Infrastructure Victoria

Waste and Resource Recovery Infrastructure Gap Analysis

Enabling end market development for recovered resources through optimised infrastructure planning

Contents

1 Executive Summary

Infrastructure Victoria have undertaken an Infrastructure Gap Analysis to consider the appropriate infrastructure facility types that will be required to manage current and future resource recovery needs of Victoria considering:

- Projected waste generation and resource recovery rates
- The required capacity to manage future waste tonnes
- The required capability to transform recovered resources into valuable commodities
- The potential suitable locations for future infrastructure
- The indicative capital investment required
- The indicative timing of when infrastructure will be required based on current and emerging waste policies and market challenges.

Infrastructure Victoria developed a methodology to guide its recommendations for types of infrastructure needs and the potential locations of infrastructure to respond to current and emerging waste trends. To guide this, Infrastructure Victoria commissioned Brock Baker Environmental Consulting to undertake a 'Waste and Resource Recovery Infrastructure Data and Spatial Analysis' report and Blue Environment to develop a 'Victorian Waste Flows Projection' model. Drawing upon this work, Infrastructure Victoria's methodology included analysis of:

- Current and predicted waste generation by material type
- Reprocessing capacity by material type
- Reprocessing capability by material type
- Location of resource recovery infrastructure and its proximity to end markets
- The Statewide Resource Recovery Infrastructure Plan (SWRRIP) and Regional Implementation Plans
- Existing resource recovery hubs of statewide significance as identified in SWRRIP
- Stated government priorities to support regional economies in transition e.g. in the Latrobe Valley
- The ability to meet a range of policy and resource recovery target scenarios by 2022, 2025, 2030 and 2039. These include:
    - The COAG Waste Export Ban proposal that seeks to restrict the export of 'scrap' glass, paper and cardboard, plastics and tyres which will be phased in from July 2020 and come into full effect by July 2024 (as agreed upon in March 2020).
    - The APCO plastics recycling target of 70% of plastics to be recycled in Australia by 2025.
    - The National Waste Policy target of an 80% average resource recovery rate from all waste streams following the waste hierarchy by 2030.
    - The Victorian e-waste landfill ban.

Infrastructure Victoria recommends that there is an immediate and an ongoing need for investment in Victoria's waste and resource recovery network. Infrastructure Victoria estimates that by 2039:

- Investment in approximately 87 new or upgraded resource recovery infrastructure facilities will be required throughout Victoria

- An increase in total resource recovery infrastructure capacity of 3,157,500 tonnes
- A forecast capital investment of approximately $1 billion by 2039

Appropriate phasing of infrastructure investment, construction and commissioning will be different for each priority material. Specifically:

- By 2024, investment in recovery and reprocessing infrastructure will be needed for Paper and Cardboard, in response to the COAG ban.
- By 2025, investment in recovery and reprocessing infrastructure will be needed for Organics and Plastics.
- By 2030, investment in recovery and reprocessing infrastructure will be needed for e-waste.
- And by 2039, investment will be needed in value-add recovery and reprocessing infrastructure for Glass and Tyres.

To manage total forecast resource recovery trends by 2039, it is estimated that future resource recovery investment required by 2039 will include:

- e-waste investment between $12m to $55m to manage 34,500 tonnes per annum
- Glass investment between $17.5m to $24.3m to manage 328,000 tonnes per annum
- Organics investment between $229.75m to $317.32m to manage 805,000 tonnes per annum
- Paper and cardboard investment between $163m to $205m to manage 2,040,000 tonnes per annum
- Plastics between $367.9m to $511.28m to manage 515,000 tonnes per annum
- Tyres investment between $6m to $8m to manage 15,000 tonnes per annum
- MRF investment between $12m to $20m to manage 80,000 tonnes per annum

Infrastructure Victoria has also identified significant market development activities that will be required to complement and support any future infrastructure investment to enable growth in the use of recycled materials in domestic manufacturing and construction, and to access future export markets. Market development recommendations include:

- Further support for research, development and demonstration activities.
- Establishment of working groups to facilitate development of standards, specifications, and strategic investment.
- Provision of guidance for consumers and industry to better understand and use recycled materials.
- Improve strategic planning approaches to ensure appropriate location of resource recovery and reprocessing infrastructure to manage amenity, protect industry, and to realise economies of scale.

The recommended infrastructure facilities are an estimated forecast of what may be required in future years to respond to emerging waste and resource recovery trends. They are not prescriptive and should be used for guiding purposes only.

1.1 Infrastructure Gap Analysis Methodology

Infrastructure Victoria engaged Brock Baker Environmental Consulting to work with the project team to provide a comprehensive understanding of the location, capacity and capability of Victoria's resource recovery infrastructure network through a 'Waste and Resource Recovery Infrastructure Data and Spatial Analysis'. Brock Baker Environmental Consulting incorporated data modelling from Blue Environment to assess current and future infrastructure needs based on waste data projections.

Infrastructure Victoria commissioned Blue Environment to further develop the waste model and data that underpinned its Victorian Waste Flows report (Blue Environment 2019a) that was used for Infrastructure Victoria's waste and resource recovery Evidence Base Report published in October 2019. Blue Environment conducted further work that examined future waste flows under a range of scenarios, taking into account possible significant changes to the management of waste materials due to policy options and market developments.

Drawing upon the information and analysis prepared by Brock Baker Environmental Consulting and Blue Environment, Infrastructure Victoria have undertaken an Infrastructure Gap Analysis to consider the appropriate infrastructure facility types that will be required to manage current and future resource recovery needs of Victoria, the required capacity and capability to manage projected waste materials, the potential locations, indicative investment required and indicative timing of when infrastructure will be required.

Infrastructure Victoria has identified and undertaken detailed analysis of six priority waste material streams. These are:

e-waste	Glass	Organics	Paper and Cardboard	Plastics	Tyres

Figure 1: Priority materials for recovery

Infrastructure Victoria has identified these as priority waste materials for analysis based on:

I. Their exposure to current market challenges including international import bans and fluctuating commodities prices
II. The potential impacts of the COAG waste export ban that seeks to restrict the export of 'scrap' glass, paper and cardboard, plastics and tyres which will be phased in from July 2020 and come into full effect by July 2024.
III. The opportunity to divert organics from landfill, which comprises significant tonnes that could be readily recovered for beneficial uses.
IV. The introduction of the Victorian e-waste landfill ban in July 2019, which requires diversion of e-waste to resource recovery pathways. It is noted that e-waste is also heavily exposed to increasing international import restrictions as well.

This analysis considers Victoria's existing resource recovery and reprocessing infrastructure's capacity and capability to respond to a variety of resource recovery and recycling objectives.

1.2 General overview of Victorian resource recovery infrastructure

To assess the resource recovery infrastructure capability and capacity in Victoria for the six identified priority materials (e-waste, glass, organics, paper and cardboard, plastics, and tyres).

Infrastructure facilities were grouped as either ‘recovery’ or ‘reprocessing’.

Recovery was determined as infrastructure that is primarily dedicated to collecting resources prior to delivery to a facility for further processing. As such collection infrastructure, also known as ‘binfrastructure’ is included in the analysis and mapping as ‘recovery’ infrastructure.

Recovery includes:

- Baling infrastructure
- Manual separation and sorting of resources
- Shredding of organic wastes for the purposes of size reduction to transport to a reprocessor or production of basic mulches
- Collection infrastructure such as stillages, skip bins, and cages
- Other (a variety of other collection type infrastructure)

Reprocessing was determined as infrastructure that is primarily used to physically change change the composition of a recovered resource into a new product or as feedstock ready for manufacturing.

Reprocessing includes:

- Anaerobic digestion
- Blast furnace
- Compaction
- Composting
- Crushing, grinding, washing
- Extrusion / injection moulding
- Flaking
- Granulating / crumbing
- Hazardous processing
- Paper and pulp
- Shredding
- Other (a variety of other reprocessing type infrastructure)
- Unknown (operations thought to be reprocessing but where infrastructure used is unknown)

1.3 Capacity and capability

To date, Victoria's resource recovery infrastructure network has often been viewed through an assessment of capacity only i.e. the ability to manage throughputs of materials. However, in recent years there have been significant regulatory and market reforms that now mean the capability of operators is now of equal importance to a healthy and viable resource recovery sector.

1.3.1 Capacity

Capacity has been considered with regard to the physical abilities and regulatory requirements that recovery and reprocessing infrastructure operators are able to manage.

Infrastructure Victoria's capacity analysis has assessed the amount of tonnes that a site can manage including its capacity to:

- Receive incoming materials
- Sort via relevant technologies and procedures
- Reprocess via relevant technologies and procedures
- Store recovered or reprocessed materials on-site before selling to market

Other considerations include any regulatory requirements to manage materials on site e.g. licences, permits, registrations, works approvals, planning permits, building permits, etc.

1.3.2 Capability

Capability has been considered with regard to the ability of resource recovery and reprocessing infrastructure to transform 'waste' materials into 'recovered resources'.

Key attributes of capability include:

- Technologies used
- Materials accepted as inputs
- The quality of recovered or reprocessed materials as outputs or products
- Access to markets for resource recovery operators.

1.4 Policy and target considerations

At the time of undertaking this Infrastructure Gap Analysis, the Victorian Government was still developing its Circular Economy Policy. In the absence of this policy, and any prior existing policy (noting there has not been a waste policy in Victoria since 2014), Infrastructure Victoria has considered several other Victorian and national waste policy objectives, targets and discussion papers to guide this analysis.

Specifically, this analysis has considered Victoria's current infrastructure capacity and capability to meet current material challenges and future material challenges that align with four policy and target settings. These are:

This chapter's analysis considers three policy and target scenarios to assess infrastructure capacity and capability against achieving these.

I. The COAG Waste Export Ban that will restrict the export of ‘scrap’ glass, paper and cardboard, plastics and tyres which will be phased in from July 2020 and come into full effect by July 2024.
II. The APCO plastics recycling target of 70% of plastics to be recycled in Australia by 2025.
    - This has been applied as a proxy percentage target for all other priority materials with the view that if the National Waste Policy target (see below) is to be achieved, then significant progress must be made by 2025.
III. The National Waste Policy target of an 80% average resource recovery rate from all waste streams following the waste hierarchy by 2030.
    - Victoria has endorsed this target through its agreement to the National Waste Policy at the Meeting of Environment Ministers, meeting 8 on December 7 2018.

The analysis also considered the role of waste to energy in Victoria and took note of existing waste to energy to proposals and works approvals in Victoria.

1.5 Infrastructure Recommendations

Infrastructure Victoria developed a methodology to guide its recommendations for types of infrastructure needs and the potential locations of infrastructure to respond to current and emerging waste trends. To guide this, Infrastructure Victoria commissioned Brock Baker Environmental Consulting to undertake a ‘Waste and Resource Recovery Infrastructure Data and Spatial Analysis’ report and Blue Environment to develop a ‘Victorian Waste Flows Projection’ model.

The methodology included analysis of:

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- The Statewide Resource Recovery Infrastructure Plan (SWRRIP) and Regional Implementation Plans
- Existing resource recovery hubs of statewide significance as identified in SWRRIP
- Stated government priorities to support regional economies in transition e.g. in the Latrobe Valley
- The ability to meet a range of policy and resource recovery target scenarios by 2022, 2025, 2030 and 2039

2 Resource recovery and reprocessing supply chain overview

2.1 Generation

In 2018, Victoria had a resource recovery rate of approximately 69% with Victorians generating around 14.4 million tonnes of waste. Of this approximately 10 million tonnes was recovered and prevented from disposal in landfill.

The chart below shows a breakdown of tonnes generated and the resource recovery rate by the three main waste generation streams, Municipal Solid Waste (MSW), Commercial and Industrial Waste (C&I), and Construction and Demolition (C&D).

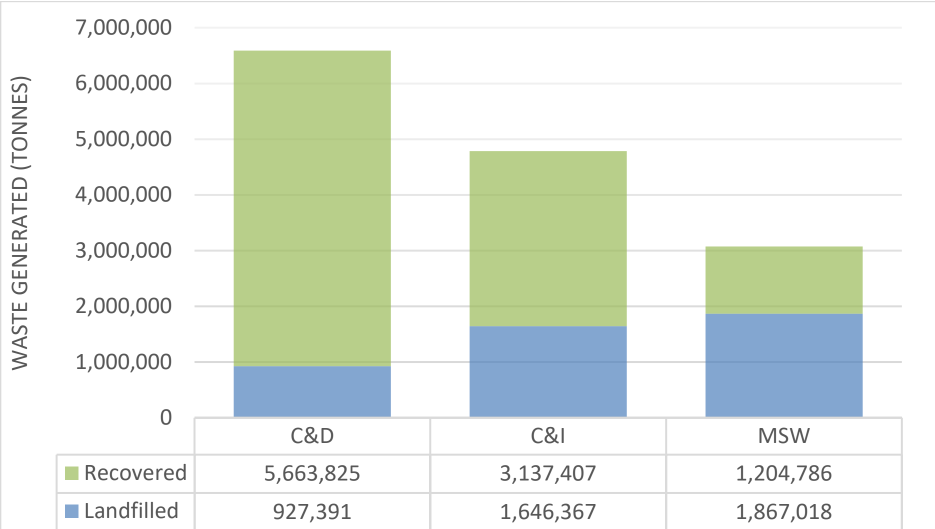

Figure 2: Victorian waste generation and resource recovery 2018

Infrastructure Victoria has identified 430 key resource recovery infrastructure facilities that recover and reprocess e-waste, glass, organics, paper and cardboard, plastics, and tyres across the state.

These are identified below.

Infrastructure type	Paper & Cardboard	Plastics	Glass	Tyres	Organics	E-waste	Multiple
Processing Infrastructure							
Reprocessing Facility	9	32	6	3	19	4	-
Recovery Infrastructure							
Specific Materials Recovery Centre	7	-	1	5	5	24	-
Materials Recovery Facility	-	-	-	-	-	-	13
Resource Recovery Centre	1	-	-	-	-	-	265
Bulk haul Consolidation Centre	-	-	-	-	-	-	1
Drop-off Centre	-	-	-	-	-	6	15
Other	-	-	-	-	-	-	14

Table 1: Summary of resource recovery infrastructure by priority material

The locations of these facilities are presented in Figure 3.

