supporting resource use efficiency in food production. See **Figure 1**.

Figure 1: Food waste disposed in green bins is recirculated through the SA economy

What is the organics sector?

The organics sector includes businesses and organisations that collect, and process discarded organics into valuable products. In South Australia, this includes local councils, waste collection/transport companies, meat renderers, compost and mulch producers, distillers, alternative fuel facilities, co-digestion facility operators. It also includes landfill operators that manage the unrecovered organics.

This study is the first in South Australia to measure the impact of the organics sector on soil health, climate change, water savings and the economy.

This study mapped the discarded organics through the economy (the **material flow analysis**) and quantified contributions of the organics sector regarding:

- **soil health** – which was measured by the level of soil organic carbon (SOC) associated with adding recycled organics products (like compost) to soils.
- **the environment** – including diversion of materials from landfill, greenhouse gas emission reductions and water savings.
- **South Australia's economy** – including the contribution of the organics sector to employment, gross state product and household income. We also estimated the economic benefits to agriculture, viticulture, and horticulture sectors from using compost and mulches.

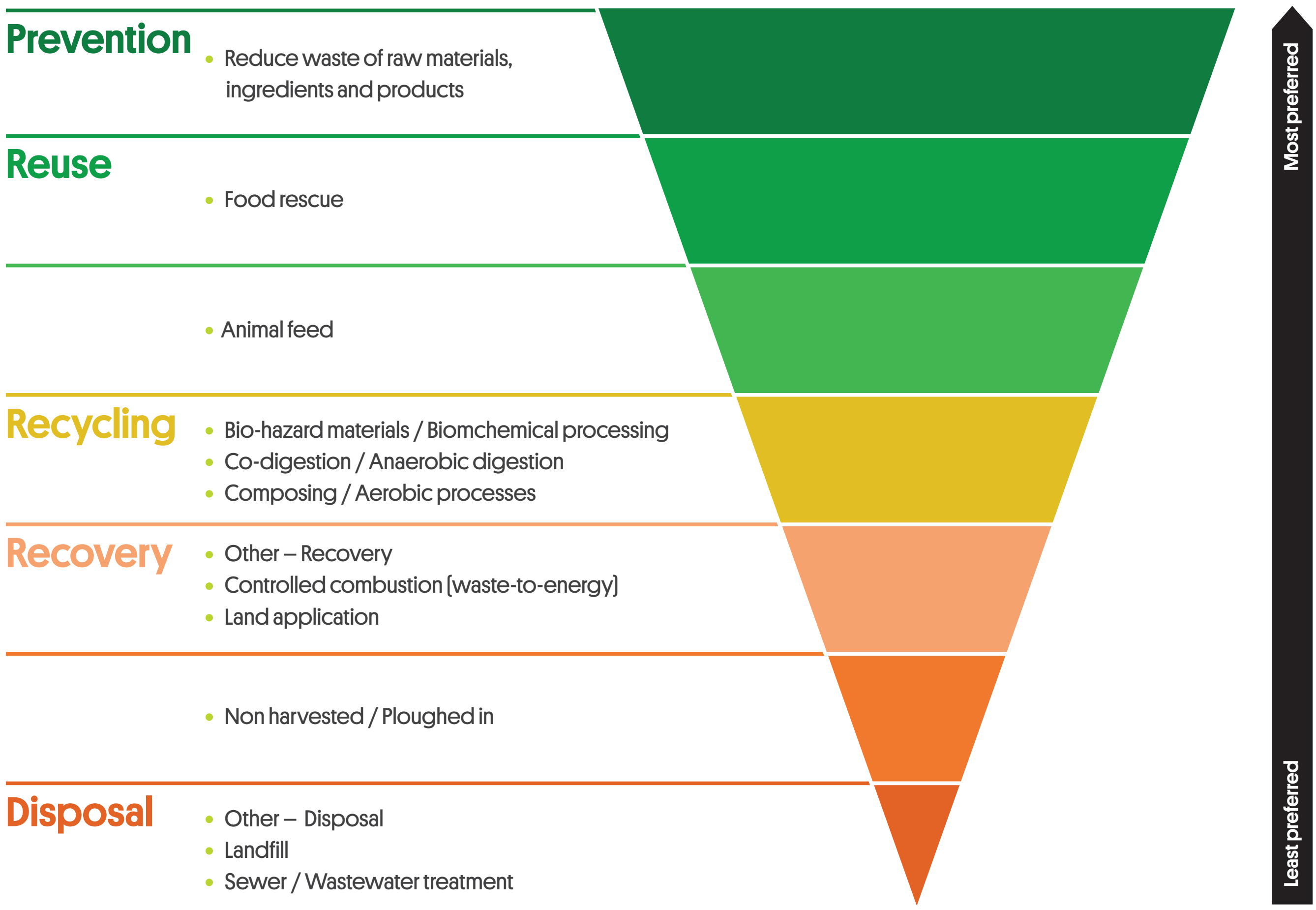
Using a holistic approach to modelling, the outputs from one discipline fed into another. For example, the soil health analysis identified improvements in crop performance from using compost on farms. This was fed into the economic analysis to identify improvements in farm resource use efficiency and productivity. The interactions between the models are illustrated in **Figure 3** overleaf. More information about our estimation method is provided in an accompanying technical report.

The findings from this study will be used to help shape future projects and strategies.