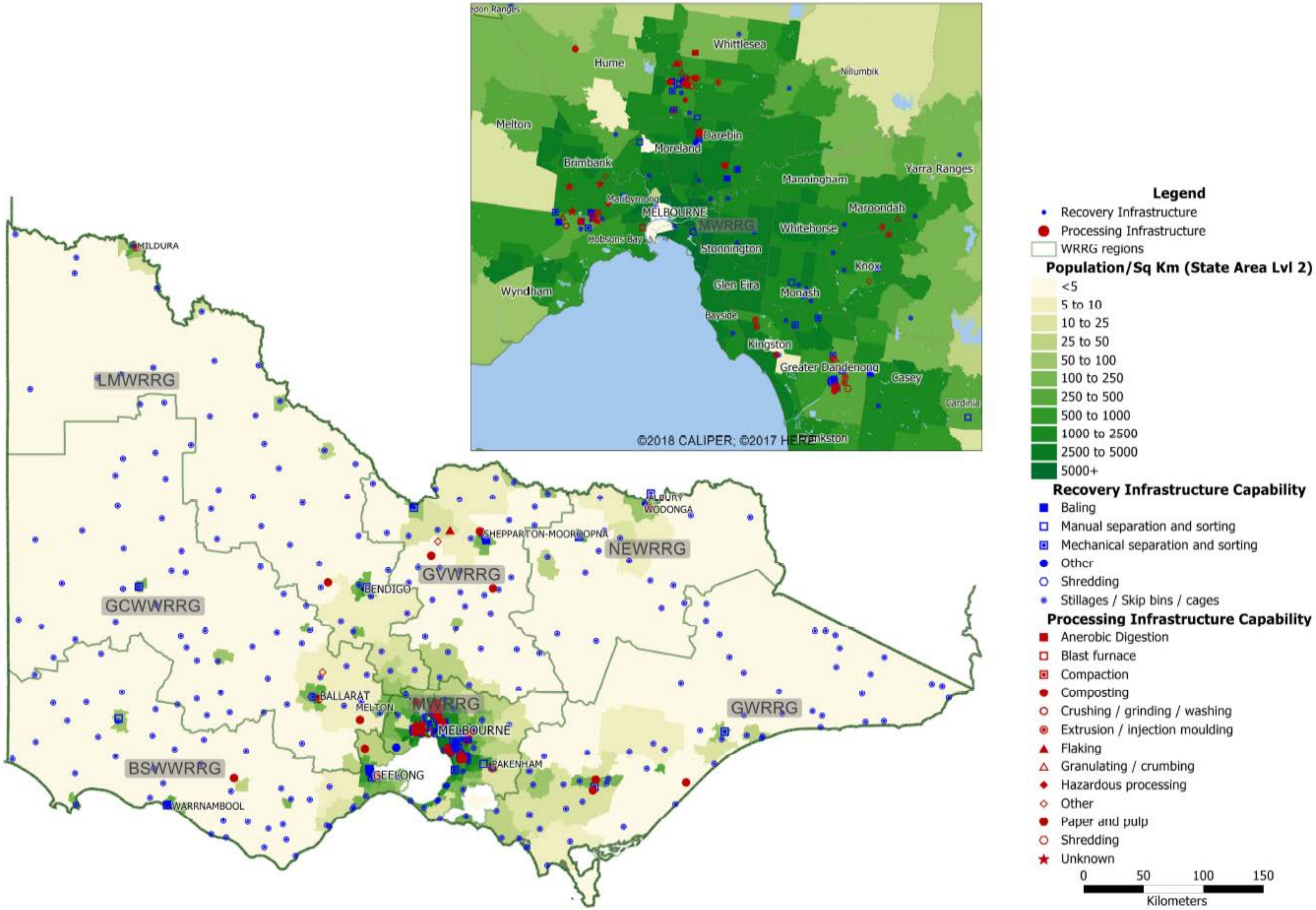

Figure 3: Current Victorian resource recovery and reprocessing infrastructure

2.2 Collection and Transport

A range of recovery facilities play a critical role in the waste and recycling system by aggregating, sorting and consolidating materials and making them available for recycling or reprocessing in Melbourne, regional Victoria or interstate.

The SWRRIP outlines five types of recovery facilities operating across Victoria. Each differs in the type of infrastructure required, standard of facility and level of service provided across the state.

In Metropolitan Melbourne, the provision of Resource Recovery Centres are primarily managed by private operators, with some owned and operated by local government. In Regional Victoria, local government is the predominant owner and operator of Resource Recovery Centres. The table below summarises the different infrastructure facility types.

Facility Type	Function and service	Materials managed
Drop-off centres	Unload of materials Point source separation Aggregation for transfer	Varies depending on the facility Can include residual waste
Resource Recovery Centres (also called Transfer Stations)	Unload of materials Point source separation and sorting Aggregation and consolidation for further transfer Consolidation of kerbside collected material for bulk haul (increasing trend) Some resale to public i.e. Tip Shop	Wide range of materials depending on the facility including garden organics, wood, timber, commingled recyclables, batteries, e-waste, whitegoods, tyres, mattresses and residual waste
Bulk haul consolidation centres	Consolidation of kerbside collected materials for bulk haul transfer	Kerbside collected commingled recyclables, garden organics, combined FOGO and residual waste
Specific materials recovery centres	Unload of specific material streams Sorting and some separation of components Aggregation and consolidation for transfer Some resale to public	Most facilities will only accept certain types of materials. For example, scrap metal yards or C&D materials or paper and cardboard. They generally do not accept residual waste.
Material recovery facilities (MRF)	Sorting Aggregation and consolidation for transfer	Currently primarily kerbside collected commingled streams. Some facilities also cater for mixed streams of materials from C&I and C&D activities.

Table 2: Recovery facility infrastructure types

Each of these facilities plays a role in the management of resource recovery and is related to the transport and logistical movements of recovered resources. The differences in infrastructure facility types and transport movements for MSW, C&I and C&D are detailed in the following section.

2.3 Municipal Solid Waste transport pathways

Municipal Solid Waste (MSW) includes solid waste materials emanating from municipal and residential activities, and includes materials collected for local councils through kerbside collections, resource recovery centres, transfer stations, and other services delivered by or on behalf of local councils.

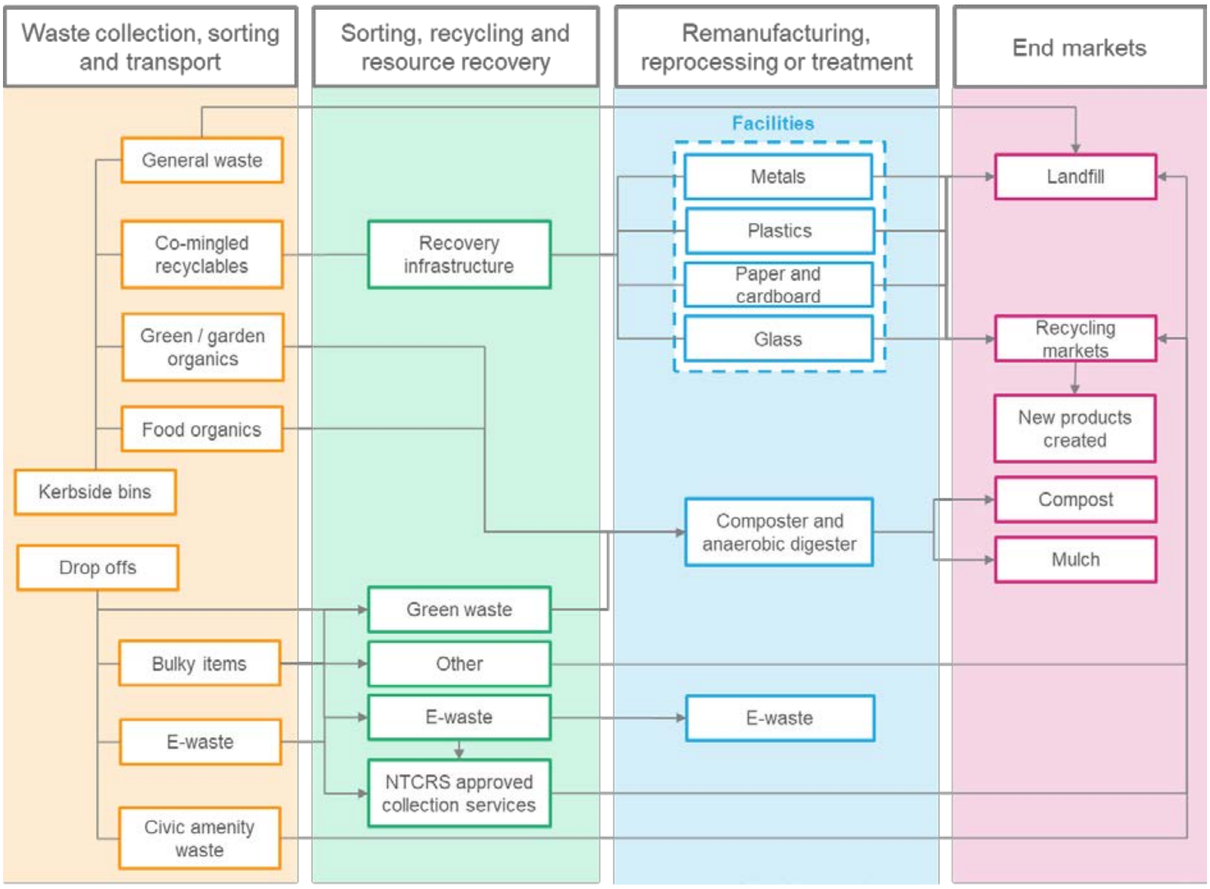

Figure 4: Waste and resource supply chain for MSW

The diagram above summarises the typical flow of materials through the MSW infrastructure supply chain. Note the NTCRS refers to the National Television and Computer Recycling Scheme.

For MSW, appropriate, consistent, easy to use collection infrastructure is fundamental to ensuring that resources are recovered with minimal contamination in order to realise the full recycling potential of end of life materials. Transportation assets need to be appropriately used to minimise risks, maximise recovery and provide efficient transport movements from the point of collection to the point of recovery.

At a household and business level, appropriate 'binfrastructure' is required that is consistent with *Australian Standard for Mobile Waste Containers AS 4123.7 2006* and encourages improved source separation and reduction in contaminating materials. It is noted that the current standard would benefit from updating to reflect industry changes and the emergence of new collection approaches such as kerbside bins for glass collections in Victoria.

2.4 Commercial and Industrial transport pathways

Commercial and Industrial (C&I) waste includes solid waste materials stemming from commercial and industrial activities and includes waste generated by the government sector. Examples include factories, hospitality, manufacturing, offices, education institutions, small to medium enterprises, and state government operations.

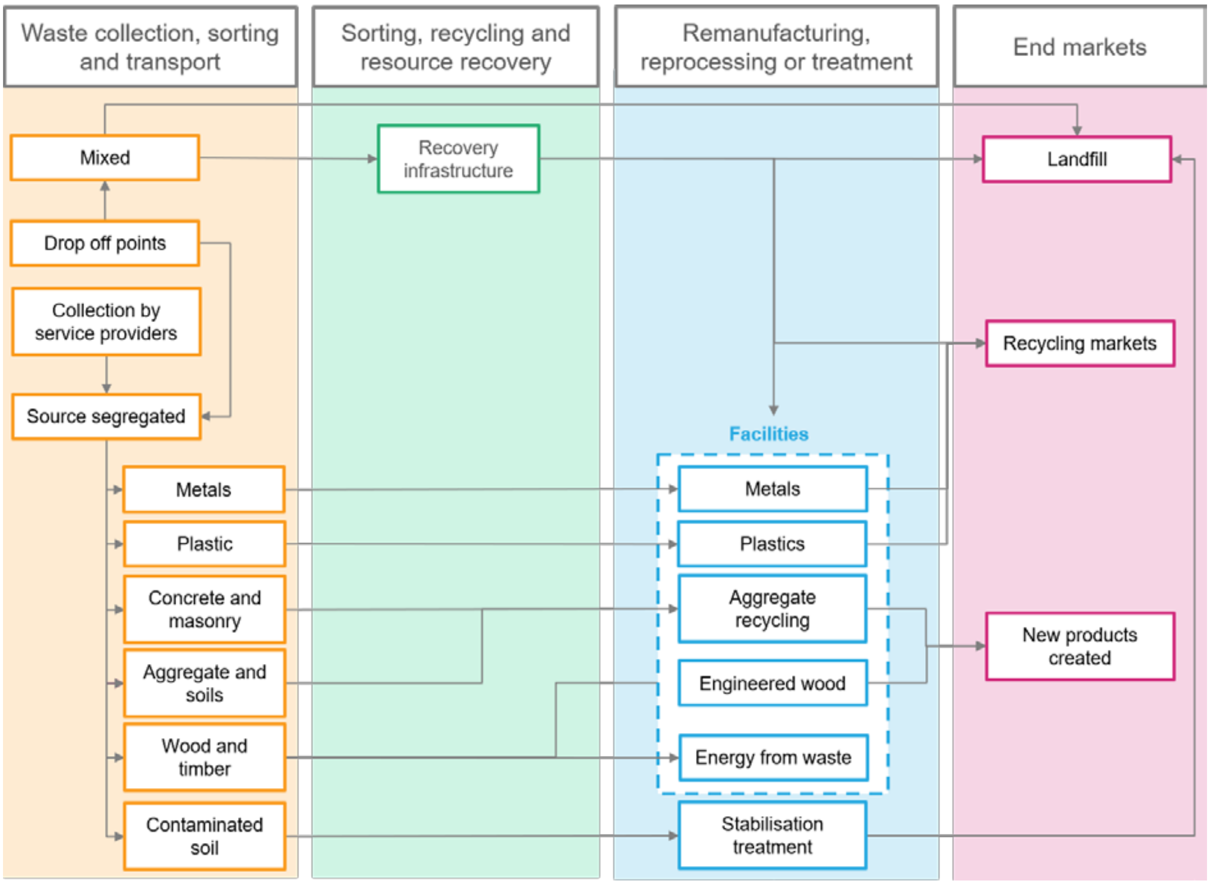

Figure 5: Waste and resource recovery supply chain for C&I

The diagram above summarises the typical flow of materials through the C&I infrastructure supply chain.

For C&I, appropriate, consistent, easy to use collection infrastructure is fundamental to ensuring that resources are recovered with minimal contamination in order to realise the full recycling potential of end of life materials.

Transportation assets need to be appropriately used to minimise risks, maximise recovery and provide efficient transport movements from the point of collection to the point of recovery.

At a business level, appropriate 'binfrastructure' is required that is consistent with *Australian Standard for Mobile Waste Containers AS 4123.7 2006* and encourages improved source separation and reduction in contaminating materials.

2.5 Construction and Demolition transport pathways

Construction and Demolition (C&D) waste includes solid waste materials generated from construction and demolition activities such as masonry and aggregates.