Reducing food waste

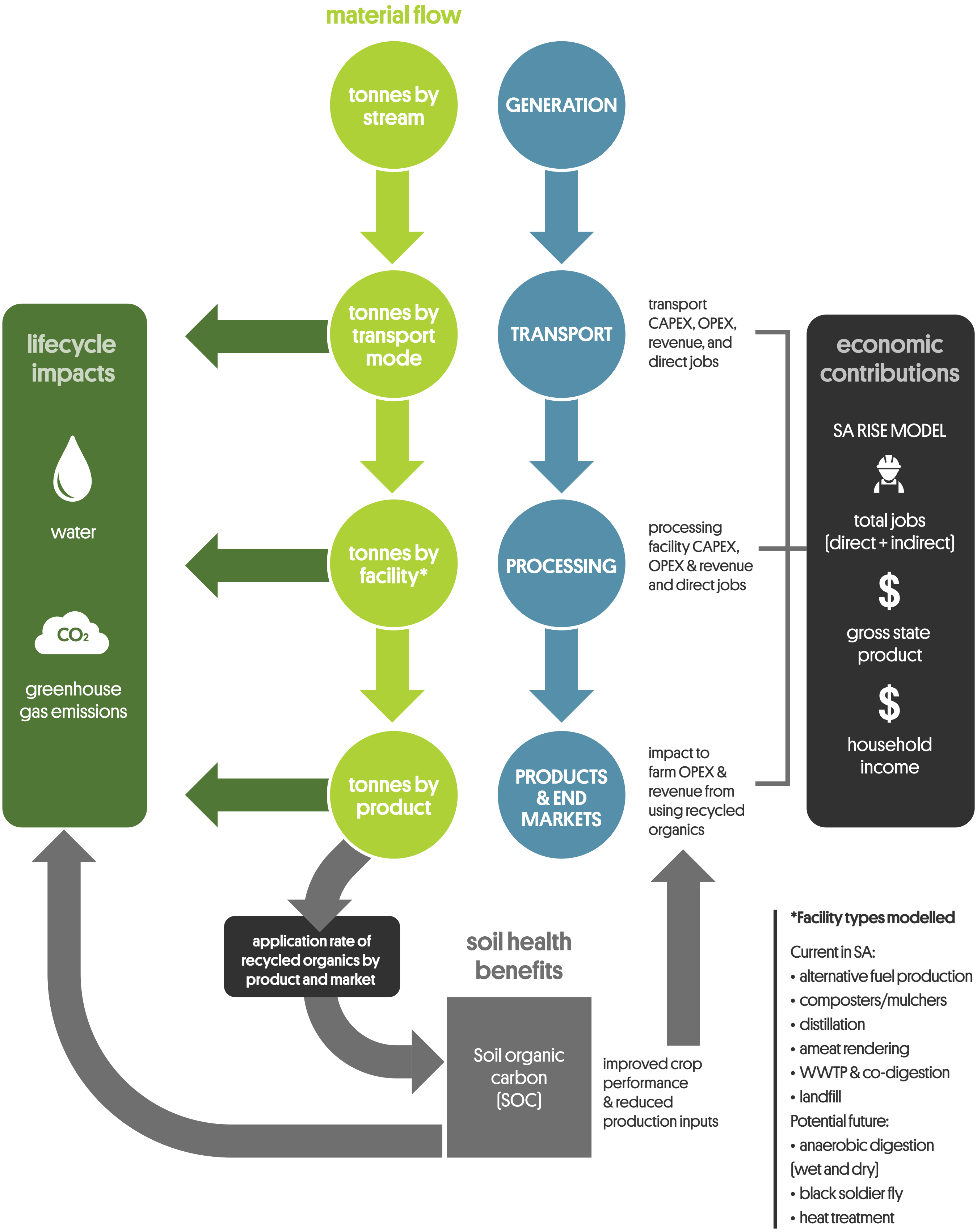
Although not the focus this project, reducing organic waste (rather than treating or disposing it) provides the greatest environmental benefits. Food waste alone consumes nearly a quarter of all the water used in agriculture, produces 8% of global greenhouse gas emissions and costs Australia $20 billion per year[1]. Preventing and reusing food waste higher up the waste hierarchy is a major strategy for moving to a more circular economy, alongside processing discarded materials through recycling. See **Figure 2**.

Figure 2: The food waste hierarchy indicating preferred outcomes (image credit: Arcadis)



1 Commonwealth of Australia. (2017). *National Food Waste Strategy: Halving Australia's food waste by 2030.*

Figure 3: Interactions between material flow, lifecycle, soil health and economic contribution models



2 What organics streams were included?

The study includes source-separated organics that are collected through formal solid or liquid waste collection pathways for processing, e.g. waste collection trucks or sewer infrastructure. This includes:

- agricultural residuals e.g. straw, manure, and other organics residuals from agriculture that are collected via formal pathways
- winemaking residuals e.g. wine lees, grape skins, and seeds
- meat processing waste, including meat waste from abattoirs and butchers
- high strength organics e.g. unsold/expired beverages
- timber e.g. offcuts from timber production, demolished timber structures
- grease and fat e.g. from restaurants
- commercial food waste e.g. food waste from restaurants, institutions and other commercial and industrial (C&I) sources not captured in the above categories
- kerbside organics (food and garden waste collected via municipal kerbside services)
- other garden organics e.g. from parks and garden maintenance
- biosolids
- miscellaneous organics (other tonnages of organics that have been reported as recovered but are not captured in the above categories)

Organics streams excluded from the modelling

The project did not include organics that are managed onsite e.g. crops ploughed into land, or via informal processes e.g. farmers collecting untreated organics for animal feed. These were beyond the project scope and resources.

Current contributions to the organics sector

3 Material flows

An estimated 1.35 million tonnes per annum (tpa) of discarded organics are managed in South Australia. The sector is highly circular with 83% of materials diverted from landfill.

Figure 4: Total organics diverted from landfill, % by weight.

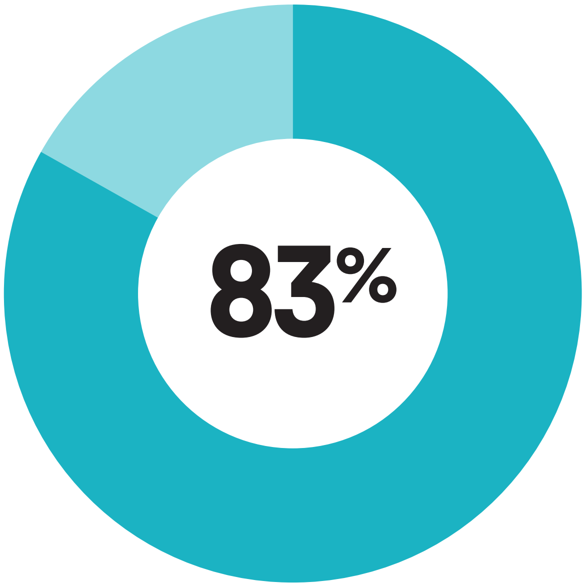


Table 1 shows a further breakdown of organics tonnages showing:

- **Kerbside organics (54% diversion):** this is organic material (including food and garden organics) collected by municipal kerbside services.
- **Commercial, industrial, and other sources (92% diversion):** includes all other organics that are collected through formal pathways as identified in Section 2. This includes food waste generated by commercial sources e.g. restaurants, grease and fat, industrial organics e.g. meat processing waste, agricultural residuals, biosolids, other garden organics, construction and demolition organics e.g. timber, and other organics.

Table 1: Materials generated, diverted, and recycled organics products

Total	Kerbside organics	Commercial, industrial, and other sources	Total
Total generated	0.30 MT	1.05 MT	1.35 MT
Diverted for recycling	0.16 MT	0.97 MT	1.13 MT
Landfilled	0.14 MT	0.09 MT	0.23 MT
% Landfill diversion	54%	92%	83%
Recycled organics products			0.72 MT *

Values in table may not sum due to rounding.
* Loss in mass due to microbial metabolism and moisture evaporation which is inherent to some processes.

4 Economic contributions

The organics sector is similar in size to South Australia's forestry, fishing, or aquaculture industries.

The organics sector creates value and jobs associated with collecting, transporting, processing, and managing organics. It contributes an estimated $189 million to GSP, including $90 million to household income. The sector provides 1,261 FTE jobs. Section 6 provides a further breakdown of these contributions by activity (collection and processing facility).

Using recycled organic products (mulch and compost) on farms provides soil health benefits, thus maintaining or improving productivity. The downstream impacts of improved productivity and/or reduced production inputs contributes a further $190 million to GSP (including $24 million to household income) and 233 FTE jobs.

Table 2: Contributions to economy, organics sector and downstream contributions from using recycled organics to improve farm productivity

	organics sector	downstream (farm productivity)	total
gross state product (GSP)	$189 million	$190 million	$379 million
household income (sub-set of total GSP)	$90 million	$24 million	$114 million
employment	1,261 FTE jobs	233 FTE jobs	1,494 FTE jobs

Figures in table may not sum due to rounding.

5 Environmental savings

Environmental savings have been calculated based on the net reduction in emissions from products created from the discarded organics after accounting for all the impacts from treating those wastes including disposal of unrecovered waste.

The organics sector activities save 2,300 ML of water per year, which is equivalent to the annual water consumption of over 18,000 households, and saves 239 kT per year of CO_2 e, which is equivalent to the annual electricity consumption of 90,000 households.

Table 3: Environmental savings

	annual savings	equivalent to
water savings	2,300 ML e	annual water consumption of over 18,000 households
greenhouse gas emission savings	239 kT CO_2 e	annual electricity consumption of 90,000 households