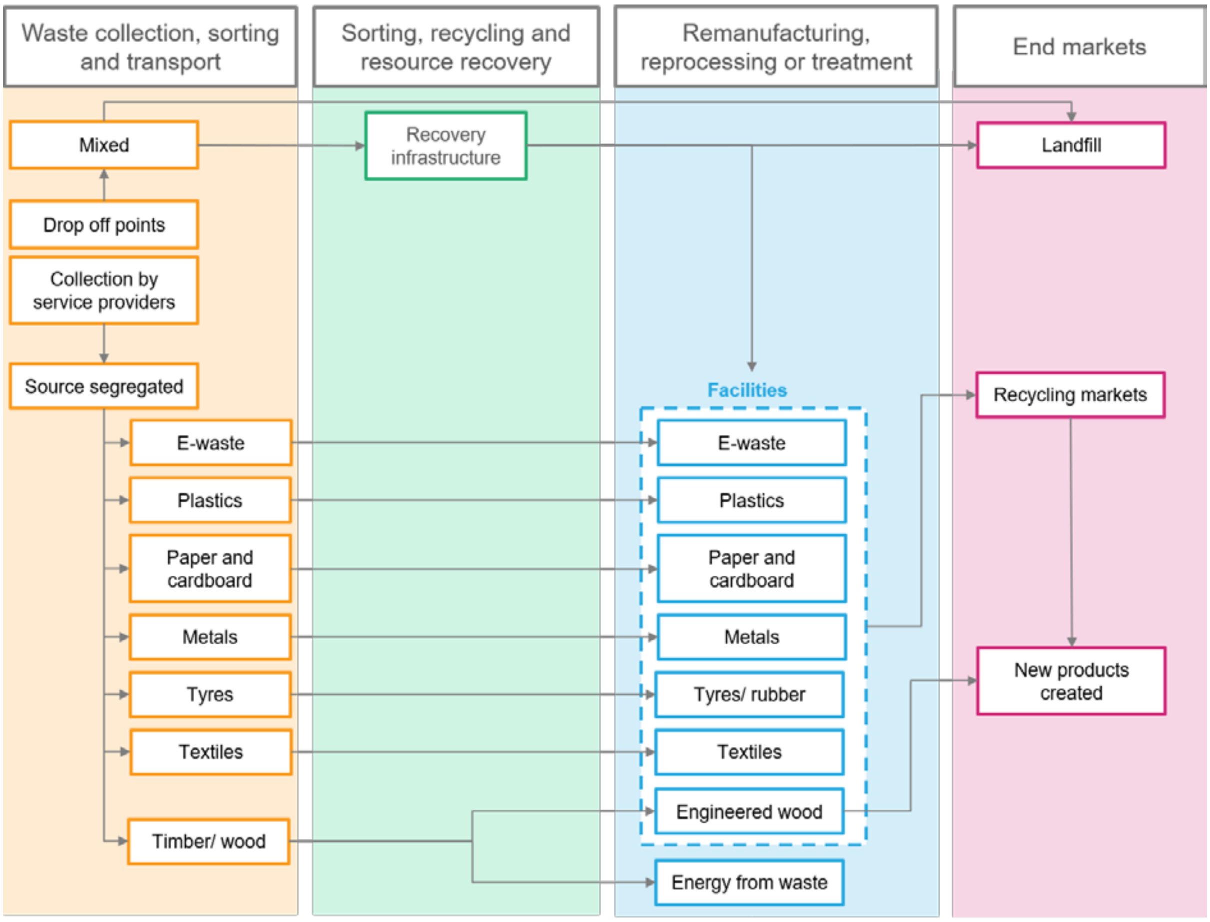

Figure 6: Waste and resource recovery supply chain for C&D

The diagram above summarises the typical flow of materials through the C&D infrastructure supply chain.

Separation of C&D materials typically incurs a lower gate fee than unsorted materials and due to the weight of C&D acts as a considerable incentive for source separation.

Transportation assets need to be appropriately used to minimise risks, maximise recovery and provide efficient transport movements from the point of collection to the point of recovery.

2.6 Sorting, Reprocessing and Recycling

Whilst there are many touch points in the waste and resource recovery supply chain, there are three broad steps required to transform waste into a recovered feedstock suitable to enable recycling to occur.

These are illustrated in diagram below.

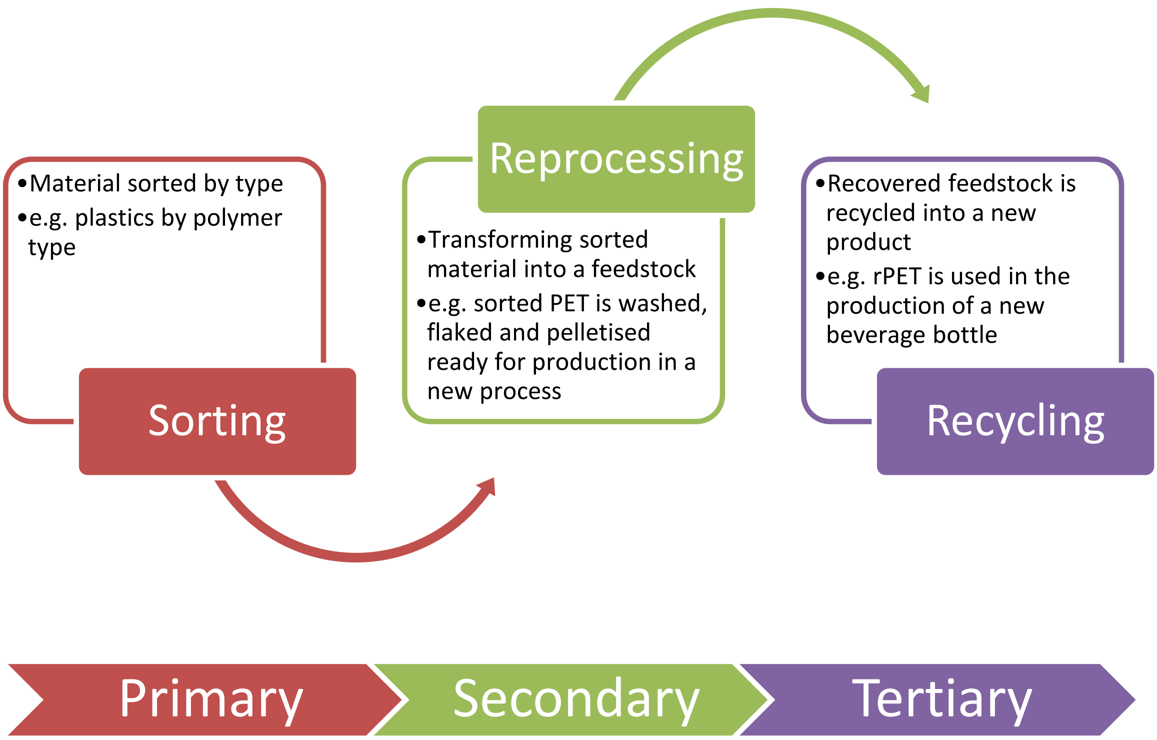

Figure 7: Steps to achieve recycling

2.6.1 Value add reprocessing

Sufficient reprocessing infrastructure needs to be in place to ensure commercial quantities of recycled material can be reprocessed and delivered to market with a high quality.

As export markets tighten and domestic legislation tightens, infrastructure operations that only sort recovered resources, such as the baling of mixed plastic packaging containers or baling of whole tyres, will no longer be a viable option. There is considerable risk that comes with this unless sufficient planning by the Victorian Government is pursued. Leaving it to the market alone is unlikely to deliver the best community and environmental outcomes for waste materials. This has been witnessed in recent years with multiple stockpiles accumulating in the absence of appropriate infrastructure, viable end-markets, and unrealistic low-priced gate fees that mean true recycling is unviable.

To mitigate against these risks, and to meet emerging policy objectives such as that of the Circular Economy, the Victorian Government will need to prepare a clear strategy for Victoria’s future waste and resource recovery infrastructure needs.

Resource recovery infrastructure will need to provide a 'value-add' to recovered materials. Effectively this will mean transforming the physical composition of recovered waste materials from an original form (e.g. a plastic soft drink bottle) into a new product (e.g. a flaked or pelletised plastic feedstock ready for re-manufacture).

2.7 Recycling and end markets

Over the last decade, there has been a significant focus on establishing infrastructure to collect, sort, and to an extent, reprocess recovered resources. However, the supply of recycled materials has not always been matched by sufficient market interest to establish significant, ongoing demand for products made from recycled materials. Effectively, investment in developing local markets for recycled products or high-quality products for export have been limited.

In the absence of a healthy equilibrium of supply and demand of recovered resources, stockpiling of recovered resources can arise resulting in challenges for the resource recovery sector such as commercial viability, non-compliance with regulatory requirements, and in worst case scenarios, waste material fires.

In addition to the ability to reprocess recovered resources, the next step in the supply chain is for end users to purchase and produce goods with these recovered resources. In order to do this, the production and manufacturing equipment of (re)manufacturers needs to be able to accept and use recycled material appropriately. This may mean modification to existing equipment and processes or addition of new equipment and production lines to manage both virgin and recycled materials. This Infrastructure Gap Analysis does not assess any upgrades required for (re)manufacturing in Victoria.

3 Resource recovery and reprocessing infrastructure analysis and recommendations for priority materials

This chapter presents the analysis and recommendations for each of the six priority materials (e-waste, glass, organics, paper and cardboard, plastics, and tyres) based on the methodology described in Chapter 2.

Each material is presented in this chapter with consideration to:

- The characteristics of each material
- Current reprocessing approaches
- Emerging reprocessing approaches (where known)
- Current infrastructure network
- Forecast infrastructure facility types required
- Forecast infrastructure capital costs

3.1 Overall infrastructure recommendations

This analysis recommends 87 new or upgraded facilities, many of which are in regional areas. These facilities can address identified infrastructure gaps, minimise transport costs, capitalise on existing resource recovery and recycling hubs and maximise the likely economic viability of facilities.

These are identified in the following map.

3.1.1 Overall forecast infrastructure

The map below shows indicative locations that would be suitable for new or upgraded recovery and reprocessing infrastructure based on Infrastructure Victoria's analysis.

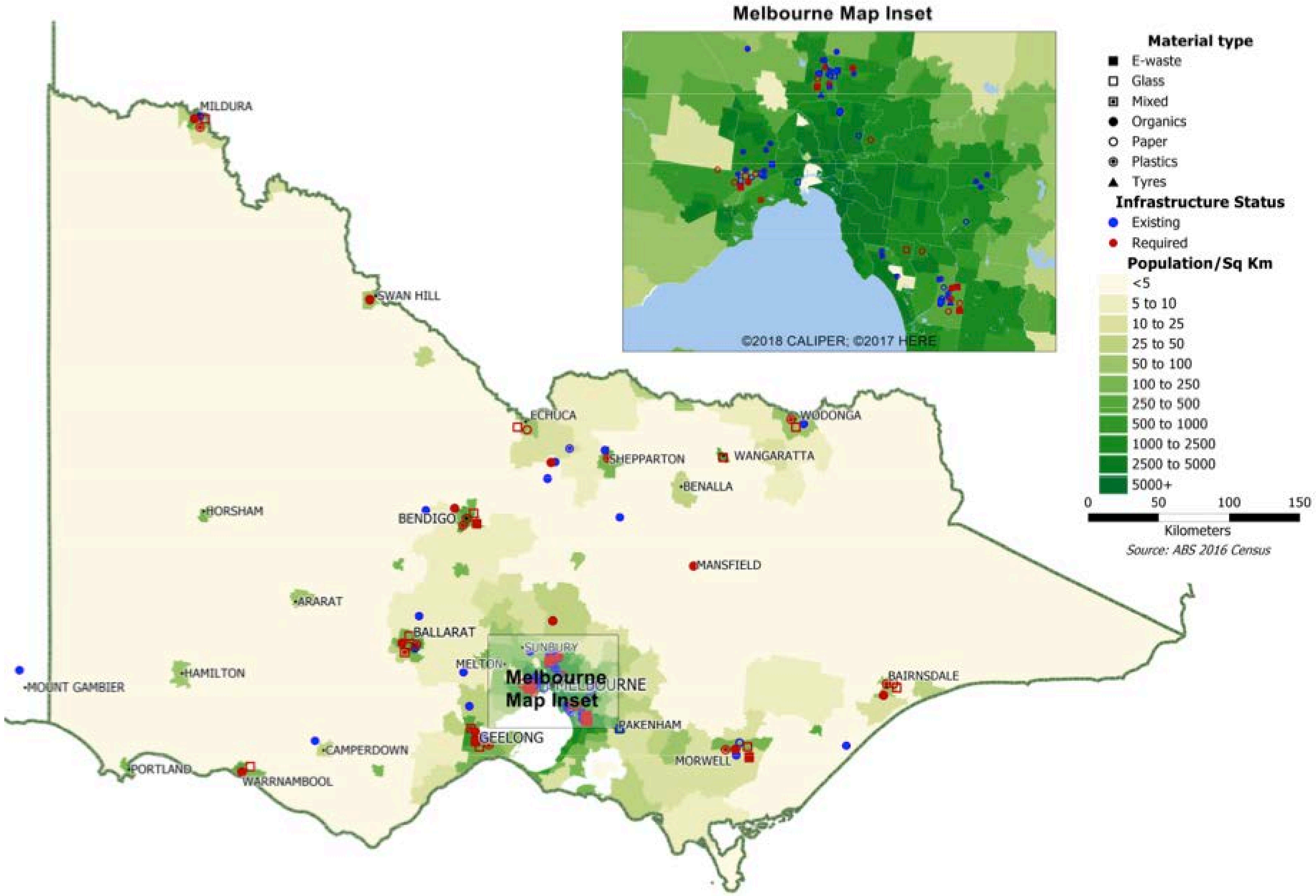

Figure 8: Overall forecast recovery and processing indicative infrastructure locations

3.2 E-waste

In Victoria, e-waste (electronic waste) covers any electrical item that is powered by an electromagnetic current, or simply with a plug, battery or cord, that is no longer wanted or used. This includes:

- Large appliances such as whitegoods
- Small appliances such as irons and toasters
- IT, telecommunications and television equipment such as computers, mobile phones, televisions, batteries, DVD players and remote controls
- Lighting equipment such as lamps, fluorescent lamps and LEDs
- Electrical and electronic tools such as drills, saws, lawn mowers and batteries
- Toys, leisure and sports equipment such as electric trains and racing cars, handheld video games, musical instruments and amplifiers
- And a wide range of other end-of-life electronic products including solar photovoltaic panels, medical devices, smoke detectors and thermostats

E-waste can contain both hazardous and valuable materials that can be recovered when they reach the end of their working life. At the other end of the spectrum, much e-waste contains low value material and difficult to recover low value material which can impact on the viability of recovering some e-waste products.

In July 2019, the Victorian Government banned e-waste from being sent to landfill, requiring resource recovery pathways to be followed.

3.2.1 Material reprocessing approaches – E-waste

In Victoria there are presently two main approaches to e-waste reprocessing.

1. Manual processing	2. Mechanical processing
Manual labour is used to disassemble e-waste into sub-components that are on-sold for further downstream processing and recovery.	Mechanical processing typically involving shredding e-waste into shredded outputs that are on-sold for further downstream processing and recovery.
Process includes sorting, dismantling and separation into outputs such as: • Plastics • Ferrous and non-ferrous metals • Leaded and non-leaded glass • Copper cables, wires and TV yolks • Intact, printed circuit boards, hard disk drives, central processing units.	Process includes: • Initial partial manual disassembly • Crushing • Shredding • Magnetic separation of ferrous metals • Optical sorting and separation of glass, plastics, other metals) • X-ray sorting for specific metal-containing materials e.g. leaded glass screens.

Table 3: E-waste reprocessing approaches

Recent industry trends suggest bigger e-waste reprocessing operators are moving to mechanical processing while smaller operators continue with manual processing practices.

The e-waste recovery and reprocessing steps are illustrated below in the chart below.