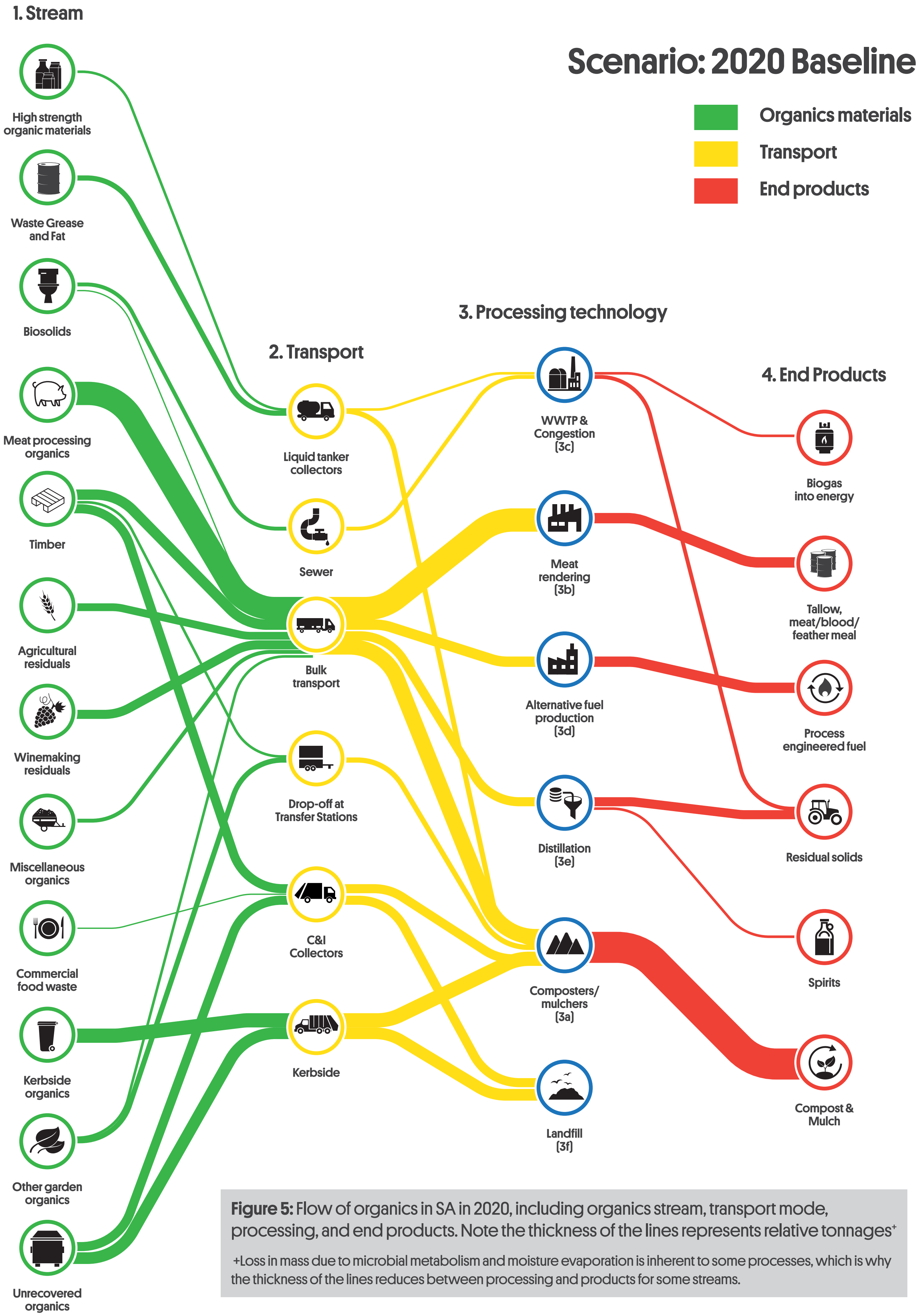


Figure 5: Flow of organics in SA in 2020, including organics stream, transport mode, processing, and end products. Note the thickness of the lines represents relative tonnages+

+Loss in mass due to microbial metabolism and moisture evaporation is inherent to some processes, which is why the thickness of the lines reduces between processing and end products for some streams.

6 Close-up by activity

This section provides a close-up of recycling, economic and environmental outcomes associated with managing organics for:

- **transport** (step 2 in **Figure 5** above, inclusive all transport types)
- **processing activity by technology** (associated with processing organics in step 3 and sale of resulting products in step 4)
    - » compost/mulchers (3a)
    - » meat rendering (3b)
    - » other processors (includes 3c, 3d and 3e)
    - » landfill (3f)

For each processing activity, we have estimated:

- incoming organics (tonnes per annum)
- recycled organics products as applicable (tonnes per annum)
- contributions to GSP and household income (total, and $ per tonne incoming)
- jobs (total FTE jobs, and FTE jobs per 10,000 tonnes incoming)
- climate impact (total CO_2 e tonnes, and kg CO_2 e per tonne incoming organics)
- water scarcity impact (total water savings ML/yr, and kL per tonne incoming)

Interpreting results

Economic contributions – all estimates

Gross state product (GSP), household income, and jobs were estimated using the Regional Industry Structure and Employment (RISE) model. The values presented in this report include both direct <u>and</u> indirect contributions (production-induced and consumption-induced).

Economic contributions – composters/mulchers

This study also quantified the productivity benefits of using recycled organics (compost and mulch) on farms. The benefits to agriculture (and related contributions to GSP, household income and jobs) are included in the estimates provided for composters/mulchers.

Environmental savings/impacts – all estimates

The environmental savings /impacts (greenhouse gas emissions and water) were estimated using lifecycle analysis. It is estimated from the point of collection through to production of end products and their use. It does not include impacts from initial generation of the waste.

Transport of organics

Organics are collected from a range of sources and transported to facilities for processing/disposal. Transporting organics contributes to GSP, household income and jobs. However, it has net greenhouse gas emissions and water loss.

Organics tonnages transported from source to processing or landfill facility:

1.35 million tonnes

This includes all discarded organics that are collected through formal pathways, including by liquid tankers, bulk transport, bulk transport, kerbside collection, and C&I collections (e.g. skip bins, front lift, rear lift, etc) and other modes.

GSP contribution of:

$38.9 million or $29 per tonne

The above includes contributions to household income of:

$24.4 million or $18 per tonne

Employment:

299 FTE jobs
or 2.2 FTE jobs per 10,000 tonnes

GHG emissions of:

2,900 tonnes CO2 e /yr
or 2kg per tonne

Water loss of:

16 ML e /yr or 0.01 kL water e per tonne

Processing activity by technology

Composters/ mulchers

South Australia has a well-established composting industry that receives materials from households and businesses. This material is transformed into compost, mulch, and other recycled organics products.

These activities contribute an estimated $223 million to GSP, including $33 million from processing the material into recycled organics products, and a further $190 million of downstream contributions from using recycled organics to improve farm productivity (see section 7).

Incoming organics:

607,600 tpa

Recycled organics products:

367,400 tpa including:

- Potting mixes (AS 3743) - 9,600 tpa
- Soils for landscaping/ garden use (AS 4419) – 37,900 tpa
- Composts, Soil conditioners and mulches (AS 4454) – 118,900 tpa
- Organic product standard - 100,900 tpa
- Other product standard - 15,400 tpa
- Other products (not certified to a standard) – 84,600 tpa.

GSP contribution of:

$223 million or $367 per tonne

The above includes contributions to household income of:

$43 million or $71 per tonne

Employment:

586 FTE jobs
or 9.6 FTE jobs per 10,000 tonnes

GHG emission savings of:

43,700 tonnes CO_2 e /yr
or 69 kg per tonne

Water savings of:

1,500 ML e /yr or 2.4 kL per tonne

Meat rendering

Meat rendering facilities receive meat processing waste and turn it into tallow, ovine meat meal and blood meal.

Incoming organics: **244,000 tpa** Recycled organics products: **97,600 tpa** including: • Tallow – 53,700 tpa • Ovine meat meal – 39,000 tpa • Blood meal – 4,900 tpa	GSP contribution of: **$62.4 million** or $256/tonne The above includes contributions to household income of: **$18.4 million** or $75 per tonne
	Employment: **239 FTE jobs** or 9.8 FTE jobs per 10,000 tonnes
	GHG emission savings of: **136,500 tonnes CO_2e /yr** or 558 kg per tonne
	Water savings of: **531 ML e /yr** or 2.2 kL water e per tonne

Landfill

The remaining 228,400 tpa (or 17% of organics) is unrecovered and sent to landfill.

Incoming organics: **228,400 tpa of uncovered organics**	GSP contribution of: **$7.5 million** or $33 per tonne The above includes contributions to household income of: **$4.0 million** or $17 per tonne
	Employment: **82 FTE jobs** or 3.6 FTE jobs per 10,000 tonnes
	GHG emissions of: **116,500 tonnes CO_2e /yr** or 507 kg/ tonne
	Water loss of: **13 ML e /yr** or 0.06 kL water e per tonne

Other organics recycling facilities

Another 274,100 tpa, which is processed by a range of organics recycling facilities. This includes:

- A distillation plant that is turned into grape sprit, tartaric acid, and residual solids.
- an alternative fuel facility for timber into process-engineered-fuel (PEF) to displace natural gas in cement production.
- wastewater treatment plants (WWTP) and co-digestion facilities and turned into biogas and biosolids.

Incoming organics:

274,100 tpa

Recycled organics products:

259,600 tpa including:

- Biosolids - 46,000 tpa
- A range of other products across the technologies – 213,600 tpa, which includes process engineered fuel, grape spirit, tartaric acid, biogas, and residual solids.

GSP contribution of:

$46.9 million or average of $171 per tonne

The above includes contributions to household income of:

$23.8 million or $87 per tonne

Employment:

284 FTE jobs

Or 10.4 FTE jobs per 10,000 tonnes

GHG emission savings of:

179,400 tonnes CO_2 e /yr

or 655 kg/ tonne

Water savings of:

288 ML e /yr or 1.1 kL water e per tonne

7 Soil health and farm productivity benefits

Recycled organics are used to improve an estimated 21,500 hectares of agricultural land. This supports farming productivity, contributing an estimated $190 million to GSP.

Table 4: Soil health benefits

Soil health benefits	recycled organics applied to agriculture	**123,400 dry tpa**
	soil organic carbon (dry tonnes)	**34,700 tpa**
	agricultural land improved	**21,500 ha**
	GSP from improved farm productivity	**$190 million**

Recycled products

A range of recycled organics can be applied to soils. Our analysis of soil health benefits is limited to composts and mulches (produced to Australian Standard AS4454-2012[2] and NASAA organic standard) that are applied to agricultural land.

Soil health improvements

Applying recycled organics to soil is important in SA because soils are inherently low in carbon and carbon is lost due to tillage and fallow phases. Soils with low carbon can limit productivity, require relatively high inputs of water and nutrients, and increase production risks, especially due to pests and diseases but also due to salinity or erosion, both occurring throughout the state.

We used soil organic carbon (SOC) as a quantifiable measure of soil health. SOC has a positive relationship to other soil health metrics, such as water holding capacity, cation exchange, bulk density, earthworm counts and microbiological activity. SOC is also used to measure carbon sequestration.

We estimate that 34,700 dry tonnes of organic carbon are added to SA soils each year by using compost and mulch. This improves an estimated 21,500 hectares (ha) of agricultural land.

2 Australian Composts, Soil Conditioners and Mulches Standard (AS4454 - 2012)

Reduced farming inputs

The flow-on effect from the soil improvements can, to varying degrees, result in a reduced need for other inputs, such as:

- **irrigation water:** increased SOC in form of compost increases the water holding capacity of soils which reduces the need for irrigation water inputs.
- **fertilisers:** pure compost that has no manure feedstock provides too little nutrients to warrant a reduction of applied fertilisers in the short-term. However, if compost is applied continually it is very likely to provide nutrient (N:P:K:S:Mg:Ca and trace elements) both, by addition to the soil and by facilitation of improved nutrient holding capacity and cycling through soil organisms.

Using recycled organics on farms contributes an estimated $190 million to GSP.

Productivity benefits

The impacts of improved soil health on productivity are complex and variable for crop and soils types. Rather than considering yield increases, qualitative product improvements and operation efficiencies can increase overall productivity. Yield increases from the use of composts and mulches are often reported when soil amendments are used on degraded soils. This means productivity has been restored rather than increased.

Restoring or maintaining productivity, i.e. a reduction in inputs and risks and an improvement in quality/ marketable yield, are the main drivers for compost use in agriculture and horticulture.