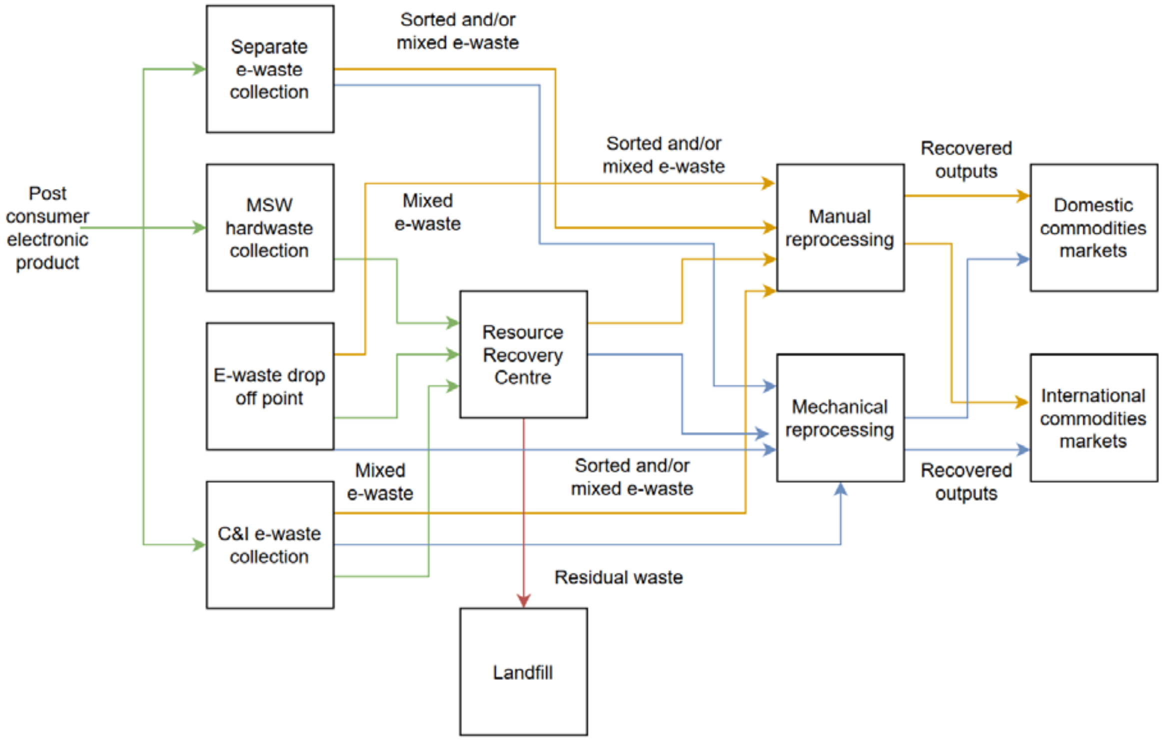

Figure 9: e-waste recovery and reprocessing steps

3.2.2 Emerging reprocessing

Considerable research is underway both in Australia and throughout the world to improve techniques and processes to recover hazardous and high-value materials contained within e-waste. It is recommended that these emerging technologies are both monitored and supported as they progress from research and development to commercialisation.

Some of these techniques include:

- **Chemical processing:** Whilst chemical processing for e-waste, such as acid baths, are already used internationally, research continues to explore and advance the effectiveness, safety and sustainability of these approaches to recover e-waste materials.
- **Thermal processing:** Techniques such as pyrolysis (thermal treatment in the absence of any reactive gases such as air or oxygen) and gasification (thermal treatment with the presence of low levels of oxygen) are emerging as possible approaches for recovering e-waste materials. Academic literature points to successful research trials however there are presently no known commercial uses of these thermal techniques to recover e-waste at scale.
- **Nanotechnology processing:** An emerging novel area of research is the crushing and pulverising of e-waste components into nanosized particles to recover the constituent materials for remanufacturing into new products.
- **Biological processing:** Researchers and start-ups are exploring biological approaches to recover e-waste materials using microorganisms, earthworms and plants for reprocessing. It is hypothesized that biological processing stands to be a safer approach than using more hazardous materials and techniques.

3.2.3 Infrastructure map current – e-waste

The map below shows the current e-waste recovery infrastructure and the current e-waste reprocessing infrastructure located and operating in Victoria.

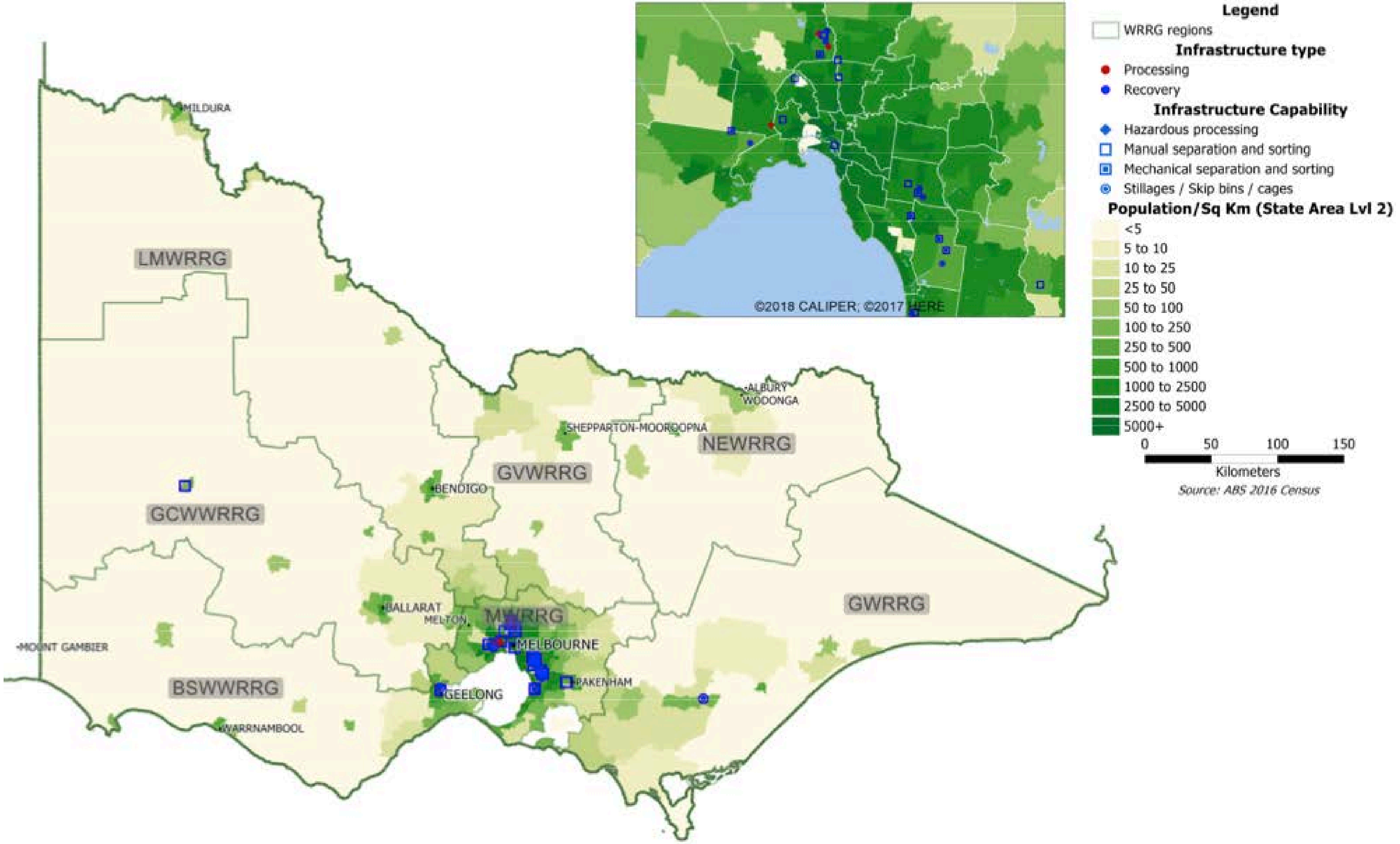

Figure 10: e-waste current recovery and reprocessing infrastructure

3.2.4 Capacity and capability – e-waste

Overall there is a small shortfall by an estimated 4,000 tonnes by 2030 and 9,000 tonnes by 2039 in recovery infrastructure capacity to meet future policy settings.

	2022 (COAG Ban phased introduction)	2025 (COAG Ban fully implemented & 70% RR)	2030 (80% RR)	2039 (90% RR)
Generation	61,000	63,400	67,100	73,200
Current processing infrastructure capacity	49,400	49,400	49,400	49,400
Projected recovery required to meet policy settings	22,500	44,400	53,700	58,500
Excess or shortfall in capacity	26,900	5,000	-4,300	-9,100
	✓	✓	✗	✗

Table 4: Summary of current infrastructure capacity to meet future generation and policy settings

The capacity of the e-waste recovery network to dismantle and sort is not fully known and therefore caution should be taken with this assessment. The current network has primarily been established to support the delivery of the National Television and Computer Recycling Scheme (NTCRS) which has annual targets. It is understood that as the target increases, capacity will increase in line with the target. The capacity outlined excludes the capacity within the metal recovery network who receive whitegoods and other large e-waste appliances which have a high metal content.

For the purposes of this analysis it is assumed that there is enough metals recycling capacity in Victoria to manage large appliances i.e. whitegoods. Recovery of metals have historically been high and in recent years have not been impacted significantly by international import restrictions. Metals are technically easier to recover and as such, the recovery of large appliances are expected to continue to be managed by the metals sector rather than dedicated e-waste recyclers.

Infrastructure Victoria notes that there is a landfill ban in place and a 100% recovery rate is the current policy objective.

Whilst there is sufficient capacity and capability to collect and sort e-waste in Victoria, this recovery practice is heavily exposed to international trading markets and an increasing preference from Asian trading partner nations to introduce waste restrictions. Already for e-waste, import restrictions have been introduced in Thailand and Vietnam.

Based on the best available data, there is sufficient reprocessing capacity to manage the overall tonnes of e-waste containing hazardous materials. However, it is recommended that further analysis be conducted that explores the preparedness of the Victorian e-waste reprocessing sector to manage emerging hazardous e-waste streams of note as waste projections suggest there will be increasing tonnages of hazardous items that are yet to reach their end of useful life will enter the waste stream in future years.

These e-waste types include equipment with reasonably long lifespans such as solar photovoltaic systems and energy storage batteries for solar systems and electric vehicles. Not only is there a shortfall in reprocessing capacity for these types of e-waste there is also a lack of proven technological reprocessing solutions that can be deployed at a commercial scale to meet the forecast end of life generation rates.

3.2.4.1 2024: COAG Waste Export Bans

✓ E-waste is excluded from the COAG Export Ban requirements.

Whilst e-waste is not impacted by the proposed COAG Export Ban, the export of e-waste is susceptible to import restrictions imposed by other nations. Countries including Thailand and Vietnam have already introduced restrictions on the importation of e-waste.

3.2.4.2 2025: APCO target and interim National Waste Policy resource recovery targets

✓ Presently there is sufficient capacity to 'recover' e-waste to meet a 70% recovery rate target to achieve the National Waste Policy target of 80% by 2030.

✗ However, it must be noted that the definition of recovery includes collection and sorting which would see the wording of the National Waste Policy target achieved. Infrastructure Victoria's analysis suggests that there is an opportunity to increase reprocessing capability to achieve greater recovery of high-value materials.

3.2.4.3 2030 National Waste Policy 80% resource recovery rate

✗ There will be insufficient capacity to 'recover' e-waste in Victoria and achieve the National Waste Policy target of 80% by 2030.

3.2.5 Infrastructure Recommendations and Forecast – e-waste

Based on the analysis of waste generation, reprocessing capacity and capability, infrastructure proximity to end markets, the SWRRIP and regional plans, statewide hubs of significance, stated government priorities, and the ability to meet a range of policy and resource recovery target scenarios by 2039, Infrastructure Victoria recommends the following e-waste infrastructure facility types and locations. Indicative capital expenditure has been presented with a range of low cost and high cost infrastructure facility types.

Infrastructure is recommended to manage emerging waste streams of high hazard and high value.

Reprocessing locations for e-waste products including batteries, televisions, computers, monitors and peripherals have been recommended in existing metropolitan Melbourne hubs.

Solar photovoltaic (PV) panel reprocessing has been recommended to:

- Account for installation of solar PV panel uptake and density throughout Victoria based on data from the Clean Energy Regulator and mapping by the Australian PV Institute (https://pv-map.apvi.org.au/historical#7/-36.545/144.316)
- Complement existing metropolitan Melbourne e-waste reprocessing hubs.
- In Bendigo due to its proximity to current and future deployment of household, commercial and large-scale solar in central and northern Victoria.
- In both Geelong and Morwell to service future end-of-life arisings in South West Victoria and Gippsland and to leverage existing infrastructure and labour forces where economic transition is occurring in Victoria.
- Outside Melbourne and the Geelong region, the northern and eastern regions of Victoria have the highest density of solar PV installations. Both Bendigo and Morwell can potentially serve as the reprocessing hubs for these regions.

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Reprocessing	Processing facility	2	Manual dissassembly & Mechanical processing - Batteries	Hazardous processing	4,000	$1,750,000	$2,200,100	MWRRG	Dandenong South
Reprocessing	Processing facility	2	Mechanical processing - Batteries, Monitors, televisions	Hazardous processing	5,500	$2,775,000	$3,375,100	MWRRG	Campbellfield
Reprocessing	Processing facility	1	Solar photovoltaic panel reprocessing	Other	5,000	$1,500,000	$10,000,000	LMWRRG	Bendigo
Reprocessing	Processing facility	1	Solar photovoltaic panel reprocessing	Other	5,000	$1,500,000	$10,000,000	MWRRG	Dandenong South

Reprocessing	Processing facility	1	Solar photovoltaic panel reprocessing	Other	5,000	$1,500,000	$10,000,000	BSWWRRG	Geelong
Reprocessing	Processing facility	1	Solar photovoltaic panel reprocessing	Other	5,000	$1,500,000	$10,000,000	MWRRG	Laverton North
Reprocessing	Processing facility	1	Solar photovoltaic panel reprocessing	Other	5,000	$1,500,000	$10,000,000	GWRRG	Morwell
Total		9			34,500	$12,025,000	$55,575,200		

Table 5: e-waste forecast indicative infrastructure type, costs, locations

3.2.6 Forecast Required Infrastructure Map – e-waste

The map below shows indicative locations that would be suitable for e-waste recovery and reprocessing infrastructure based on Infrastructure Victoria's analysis.