Table 5: Productivity benefits

Potential reduction of inputs	Potential productivity benefits
• irrigation water • fertilisers • agrichemicals • reduced labour costs (soil and crop management, harvest, packing) • energy / fuel use for soil management and irrigation (pumping costs)	• more uniform crop growth • increased marketable (saleable) yield and or quality (brix, flavour, shelf life) • maintaining productivity in intensive production systems (short rotations) • increased pasture production (dry matter) and or feed quality • reduced product loss (in field, packing operations and supply chains) • reduced production and supply chain market risks (risk of losses & waste) • productivity related reduction of farmed land (ha) • vineyard or orchard longevity improved • better overall resource use efficiency and reduction of land-based emissions • reduced wear and tear on machinery used for inputs and tillage

South Australia's opportunity

8 South Australia's opportunity

An estimated 228,000 tonnes of discarded organics are landfilled in South Australia each year. There is an opportunity to divert this material to composting facilities. Doing so would contribute an extra 6.1 FTE jobs for every 10,000 tonnes diverted. Further, every tonne diverted would add $334 to GSP (including $54 per tonne to household income), save 641 kg of CO2 e emissions, and 2.5 cubic meters of water.

Table 6: Economic contributions and environmental impacts/savings of landfill versus composting

Total	Unit	Landfill	Composters/ mulchers	Change
ECONOMIC CONTRIBUTIONS				
gross state product (GSP)	$/tonne	$33	$367[3]	$334
household income (included in GSP)	$/tonne	$17	$71	$54
employment	FTE jobs per 10,000 tonnes	3.6	9.6	6.1
ENVIRONMENTAL SAVINGS (-) / IMPACTS (+)				
greenhouse gas emissions	kg CO_2 e per tonne	572*	-69	-641
water	kL e per tonne	0.06	-2.46	-2.52

* greenhouse gas emissions estimates presented in this table are based on food waste in landfill. These are different to the estimated greenhouse gas emissions per tonne associated with total organics in landfill (presented in section 6, page 14) since the latter includes not only food waste but other organics streams, such as garden waste. See technical report for methane capture assumptions. Values in table may not sum to totals due to rounding.

3 This GSP includes $54 per tonne from the organics sector and an estimated $312 associated with improved productivity from using recycled organics on farms, minus $33 from reduced landfill activity.

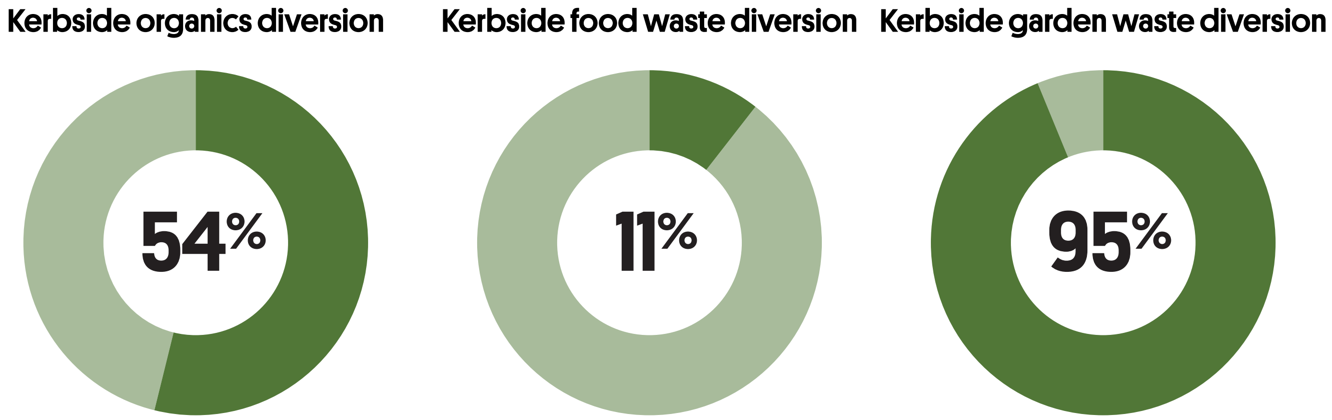
9 Target sectors

Landfilled organics largely comes from household (kerbside general waste) and business collections. Segregated organics collection systems provide an opportunity for this material to be recovered.

Kerbside organics

Overall kerbside organics (including food and garden) diversion is at 54%. Most kerbside garden waste is diverted (estimated at 95%), whereas only 11% of kerbside food waste is diverted from landfill. Therefore, the opportunity to increase kerbside diversion is mostly focused on food waste.

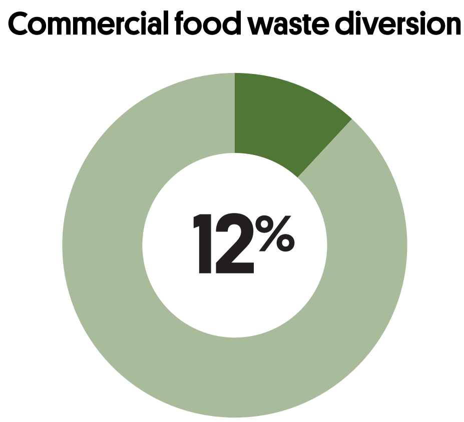
Figure 6: Kerbside organics diversion -overall, food waste, and garden waste



Commercial food waste

South Australia diverts 92% of commercial, industrial, and other sources (see **Table 1** in Section 3). However, when considering only commercial food waste, the proportion currently diverted (which is a component of these volumes) is estimated at only 12%.

Figure 7: Commercial food waste diversion



The diversion rates of food waste from households and businesses presents the major opportunity to increase the percentage of organics circulating in South Australia.

10 Increasing diversion of organics to composting

Two scenarios were considered and modelled to estimate the impacts of:

- Increased diversion of kerbside organics to 75%4 (up from 54%); and
- Increased diversion of commercial food waste to 60% (up from 12%).

As a combined impact, it is estimated this would lead to:

- An increase in overall organics diversion to 91% (up from 83%).
- An additional 112,000 tpa of organics diverted from landfill.
- An additional 67,700 tpa of recycled organics products.
- Increased economic activity, including an additional $37 million in GSP (including $6 million in household income) and 68 jobs.
- Environmental savings of 64 kilotonnes of CO_2 e/yr and 283 ML-e/yr of water.
- Increase in total organic carbon applied to soils of 6,400 tpa and an additional 4,000 ha of improved agricultural land

Table 7: Outcomes from increasing diversion of kerbside organics and commercial food waste to composting

Materials	diversion %age	Kerbside organics	75% (up from 54%)
		Commercial food waste	60% (up from 12%)
		Total organics	91% (up from 83%)
	Total tonnages diverted for recycling		Additional 112,000 tpa
	Total tonnages of recycled organics products		Additional 67,700 tpa
Economic contributions	gross state product		Additional $37 million
	employment		Additional 68 jobs
	household income		Additional $6 million
Environmental savings & soil health benefits	greenhouse gas emission savings		Additional 64 kilotonnes CO_2 e /yr savings
	water savings		Additional 283 ML e /yr savings
	total organic carbon applied to soils		Additional 6,400 t /yr of applied organic carbon
	total improved agricultural land		Additional 4,000 ha of improved land

4 Most of this increase in diversion is from increasing diversion of kerbside food waste, with diversion of kerbside garden waste staying about the same.

11 Future innovations and technologies

Potential technology options for future processing of organics were explored and modelled, including anaerobic digestion (wet and dry), heat treatment and black soldier fly.

This section provides a description of potential future technologies that were modelled in this study. It includes high-level estimates of potential recycled products, economic contributions, and environmental savings for nominated facility sizes. The commercial viability of these technologies in South Australia were not assessed, which is outside the scope and resources of this study.

How were technologies for future scenarios selected?

There are a range of organics processing technologies. The high diversion scenarios for 2030 included technologies that are not currently operating at a commercial scale in SA, however, are proven technologies elsewhere. This included:

Commercial food waste
60% diversion in 2030 scenario

- A 50,000 tpa wet AD facility
- A 22,000 tpa heat treatment into animal feed
- An 1,800 tpa modular black soldier fly unit

Kerbside organics
75% diversion in 2030 scenario

- A 50,000 tpa dry AD facility (with balance of organics going to commercial composting facilities)

These technologies were chosen to suit the feedstock. For example, a dry AD plant can process kerbside organics, which includes both garden and food waste. The size of the facilities (tonnes per annum) was chosen considering facility sizes that are common. Different facility sizes have also been set up successfully elsewhere.

This is just one possible mix of technologies, which was chosen for the project. Other mixes are possible in the future. However, further possible combinations were not modelled due to project scope and resource limitations.

Pyrolysis

Pyrolysis was not modelled in this study since the technology is not suited to the target feedstocks considered (kerbside organics and commercial food waste). However, this technology may play a role in future processing of other organics streams, such as timber. The impacts of pyrolysis on environmental outcomes, economic impacts, and soil health benefits of biochar (product of pyrolysis) may be explored in a future study.

Economic contributions of technologies

The economic contributions of a given technology can vary from one facility to the next. For example, the estimates for black soldier fly were based on a high-technology solution with very little labour input. Other black soldier fly facilities exist that are lower technology but more labour intensive (and hence would provide higher employment and household income). Therefore, the estimates provided are indicative only.

Anaerobic digestion (AD)

Anaerobic digestion is the controlled decomposition of biodegradable organic materials under managed conditions in the absence of molecular oxygen to produce biogas (methane and carbon dioxide) and digestate. It is carried out by naturally occurring bacteria at either mesophilic (30 °C to 45 °C) or thermophilic (45 °C to 80 °C) temperatures. There are two main types of AD: dry and wet. AD is an established technology which is widely used around the globe.

Dry AD

Dry anaerobic digesters operate at relatively high total solids (>15%) compared to wet systems. Feedstocks are handled as solids and are usually stacked inside the digester, with leachate percolated throughout its mass.

Dry AD is better suited to high solid wastes, such as some agricultural waste, although the process generally takes longer than wet systems.

Incoming organics:

50,000 tpa

Recycled organics products:

- 5,600 tpa of biogas
- 39,400 tpa of digestate/residuals suitable for secondary processing by a composter

GSP contribution of:

$6.8 million or average of $137 per tonne

The above includes contributions to household income of:

$3.7 million or $74 per tonne

Employment:

49 FTE jobs
or 9.9 FTE jobs per 10,000 tonnes

GHG emission savings of:

24,500 tonnes CO_2 e /yr
or 489 kg/ tonne

Water savings of:

75 ML e / yr or 1.5 kL per tonne

Wet AD

Wet anaerobic digesters operate at much lower total solids (<5-15%) than dry systems. The feedstocks are handled as a pumpable slurry, so they are suitable for high moisture materials, such as food waste. They generally yield greater volumes of biogas and operate over shorter timescales than dry systems.

Incoming organics:

50,000 tpa

Recycled organics products*:

- 7,700 tpa of biogas
- 36,900 tpa of digestate/residuals for secondary processing by a composer

GSP contribution of:

$7.9 million or average of $159 per tonne

The above includes contributions to household income of:

$4.2 million or $85 per tonne

Employment:

54 FTE jobs
or 10.8 FTE jobs per 10,000 tonnes

GHG emission savings of:

24,300 tonnes CO_2 e /yr
or 489 kg/ tonne

Water savings of:

74 ML e /yr or 1.5 kL per tonne

Heat treatment

This technology involves heat-treating surplus food at a specialist facility, making it safe to feed to pigs and other non-ruminant omnivores. This technology is common in Japan, South Korea, and a few other countries in Asia. Surplus food can be collected from retailers, manufacturers, restaurants, and households, so long as it is source separated with low contamination.