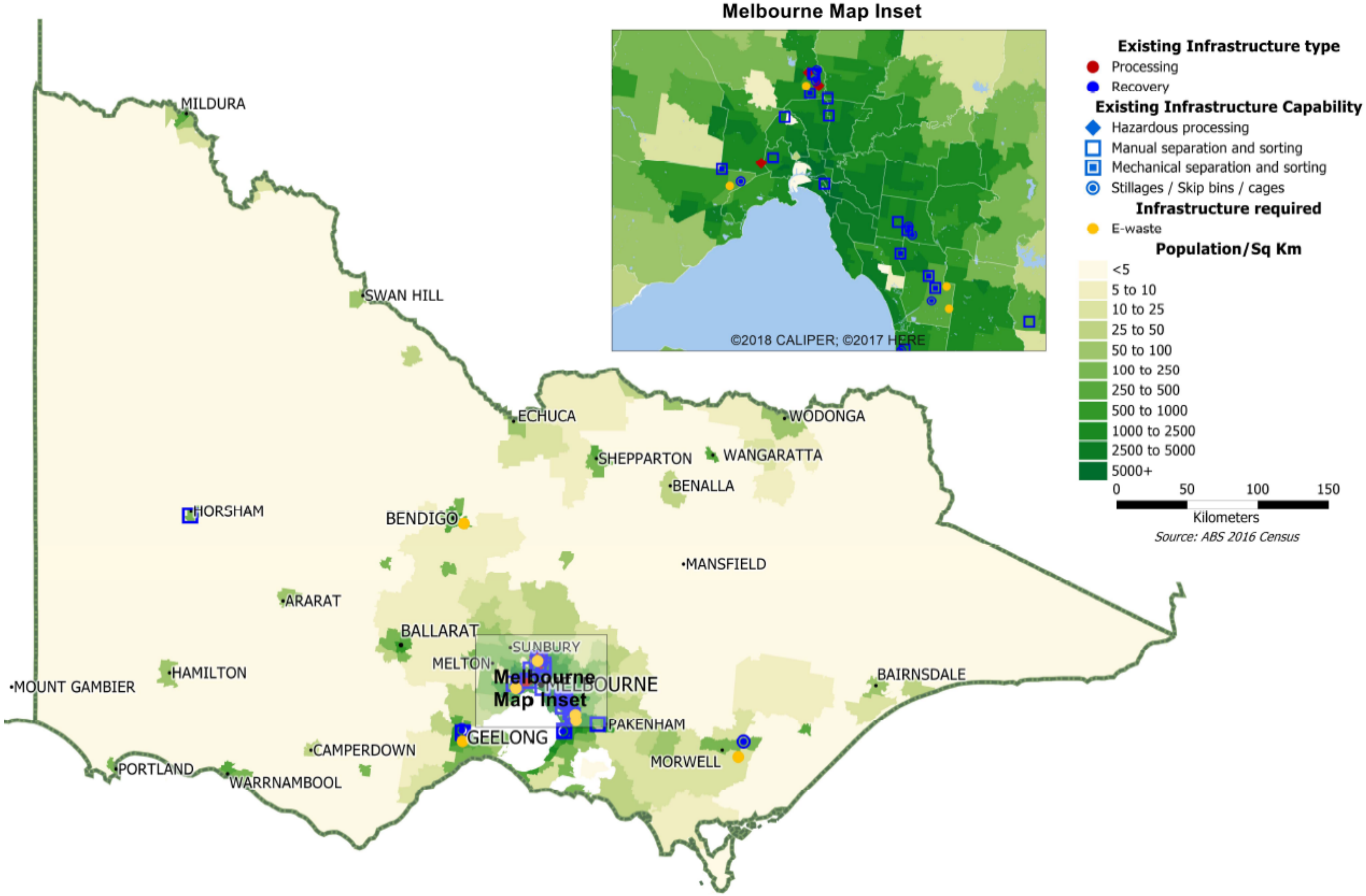

Figure 11: e-waste forecast indicative infrastructure locations

3.3 Glass

Glass is widely recycled in Victoria. Glass primarily stems from two main sources:

1. Packaging glass from containers such as bottles and jars, in three colours (flint, amber, green).
2. Non-packaging glass from windows used in buildings and vehicles.

3.3.1 Material reprocessing approaches – Glass

The recovery and reprocessing of glass is broadly described in three categories:

1. Glass waste: Post-consumer glass which is predominately recovered packaging waste (containers) and to a much lesser degree glass from other sources such as flat glass e.g. windows.
2. Glass cullet: Glass which has been recovered, sorted and crushed through the beneficiation process ready for recycling through glass manufacturing.
3. Glass fines: Glass which has been recovered but is unsuitable for use in glass manufacturing due to the particles being too small to separate by colour or is contaminated with other materials such as ceramic, treated glass e.g. Pyrex, plastics or stoneware. Glass fines can be reprocessed into glass sand products for use in sand replacement applications, crushed rock and aggregate blends, and abrasives.

Recently in Victoria, a number of new local government kerbside recycling contracts have announced or introduced a fourth bin to collect glass separately so as to reduce glass fines contaminating recovered paper. This glass is being transported directly for reprocessing into glass sand rather than for initial sorting at a MRF due to commercial arrangements.

The reprocessing steps are illustrated in the chart below.

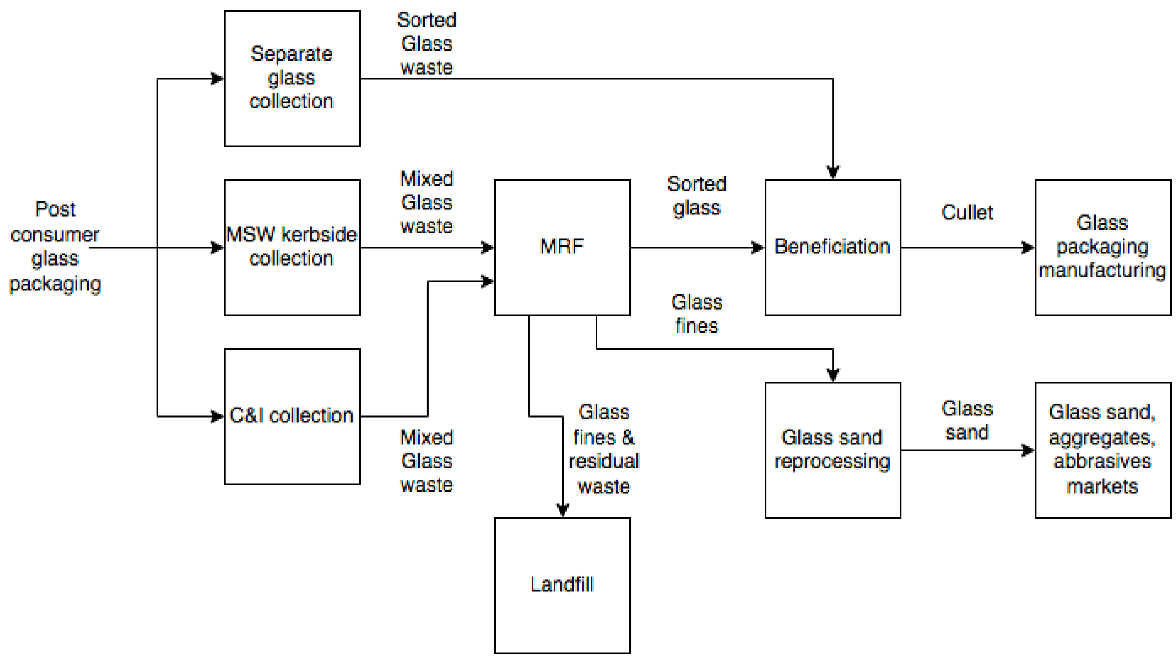

Figure 12: Glass recovery and reprocessing steps

3.3.2 Emerging reprocessing

It is recommended that these emerging end markets for reprocessed glass are both monitored and supported as they progress from research and development to commercialisation.

Emerging uses of recovered glass include:

- **Battery storage:** Novel research is exploring the use of glass as an electrolyte in batteries
- **3D Printing:** As a lightweight composite material with metals for 3D printing

3.3.3 Infrastructure map current – Glass

The map below shows the current glass recovery infrastructure and the current glass reprocessing infrastructure located and operating in Victoria.

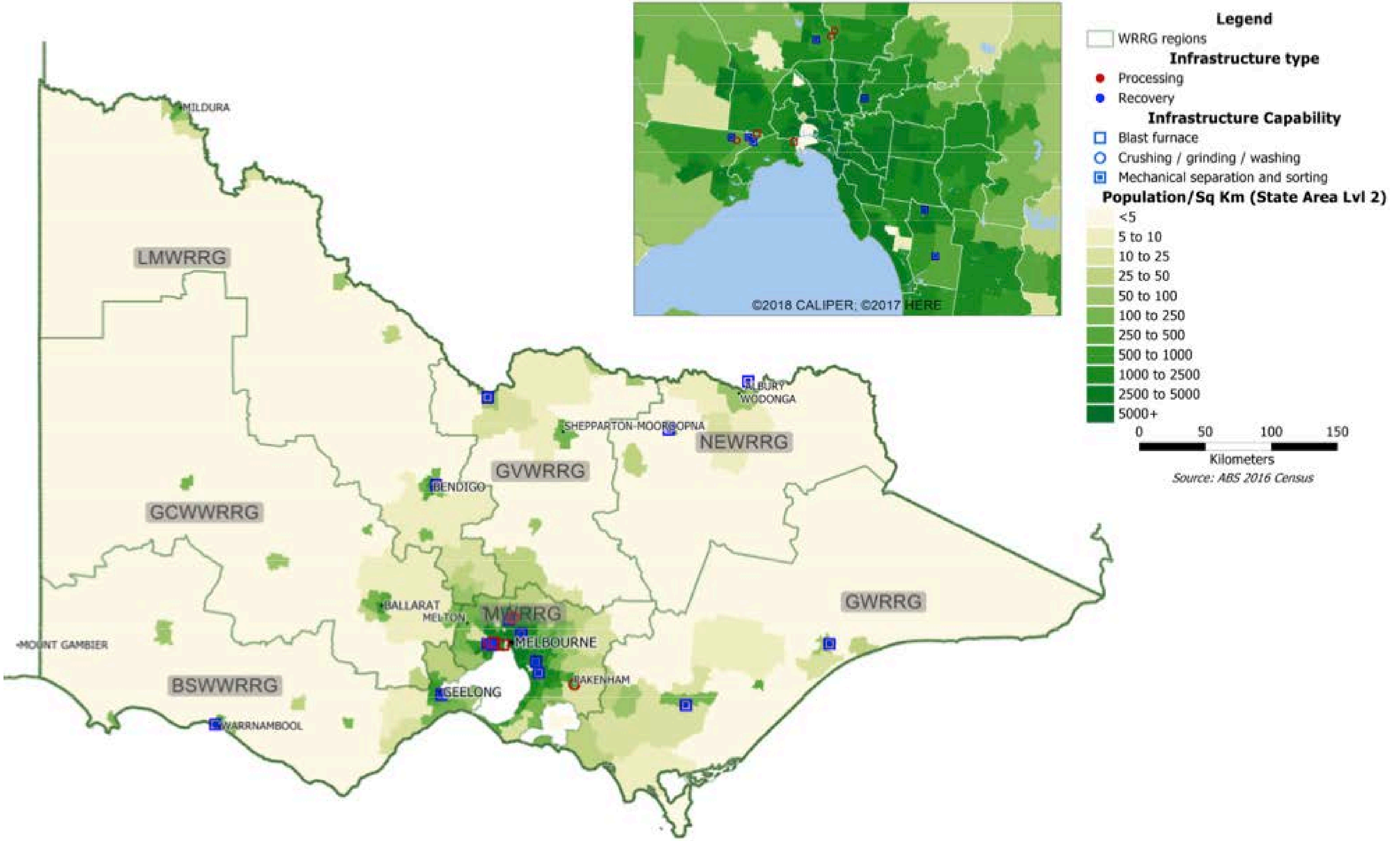

Figure 13: Glass current recovery and reprocessing infrastructure

3.3.4 Capacity and capability – Glass

The capacity of Victoria's glass processing is estimated at around 494,200 tonnes which is enough capacity to meet requirements of the ban, future policy settings and projected glass generation out to 2039.

If future recovery for processing back into packaging were to decline opposed to increasing, there is still capacity within the remaining processing capacity to process into glass sand, aggregates and other until 2039.

	2022 (COAG Ban phased introduction)	2025 (COAG Ban fully implemented & 70% RR)	2030 (80% RR)	2039 (90% RR)
Generation	367,000	382,000	404,900	442,600
Current processing infrastructure capacity	494,200	494,200	494,200	494,200
Projected recovery required to meet policy settings	282,100	267,400	323,900	398,400
Excess or shortfall in capacity	212,100	226,800	170,300	95,800
	✓	✓	✓	✓

Table 6: Summary of current infrastructure capacity to meet future generation and policy settings

3.3.4.1 Glass packaging

There is only one manufacturer of glass packaging in Victoria, Owens Illinois (O-I). Glass from two beneficiation plants (Visy, Polytrade) recover glass cullet from packaging glass and sell this to O-I as feedstock to manufacture new glass packaging products.

Until late 2019, there was a third glass beneficiation business in Melbourne, GRS, however its operations have now ceased due to non-compliance with Victoria's Combustible Recyclable and Waste Materials Waste Management Policy. This has resulted in a significant drop in Victoria's glass beneficiation capacity.

However, there is still sufficient capacity in 2018 to recover glass for OI's current glass packaging production requirements. A limiting factor though is the quality of glass cullet recovered for packaging. Presently, OI is only using approximately 37% recycled glass cullet in its production (approximately 67,000 tonnes). There is potential for this to be increased to up to 60% if the quality of the recovered glass cullet was improved. If O-I were to specify such an increase, then there would be a shortfall in Victoria's beneficiation capacity.

It is worth noting that OI is a single point of dependency for glass packaging production and therefore future infrastructure planning should take this into consideration.

3.3.4.2 Recovery of glass for recycling in the glass sand, aggregates and other markets

The recovery of glass for use as glass sand is an area of particular promise and growth in Victoria. Recently there has been significant new investment in two major resource recovery facilities, Alex Fraser in Laverton North, and Repurpose It in Epping, who have both the capacity and capability to produce high quality glass sand products. It is noted that there is ongoing uncertainty around Alex Fraser's Clarinda Recycling Facility which is located in an area that has been rezoned by Kingston City Council as a green wedge zone. Alex Fraser's licence to operate beyond 2023 has been denied by the Kingston City Council. The closure of this facility would significantly diminish glass and C&D recycling capacity in Melbourne's south east. Recent amendments to constructions specifications have seen an increase in the permissible levels of recycled glass sand in various roads construction and rail construction activities. These specifications have been enable by significant investment of resources (capital, knowledge, materials) to pursue research and development initiatives to prove the quality and fit-for-purpose nature of recycled glass sand products.

Presently, there is sufficient glass sand, aggregates and other processing capacity to manage current End of Life packaging glass generation and tonnes recovered for 2018 through to 2039.

Some commentators suggest that glass sand is a downcycling of glass however when viewed in the context of limited domestic demand for glass production, the role of glass sand will play a particularly important future role in resource recovery end markets. Glass sand is also one of the only end market uses for glass fines, the small glass fragments that are difficult to recover with existing MRF and glass beneficiation infrastructure. Glass sand will also play a vital role as the scarcity of virgin sand continues to increase. Scarcity of virgin glass sand is leading to significantly higher costs of supply and in many metropolitan uses, recycled glass sand is very cost-competitive.

Using glass sand will also play a role in reducing the need to quarry for virgin glass sand, thus enabling a circular economy where already extracted natural resources continue to cycle through the economy rather than ongoing extraction expansion.

3.3.4.3 2024: COAG Waste Export Bans

✓ Presently there is sufficient capacity to reprocess recovered glass in Victoria and meet the COAG Export Ban requirements.

The COAG waste export ban requires that by July 2020, all unprocessed scrap glass will be banned from export. Only glass cullet or processed glass fines will be permitted to be exported.

Most glass packaging that is recovered stems comingled recycling from MSW kerbside collections and the C&I sector. Most MRFs sort glass into a single mixed stream with further sorting by colour and size occurring at a glass beneficiation plant.

There are some C&I collections where glass is recovered in separate streams predominantly from hospitality type venues. This material is sent directly to glass beneficiation plants.

3.3.4.4 2025: APCO target and interim National Waste Policy resource recovery targets

✓ Presently there is sufficient capacity to reprocess recovered glass in Victoria and meet a 70% recovery rate target to achieve the National Waste Policy target of 80% by 2030.

It is worth noting though that this will only be achieved through recovered glass being recycled into glass sand.

Other factors are contributing to the limitation of recovery and reprocessing of glass in Victoria including lack of demand for use of recovered glass in existing packaging due to quality concerns.

3.3.4.5 2030 National Waste Policy 80% resource recovery rate

✓ Presently there is sufficient capacity to reprocess recovered glass in Victoria and achieve the National Waste Policy target of 80% by 2030.

As per above, this achievement is dependent on recovery of glass into glass sand, aggregates and other uses.

3.3.4.6 Glass infrastructure investment opportunities across Victorian regions

Both the packaging glass reprocessing and glass sand reprocessing capacity is in Metropolitan Melbourne only. There is no regional Victorian reprocessing capacity to manage significant tonnages now and into the future.

There are regional opportunities to process locally collected glass packaging into glass sand for local roads through investment in small scale glass crushing infrastructure. This would require the collection and aggregation of glass to occur in regional hubs rather than being transported to Melbourne for reprocessing.

3.3.5 Infrastructure Recommendations and Forecast - Glass

Based on the analysis of waste generation, reprocessing capacity and capability, infrastructure proximity to end markets, the SWRRIP and regional plans, statewide hubs of significance, stated government priorities, and the ability to meet a range of policy and resource recovery target scenarios by 2039, Infrastructure Victoria recommends the following glass infrastructure facility types and locations. Indicative capital expenditure has been presented with a range of low cost and high cost infrastructure facility types.

Infrastructure is recommended to manage future glass recovery with a view to increasing capacity and capability to process glass into glass sand products for use in sand replacement applications, crushed rock and aggregate blends, and abrasives.

In particular, glass sand and aggregate infrastructure is recommended to be deployed throughout regional Victoria to realise the potential for use in local road and infrastructure construction activities to manage future end of life arisings and support local circular economic activity.

One additional glass beneficiation plant has been recommended due to the recent decrease in capacity following the January 2020 closure of the GRS beneficiation facility in Coolaroo. However, IV cautions that any investment in additional glass beneficiation should consider both current and long-term market demand for glass cullet for use in Victorian glass packaging production.

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Reprocessing	Processing facility	1	Beneficiation plant	Optical sorting and cleaning	108,000	$8,100,000	$13,338,000	MWRRG	Laverton North
Reprocessing	Processing facility	2	Sand/aggregate plant - Large	Crushing / grinding / washing	100,000	$4,250,000	$5,000,000	MWRRG	Clayton South
Reprocessing	Processing facility	1	Sand/aggregate plant - Small	Crushing / grinding / washing	10,000	$430,000	$500,000	GWRRG	Bairnsdale
Reprocessing	Processing facility	2	Sand/aggregate plant - Small	Crushing / grinding / washing	20,000	$860,000	$1,000,000	GCWRRG	Ballarat
Reprocessing	Processing facility	1	Sand/aggregate plant - Small	Crushing / grinding / washing	10,000	$430,000	$500,000	LMWRRG	Bendigo
Reprocessing	Processing facility	1	Sand/aggregate plant - Small	Crushing / grinding / washing	10,000	$430,000	$500,000	GVWRRG	Echuca
Reprocessing	Processing facility	1	Sand/aggregate plant - Small	Crushing / grinding / washing	10,000	$430,000	$500,000	LMWRRG	Mildura
Reprocessing	Processing facility	1	Sand/aggregate plant - Small	Crushing / grinding / washing	10,000	$430,000	$500,000	GWRRG	Morwell
Reprocessing	Processing facility	2	Sand/aggregate plant - Small	Crushing / grinding / washing	20,000	$860,000	$1,000,000	BSWWRRG	North Geelong
Reprocessing	Processing facility	1	Sand/aggregate plant - Small	Crushing / grinding / washing	10,000	$430,000	$500,000	NEWRRG	Wangaratta
Reprocessing	Processing facility	1	Sand/aggregate plant - Small	Crushing / grinding / washing	10,000	$430,000	$500,000	BSWWRRG	Warrnambool
Reprocessing	Processing facility	1	Sand/aggregate plant - Small	Crushing / grinding / washing	10,000	$430,000	$500,000	NEWRRG	Wodonga
Total		15			328,000	$17,510,000	$24,338,000		

Table 7: Glass forecast indicative infrastructure type, costs, locations

3.3.6 Forecast Required Infrastructure Map – Glass

The map below shows indicative locations that would be suitable for glass recovery and reprocessing infrastructure based on Infrastructure Victoria's analysis.

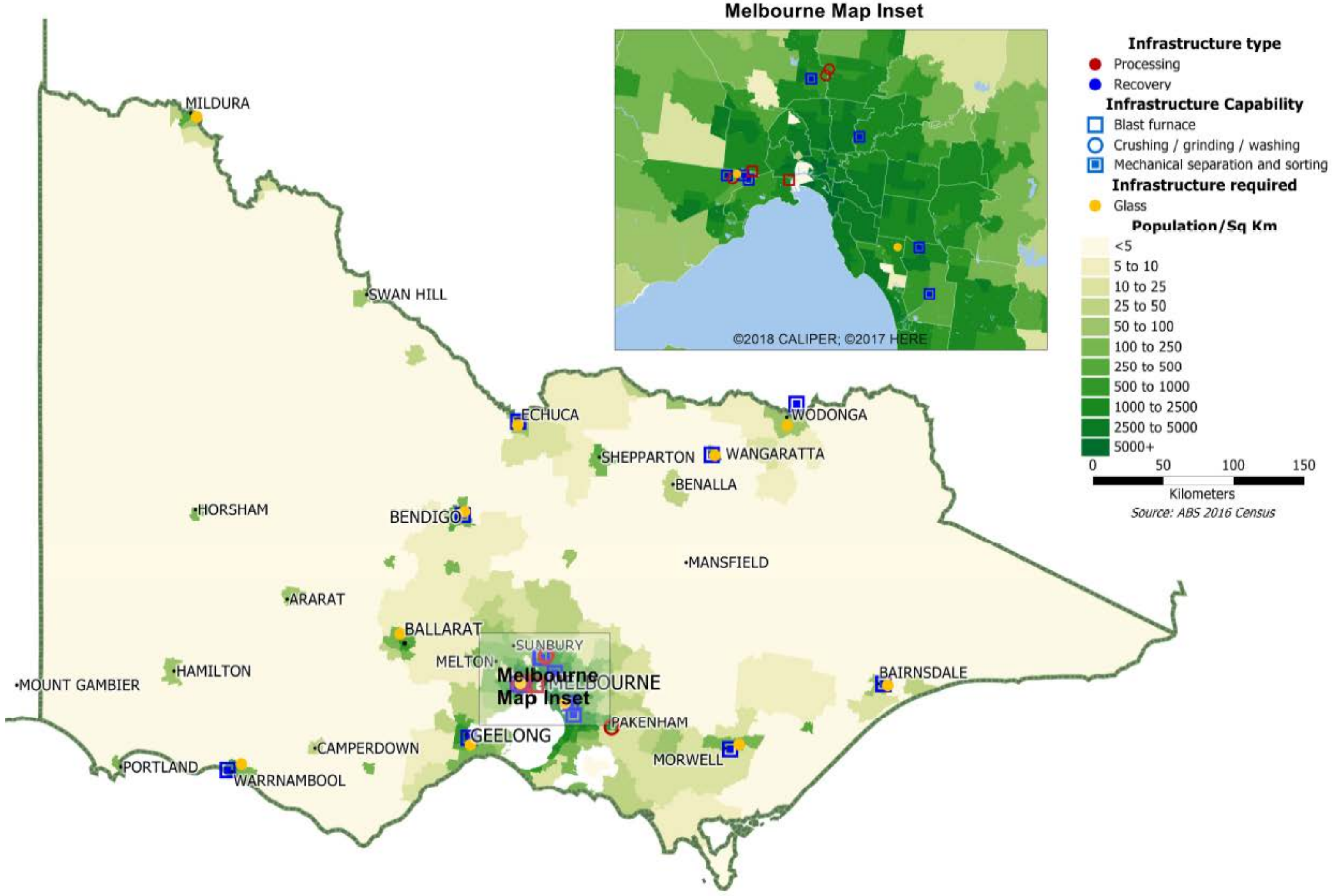

Figure 14: Glass forecast indicative infrastructure locations

3.4 Organics

Organic waste includes any material that stems from a natural and biodegradable source and can include solid materials (garden waste, food and timber) or liquid wastes (grease trap waste, sludges). It includes avoidable and unavoidable food waste from households, hospitality, supermarkets and retailers, manufacturing and also includes agricultural waste and effluent waste.

The Victorian Organics Resource Recovery Strategy broadly categorises organics as:

Biowaste	Biosolids	Biomass
Biodegradable waste derived that is either recovered or sent to landfill from: • MSW - household kerbside systems • Commercial and industrial (C&I) sectors	Organic waste disposed of through wastewater infrastructure. It is the residual of sewage treatment.	This includes both biowaste and biosolids. It incorporates all remaining organic materials from: • Animal wastes and bedding • Forest residues and timber waste • Agricultural wastes It can be converted into products including fuel, power or soil conditioners.

Table 8: Recovered organics categories

Organic waste, when disposed to landfill, decomposes and generates methane, a gas that is 25 times more potent than carbon dioxide in terms of its greenhouse impact in our atmosphere, trapping heat and contributing to climate change. Diverting and recovering organics from landfill can reduce the impacts from organic waste.

3.4.1 Material reprocessing approaches – Organics

Victoria has a well-established organics recovery industry that produces a range of different products including:

- Mulches
- Soil conditioners
- Composts
- Recovered timber
- Fuels and energy

In nature, organic material decomposes over time, returning nutrients and carbon to the soil through a natural process.

There are a wide range of different organic waste processing technologies, which address different target feedstocks and scales of operations.

Biological waste treatments create favourable conditions for particular types of bacteria and micro-organisms, promoting controlled degradation of organic waste into a safe, stable product which has value for landscaping or improving soils.

Other processes capture energy such as biomethane, electricity and heat.

The organics recovery and reprocessing steps are illustrated below in the chart below. Note an SMRC refers to a Special Materials Recovery Centre which is dedicated to handling organics.

The reprocessing steps are illustrated in the chart below.

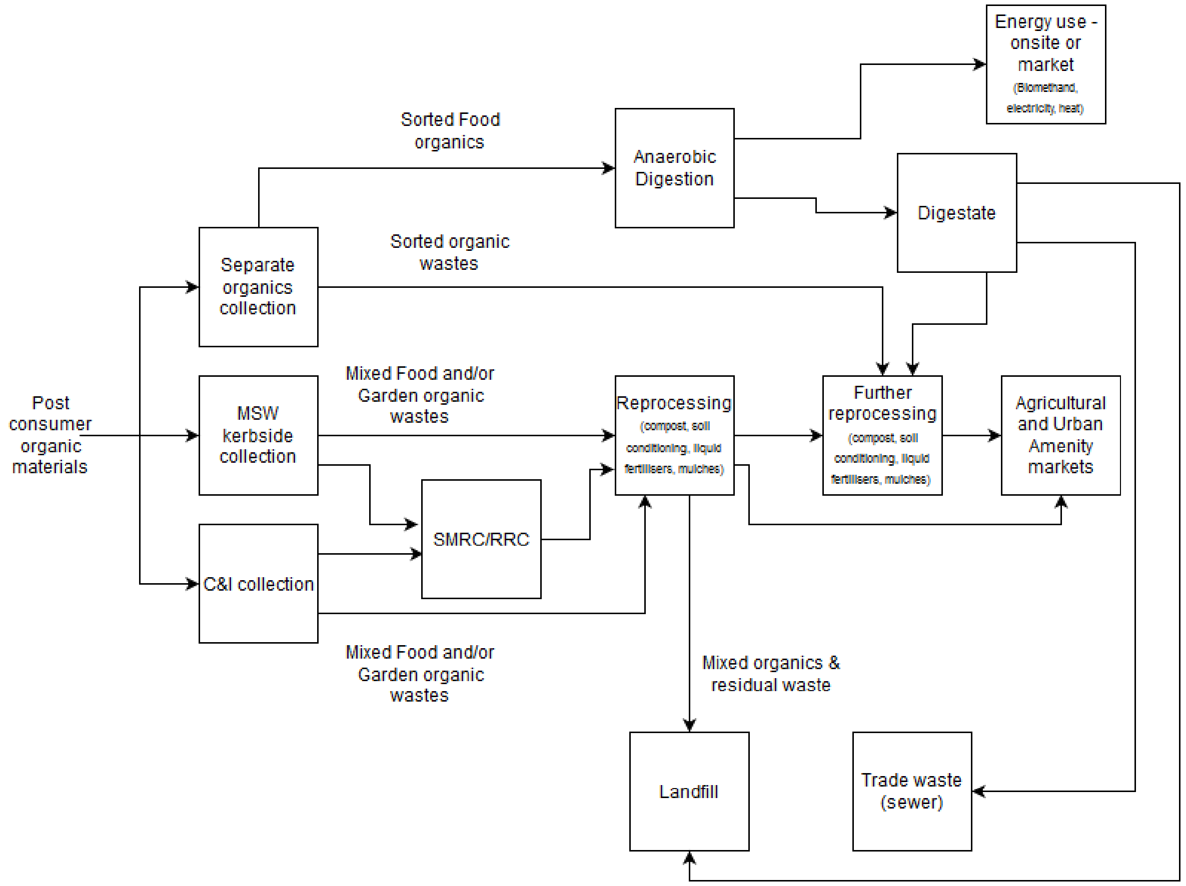

Figure 15: Organics recovery and reprocessing steps

The table below summarises the key features of prominent organics recovery technologies currently used or emerging in Victoria.

Technology / system	Target waste / material	Maturity	Barriers	Enablers	Current Victorian context and direction of travel
Open windrow composting: *Simple composting method where organic waste is piled in rows. Suitable for large volumes of organic material*	Organics: food Organics: garden Generally, more suitable for garden waste and timber/agricultural residues Outputs: compost	Well established with many facilities in Victoria and hundreds of facilities across Australia.	Contamination of feedstock Air, vermin and odour concerns Land use planning: moderate land capacity required Lack of product specifications Market confidence in product quality Transport costs to access agricultural markets Extreme weather can affect outputs (less applicable for IVC)	EPA composting guidance Awareness and education Separate food and garden waste collection services Development of product specifications Market development	The *Guide to Biological Recovery of Organics*, published by Sustainability Victoria, provides more detailed information on best-practice biological processing in the Victorian context. [1] Victoria currently has an active organics recovery industry, producing mulches, soil conditioners, composts, salvage timber, proves derived fuels and energy from organic waste. Lack of product specifications and widely varying composition and quality between products and operators is an ongoing challenge which erodes market confidence, particularly in
Aerated static pile composting: *Alternative configuration of composting to increase the precision and control of the composting process*	Organics: food Organics: garden Outputs: compost	Established: several facilities across Australia.			