The animal feed produced can be in a liquid or pelletised form. Making liquid food is cheaper. A fermentation step can be added to reduce acidity and inactivate disease pathogens of concern (like Foot and Mouth disease – see box). This 'pig yoghurt' can reduce the need for antibiotics. Liquid feed is more costly to transport than pelletised feed and needs to be consumed within two weeks. Pelletised animal feed is more costly to make, but it is cheaper to transport and has a longer shelf life.

Producing animal feed from surplus food displaces conventional feed, like cereals and soya. This reduces the amount of land needed to produce animal feed and provides environmental benefits. In Japan, the cost of this feed is about half the cost of conventional animal feed, improving farm profitability (Luyckx, 2020).

Incoming organics:

22,000 tpa

Recycled organics products:

- 7,700 tpa poultry feed
- 1,700 tpa liquid fertiliser

GSP contribution of:

$5.6 million or average of $256 per tonne

The above includes contributions to household income of:

$3.6 million or $165 per tonne

Employment:

48 FTE jobs
or 21.8 FTE jobs per 10,000 tonnes

GHG emission savings of:

4,500 tonnes CO_2 e /yr
or 207 kg/ tonne[5]

Water savings of:

29 ML e /yr or 1.3 kL per tonne

5 The benefits of heat treatment vary from 207 kg of CO2 e to 701 kg of CO2 e depending on the source of the feed offsets created by the animal feed output of the heat treatment process. Animal feed blending and ingredient sourcing is a complex and dynamic process, so it is not possible in this study to be certain of the full market-wide effects of creating more animal feed inputs from commercial food waste.

Is it safe to feed pigs treated surplus food?

In 2017, veterinary epidemiologists, microbiologists and pig nutritionists from the Universities of Leeds, Cambridge and Wageningen, APHA-DEFRA and an expert from the European Food Standards Agency FEEDAP committee reviewed existing evidence and the Japanese model of feeding treated surplus food to pigs. These experts agreed that from a technical point of view it is possible to produce safe feed from surplus food through heat treatment, potentially complemented with acidification (fermentation or adding lactic acid for example).

Reproduced from Feeding Surplus Food to Pigs Safely (Feedback, 2018)

In SA, feeding food waste to animals must conform with the Livestock Act 1997.

Black soldier fly

This technology involves using black soldier flies (BSF) to consume surplus food to produce larva. Larva can be fed to animals (such as chickens) in fresh or processed form, such as dried larva or pellets. BSF's are not a vector for human disease. They are naturalised around the world and so are not a pest species.

BSF's can consume surplus food (including meat) from a range of sources, like restaurants, manufacturers, agriculture, abattoirs, households, and hospitals. Some processors have the capacity to receive and process compostable packaging. Contamination (such as plastic bags) can be removed at the facility (Yarger, 2020). Like heat treatment, using BSF to make animal feed from surplus food displaces conventional feed. This reduces land needed to grow conventional food and has environmental benefits.

BSF is used around the world, including Australia. A small-scale operator has recently set up in the Barossa.

Incoming organics:

1,800 tpa

Recycled organics products:

- 400 tpa of insect protein

GSP contribution of:

$1 million or average of $653 per tonne

The above includes contributions to household income of:

$79,000 or $43 per tonne

Employment:

0.9 FTE jobs
or 4.9 FTE jobs per 10,000 tonnes

GHG emission savings of:

182 tonnes CO_2 e /yr or 100 kg/ tonne

Water savings of:

5 ML e / yr or 2.6 kL per tonne

Pelletised/granulated compost

South Australia is a leader in developing pelletised compost products. Introducing pelletised compost will have significant effects on the market, mainly because of its lower application rates and transport costs relative to non-pelletised compost. Other benefits are ease of application, potential for precision placement and customised nutrient enrichment. Application rates are significantly reduced on a per dry tonne basis. This is because the pellets are delivered directly to the root zone and are much more effective in delivering soil benefits where needed. Using pelletised compost provides productivity improvements to significantly more farming operations.

Conclusion

The circularity of organic material managed in South Australian is largely local, and has been enabled by a strong recovery and processing sector that has supported strategic investment in advanced technology, and the development of new products and markets. There is sustained national market demand for quality South Australian output products.

From this high-circularity base, the recovery of food waste that is still being sent to landfill from the commercial sector and from households presents as the key opportunity to increase circularity.

There is capacity within the organics recycling sector to process additional volumes of this material. Current markets for high-quality soil improvement products are constrained by the supply volume of organic material available to composters, rather than demand for these recycled products.

It is established that the application of recycled organic products by agricultural and horticultural businesses improves the structure and micro biota of soils, effectively regenerating the health of soil. This results in a reduced volume of synthetic fertiliser and water inputs, and an increase in farm productivity which extends the positive economic impact derived from use of recycled organic products.

Addressing food waste and supporting continual growth of markets for the recycled organics sector are key features in *South Australia's Waste Strategy 2020-2025*, South Australia's Food Waste Strategy – *Valuing our Food Waste* and Green Industries SA's Strategic Plan.

Building on existing foundations to address these streams and achieve the modelled diversion rates, there is the potential to increase the circularity of the organics recovery and processing sector to 92% - continuing to maintain South Australia's lead in the management and processing of organics material to realise further economic and environmental benefits to the State.


CV3