[1] Sustainability Victoria, 2018, *Guide to biological recovery of organics*, available at: https://www.sustainability.vic.gov.au/-/media/SV/Publications/About-us/What-we-do/Strategy-and-planning/Victorian-Organics-Resource-Recovery-Strategy/RRE007-Guide-to-Biological-Recovery-of-Organics.pdf?la=en

Technology / system	Target waste / material	Maturity	Barriers	Enablers	Current Victorian context and direction of travel
In-vessel composting: *Composting within a sealed chamber, using forced aeration and temperature sensing instrumentation.*	Organics: food Organics: garden	Well established: small number in Victoria, several in Australia and hundreds in Europe.	Fire risks		agricultural markets where alternative products such as synthetic fertilizers and manures are competitive and well understood.
Vermi-composting: *Vermicomposting involves breaking down organic material using worms.*	Organics: food Organics: garden Outputs: Liquid fertiliser Worm castings/ vermi-compost Worms: protein source for fish/animal feed	Limited: proven technology but limited commercial plants.			
Anaerobic digestion: *Biological degradation process where methane can be collected and used to generate power or as a fuel.*	Organics: food Organics: garden Outputs: Methane rich biogas Digestate	Well established: small number in Australia using wet AD, Dry AD has significant European presence.	Contamination of feedstock Air, vermin and odour concerns Land use planning Feedstock quality control Price and volatility of wholesale electricity market	Organics and EfW policy creation Digestate product confidence & use guidance Awareness and education Separate food and garden waste collection services Co-location of demand for energy offtake	The *Guide to Biological Recovery of Organics*, published by Sustainability Victoria, also provides more detailed information on best-practice anaerobic processing in the Victorian context.[2] It also provides guidance on products and markets from organic waste processing.
Fermentation: *Anaerobic process which converts sugars into alcohols or acids which can be sold to end markets.*	Organics: food Organics: garden Agricultural residues	Limited. Fermentation facilities are not yet operating commercially.	Commercial track record Transport economics	Demonstrated / pilot projects Education and awareness	
Dehydration / Rapid food waste decomposition: *Self-contained rapid reduction the volume of organic waste to improve amenity and reduce storage space and disposal cost*	Organics: food	Established: commercial plants in operation but only small niche applications.	Awareness and education Energy consumption and capital leasing/purchase costs	Market development Education and awareness Space and labour constraints for management of organic wastes from C&I premises in urban locations	The NSW EPA has current Resource Recovery Exemption Orders for rapid food waste decomposition technologies from three providers: Closed Loop, EcoGuardians (SoilFood System) and GreenTech Industries. Approval for a new entrant, emnrich360, is currently under consideration by the NSW EPA. Case studies are available in various Australian states including Victoria, but the technology still has a low awareness and adoption rate among potentially suitable waste generators.

Table 9: Organic waste processing technologies

[2] Sustainability Victoria, 2018, *Guide to biological recovery of organics*, available at: https://www.sustainability.vic.gov.au/-/media/SV/Publications/About-us/What-we-do/Strategy-and-planning/Victorian-Organics-Resource-Recovery-Strategy/RRE007-Guide-to-Biological-Recovery-of-Organics.pdf?la=en

3.4.2 Emerging reprocessing

Considerable research is underway both in Australia and throughout the world to improve techniques and processes to recover organic materials. It is recommended that these emerging technologies are both monitored and supported as they progress from research and development to commercialisation.

Anaerobic Digestion: There are variations to Anaerobic Digestion facilities emerging that seek to build upon existing approaches. Examples include the production of hydrogen rather than the more conventional approach of producing syngas and methane. Additionally, there are examples of technology moving to continuous flow plants rather than traditional batch plants.

Insects: The use of insects such as black soldier fly larvae to reprocess food organics is an emerging technology approach with considerable research and trials underway in Australia and internationally. The outputs include fertilisers and animal feed.

Vermiculture: The use of worms to process organic materials is a well proven approach at small scale with emerging opportunities to scale up throughout Victoria. Outputs include worm castings/vermicompost and liquid fertilisers.

3.4.3 Infrastructure map current – Organics

The map below shows the current organics recovery infrastructure and the current organics reprocessing infrastructure located and operating in Victoria.

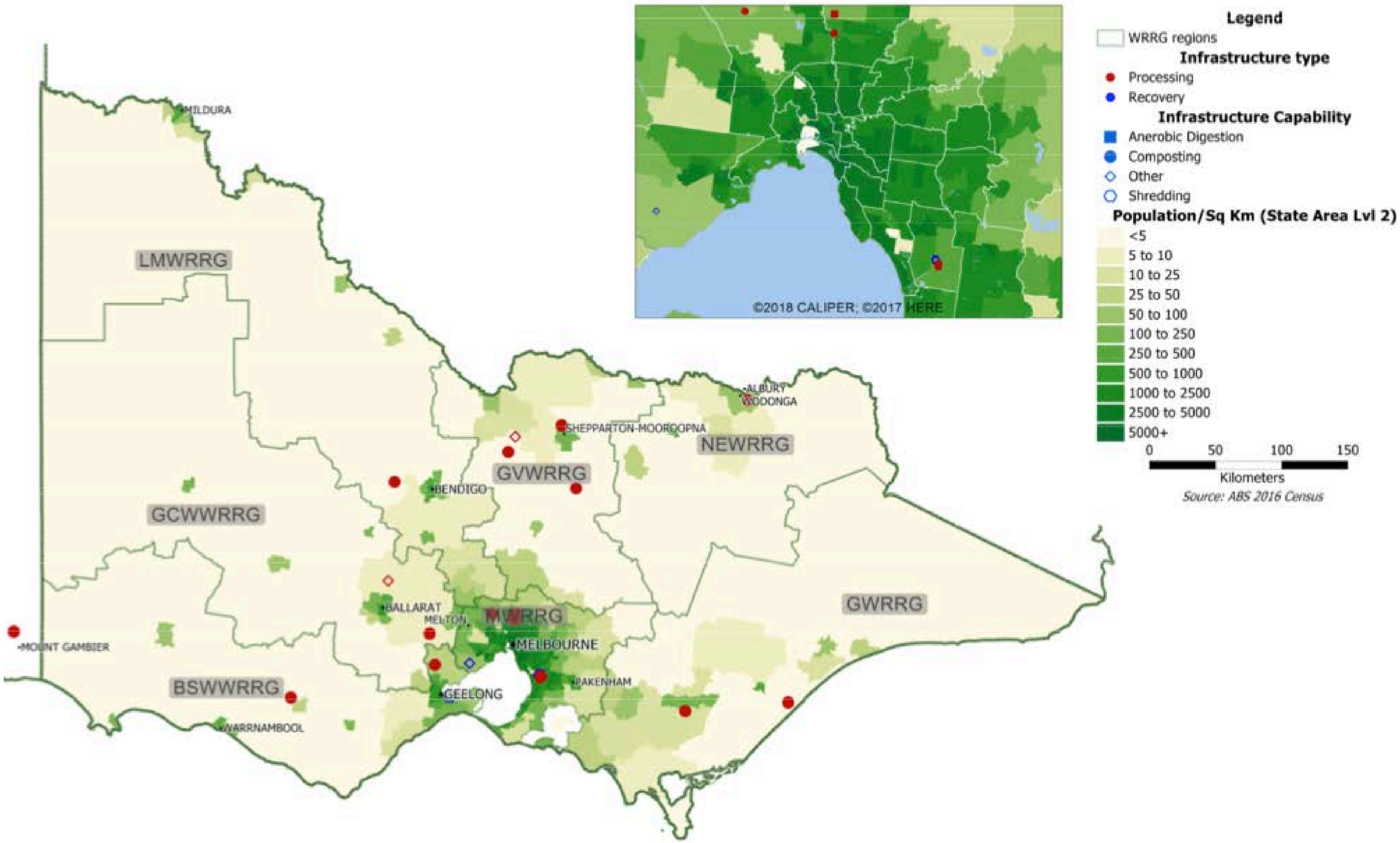

Figure 16: Organics current recovery and reprocessing infrastructure

3.4.4 Capacity and capability – Organics

It is estimated that there will be a shortfall in organics reprocessing capacity in Victoria of approximately 130,000 tonnes by 2025 and 555,000 tonnes by 2039 to meet future policy settings for food and garden waste organics. Infrastructure investment will be required for further processing capacity in regional areas alongside additional recovery infrastructure required in Melbourne to consolidate and transport recovered organics to regional and interstate processing facilities. Existing facilities manage organics wastes from a diverse range of sources included MSW, C&I including agriculture and food production/manufacturing.

	2022 (COAG Ban phased introduction)	2025 (COAG Ban fully implemented & 70% RR)	2030 (80% RR)	2039 (90% RR)
Generation	1,232,300	1,277,700	1,348,900	1,466,400
Current processing infrastructure capacity	764,800	764,800	764,800	764,800
Projected recovery required to meet policy settings	534,900	894,400	1,079,100	1,319,800
Excess or shortfall in capacity	229,900	-129,600	-314,300	-555,000
	✓	✗	✗	✗

Table 10: Summary of current infrastructure capacity to meet future generation and policy settings

Victoria's fixed organics recovery infrastructure consists of Resource Recovery Centres (RRCs) and Special Materials Recovery Centres (SMRC)s.

- RRCs, while classed as having the capability of Stillages / Skip bins / cages for the purpose of other materials such as e-waste, have the capability of consolidating organics for transport with several also having shredding capability, often provided by mobile contractors.
- SMRCs have the capability to shred and decontaminate received organics to enable consolidation of materials to create transport efficiencies and provide a clean feedstock to processing facilities.

Victoria's organics reprocessing capability is largely based around composting to produce composts and soil conditioners.

An emerging reprocessing approach in Victoria is anaerobic digestion to generate energy.

Throughout Victoria there are additional capabilities to produce animal feed and other organic products.

3.4.4.1 2024: COAG Waste Export Bans

✓ Organics are excluded from the COAG Export Ban requirements.

Whilst organics are not impacted by the proposed COAG Export Ban, it is noted that organics are a major contributor to greenhouse gas emissions and there is significant opportunity to increase recovery rates.

3.4.4.2 2025: APCO target and interim National Waste Policy resource recovery targets

❌ There will be insufficient capacity to recover organics to meet a 70% recovery rate target to achieve the National Waste Policy target of 80% by 2030.

3.4.4.3 2030 National Waste Policy 80% resource recovery rate

❌ There will be insufficient capacity to recover organics in Victoria and achieve the National Waste Policy target of 80% by 2030.

✓ Metropolitan Melbourne will require additional capacity to manage current and future organics recovery. There will be limited opportunities for significant new reprocessing to occur in Melbourne. Rather aggregation and consolidation with some initial reprocessing will likely be achievable.

✓ Regional Victoria will require significant additional capacity to manage organic waste generated in each WRRG region as well as the capacity to manage organic waste recovered from Metropolitan Melbourne.

3.4.5 Organics infrastructure investment recommendations and forecast costs

✓ There is an immediate need for future investment in organics reprocessing infrastructure in Victoria to meet current and future end of life generation and recovery rates.

3.4.6 Infrastructure Recommendations and Forecast -– Organics

Based on the analysis of waste generation, reprocessing capacity and capability, infrastructure proximity to end markets, the SWRRIP and regional plans, statewide hubs of significance, stated government priorities, and the ability to meet a range of policy and resource recovery target scenarios by 2039, Infrastructure Victoria recommends the following organics infrastructure facility types and locations. Indicative capital expenditure has been presented with a range of low cost and high cost infrastructure facility types.

Anaerobic Digestion has been identified as a suitable technology to manage current and future commercial food organics recovery.

- The north of Melbourne is already serviced in Wollert, servicing key clients such as the Melbourne Market (wholesale fruit and vegetables).
- There are still significant opportunities to service food production businesses in Melbourne's south east (Dandenong South) and in Victoria's Goulburn Valley (Girgarre).
- Other locations throughout Victoria may also be viable and further investigation of suitable location is recommended

As Melbourne councils introduce further FOGO services, the existing capacity to consolidate and reprocess organics into compost will be insufficient.

- Dedicated Special Materials Recovery Centres (transfer stations for organics) are recommended for hubs identified in the SWRRIP in Melbourne's western (Laverton North) and northern (Epping) suburbs.
- Due to the challenges in meeting EPA requirements and managing social licence to operate, it is unlikely that any future significant organics reprocessing will occur in metropolitan Melbourne.

- To meet the increasing FOGO service demands, and to meet Melbourne's growing population and traffic congestion, IV recommends that SMRCs are constructed to provide opportunities to consolidate and aggregate FOGO prior to enable transport efficiencies to be realised and haul FOGO to regional Victorian reprocessing facilities.
- Laverton North is approximately 50km from the Barwon South West region and approximately 100km from the Central West region. Epping is approximately 30km from the southern end of the Goulburn Valley region and approximately 125km from the Central West region.
- Melbourne's south east is presently well serviced.

In-vessel composting has been recommended in areas close to large regional centres to manage EPA requirements, social licence and urban amenity issues.

Open windrow composting has been recommended in regional Victorian locations that are potentially more likely to manage EPA requirements, social licence and urban amenity issues.

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Reprocessing	Processing facility	1	Anaerobic Digestion	Anaerobic Digestion	30,000	$7,500,000	$24,000,000	MWRRG	Dandenong South
Reprocessing	Processing facility	1	Anaerobic Digestion	Anaerobic Digestion	30,000	$7,500,000	$24,000,000	GVWRRG	Girgarre
Reprocessing	Processing facility	2	In-Vessel Composting - Large & Medium	Composting	125,000	$68,750,000	$80,625,000	GCWRRG	Ballarat
Reprocessing	Processing facility	2	In-Vessel Composting - Large & Medium	Composting	125,000	$68,750,000	$80,625,000	BSWWRRG	North Geelong
Reprocessing	Processing facility	1	In-Vessel Composting - Medium	Composting	25,000	$13,750,000	$15,625,000	NEWRRG	Mansfield
Reprocessing	Processing facility	1	In-Vessel Composting - Medium	Composting	25,000	$13,750,000	$15,625,000	GWRRG	Morwell
Reprocessing	Processing facility	1	In-Vessel Composting - Medium	Composting	25,000	$13,750,000	$15,625,000	BSWWRRG	Warrnambool
Reprocessing	Processing facility	1	Open Windrow composting	Composting	30,000	$3,000,000	$4,200,000	GWRRG	Bairnsdale
Reprocessing	Processing facility	2	Open Windrow composting	Composting	60,000	$6,000,000	$8,400,000	LMWRRG	Bendigo
Reprocessing	Processing facility	1	Open Windrow composting	Composting	30,000	$3,000,000	$4,200,000	LMWRRG	Mildura
Reprocessing	Processing facility	1	Open Windrow composting	Composting	30,000	$3,000,000	$4,200,000	NEWRRG	Swan Hill
Reprocessing	Processing facility	1	Open Windrow composting	Composting	30,000	$3,000,000	$4,200,000	GVWRRG	Wallan
Recovery	SMRCs	1	Transfer stations dedicated to organics with hard stand, cover, bays	Shredding	120,000	$9,000,000	$18,000,000	MWRRG	Epping

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Recovery	SMRCs	1	Transfer stations dedicated to organics with hard stand, cover, bays	Shredding	120,000	$9,000,000	$18,000,000	MWRRG	Laverton North
Total		17			805,000	$229,750,000	$317,325,000		

Table 11: Organics forecast indicative infrastructure type, costs, locations

3.4.7 Forecast Required Infrastructure Map – Organics

The map below shows indicative locations that would be suitable for organics recovery and reprocessing infrastructure based on Infrastructure Victoria's analysis.

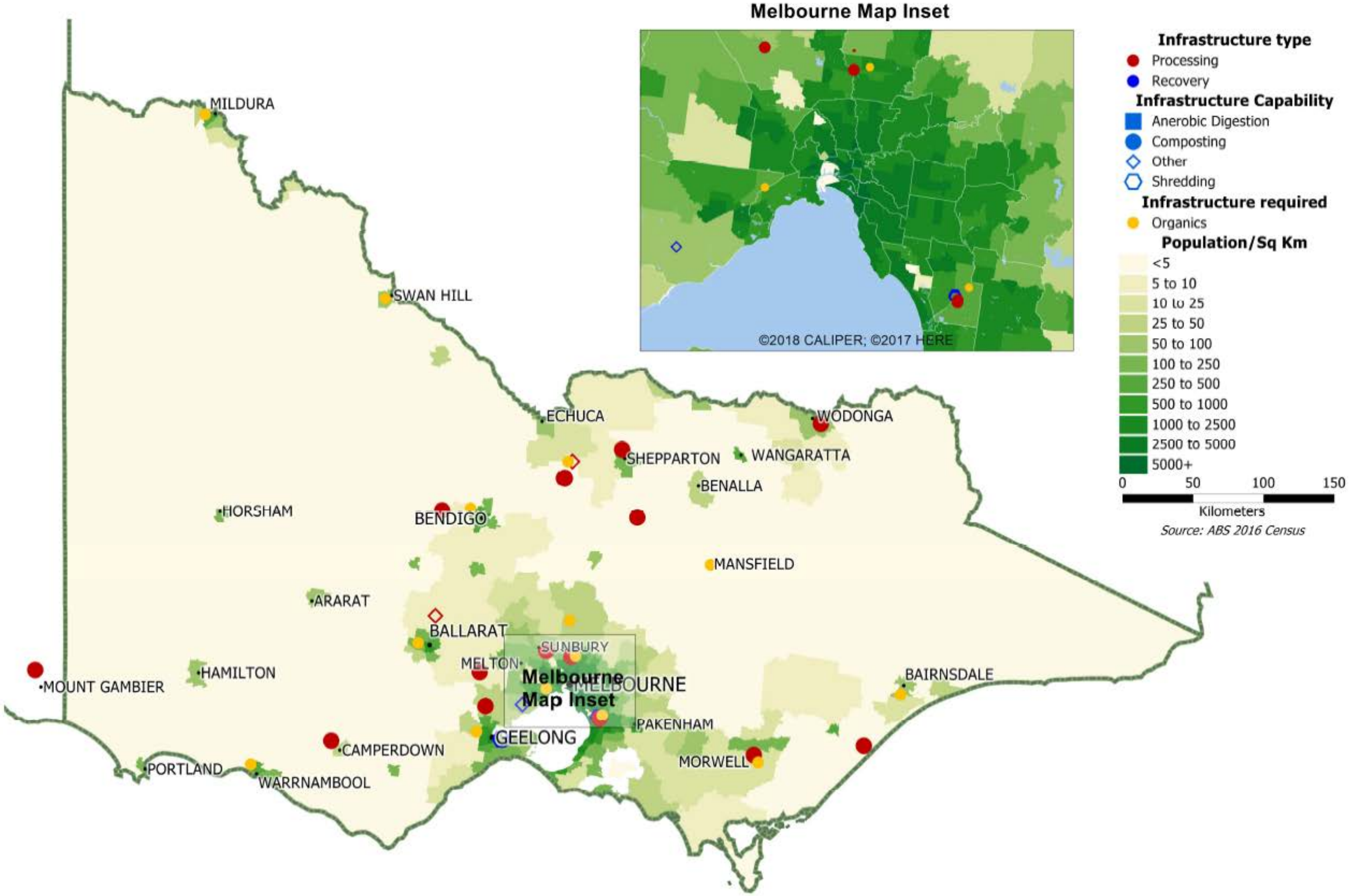

Figure 17: Organics forecast indicative infrastructure locations

3.5 Paper and cardboard

Paper and cardboard includes mixed paper, cardboard, office paper and newspaper, and magazine print.

The quality of recovered paper and cardboard typically stems from its generation source. MSW paper and cardboard collected in Victoria is mixed through the co-mingling stream and suffers from contamination from other materials including glass.

C&I paper and cardboard is typically sorted by paper type and is generally free from glass contamination. Clean and sorted paper and cardboard is highly valued by recyclers. Commercial and industrial paper is sourced from cardboard collection contracts for national retailers, office collections and other commercial operations.

3.5.1 Material reprocessing approaches – Paper and cardboard

Paper and cardboard in Victoria is primarily recovered for either domestic reprocessing at pulp and paper mills or for export reprocessing at international pulp and paper mills into to new paper and cardboard products. There are other reprocessing activities such as manufacturing insulation products with recovered paper.

3.5.2 Current reprocessing

Mixed paper waste with glass fines contamination is a significant challenge which cannot be addressed through sorting. Paper reprocessors are reluctant to accept this material and some new local government kerbside recycling contracts are introducing a fourth bin to collect glass separately to reduce glass fines contamination of recovered paper.

The removal of glass from commingled recycling improves the quality of mixed paper recovered, facilitating the material entering markets with the aim of increasing consumption by Australian and overseas paper mills.

Some other councils in NSW, have introduced a fourth bin for clean paper and cardboard. Again, the aim of this is to prevent the contamination of paper from glass fines but also from other potential contaminants such as food waste that may be present food packaging and containers in co-mingled recycling bins.

The reprocessing steps are illustrated below in the chart below.

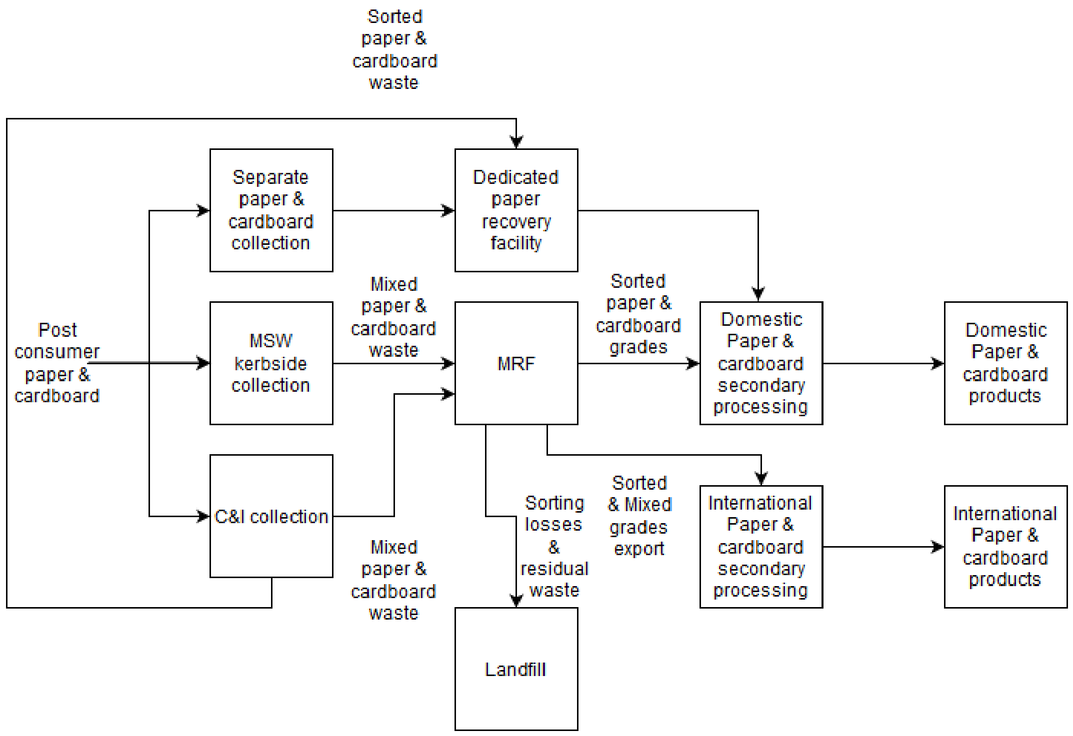

Figure 18: Paper and cardboard recovery and reprocessing steps

3.5.3 Infrastructure map current – Paper and cardboard

The map below shows the current paper and cardboard recovery infrastructure and the current paper and cardboard reprocessing infrastructure located and operating in Victoria.

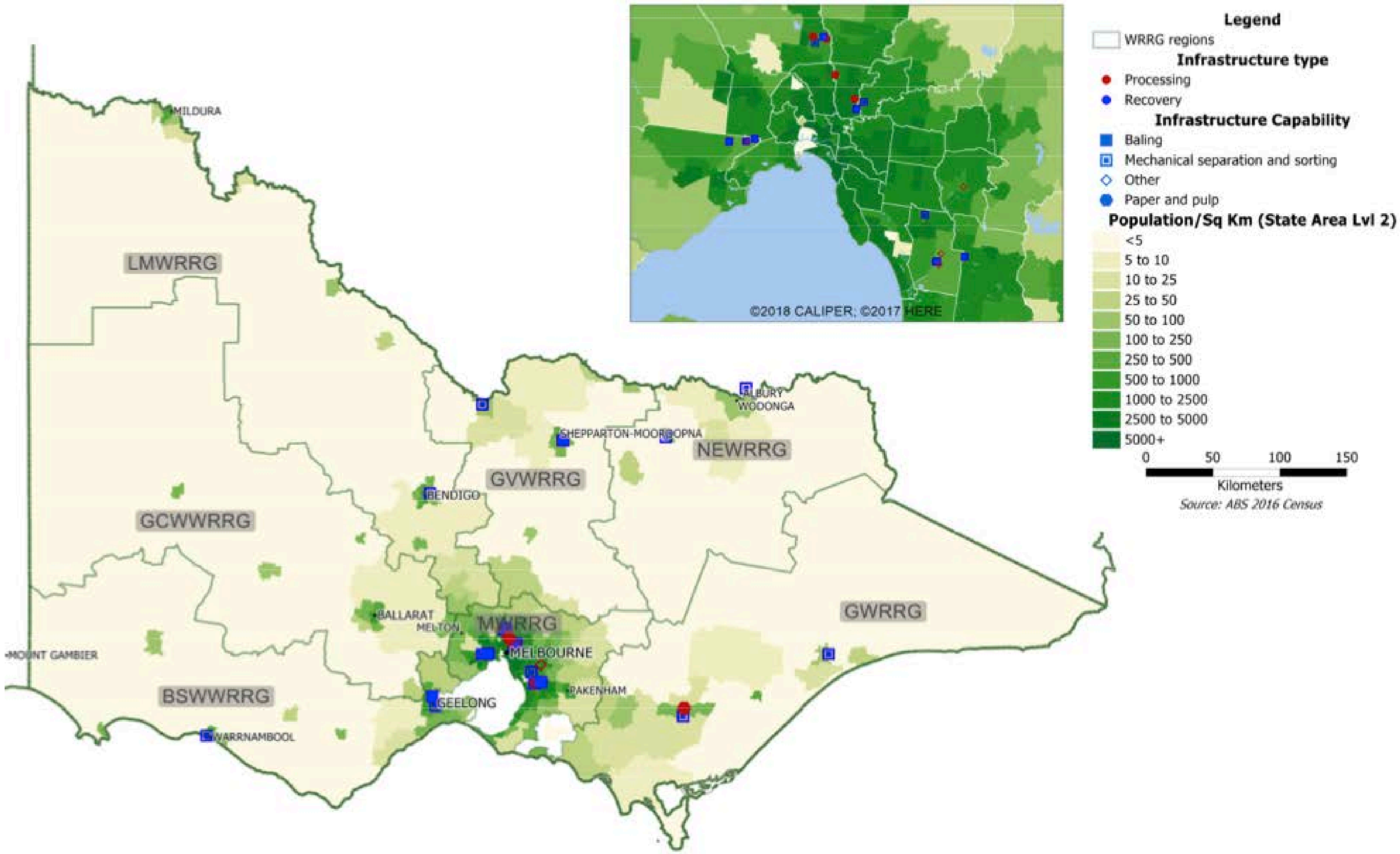

Figure 19: Paper and cardboard current recovery and reprocessing infrastructure

3.5.4 Capacity and capability – Paper and cardboard

Victoria is a major exporter overseas of paper accounting for between 40-50% of all paper exported from Australia[3].

Victoria's paper recovery infrastructure primarily consolidates and bales paper for transport to interstate sites or for overseas export.

The majority of MRFs in Victoria recover paper and cardboard from MRFs as either a mixed paper and cardboard or as a Baled paper and cardboard sorted by type. Similarly, paper and cardboard recovered from C&I is typically baled by type. Few MRF facilities have the capability to sort recovered mixed paper into separate streams by type.

The capability of Victoria's paper processing infrastructure is largely geared around recycling of recovered fibre back into paper and cardboard. Other processing capabilities exist for recovered paper in Victoria such as turning recovered paper into insulation. Paper is recovered for either local remanufacturing or export for pulping overseas.

	2022 (COAG Ban phased introduction)	2025 (COAG Ban fully implemented & 70% RR)	2030 (80% RR)	2039 (90% RR)
Generation	2,103,700	2,178,400	2,296,300	2,491,600
Current processing infrastructure capacity	1,116,105	1,116,105	1,116,105	1,116,105
Projected recovery required to meet policy settings	1,558,600	1,524,900	1,837,000	2,242,400
Excess or shortfall in capacity	-442,495	-408,795	-720,895	-1,126,295
	✗	✗	✗	✗

Table 12: Summary of current infrastructure capacity to meet future generation and policy settings

There are four paper mills in Victoria:

- Visy – Coolaroo
- Visy - Reservoir
- Australian Paper – Maryvale
- Asaleo Care – Box Hill

In addition to the paper mills, there are several other paper packaging processors and manufacturers and that sort, clean and bale papers into different paper and card grades for both domestic and export markets.

With the introduction of the COAG waste export ban, there will be insufficient capacity for Victorian paper mills to pulp paper to manage the tonnes of paper generated. Similarly, the remaining paper processors will not have the ability to meet the proposed export requirement for all tonnes of paper for export.

[3] Analysis of Australia's municipal recycling infrastructure capacity October 2018, Commonwealth of Australia 2018

3.5.5 Infrastructure capacity and capability 2018 to 2039

✗ Overall, there is insufficient infrastructure capacity and capability to manage End of Life paper and cardboard generation and recovery rates in 2018 through to 2039.

3.5.5.1 2024: COAG Waste Export Bans

✗ Presently there is insufficient capacity to reprocess recovered paper and cardboard in Victoria and meet the COAG Export Ban requirements.

By July 2024, all unsorted or mixed paper and cardboard will be banned from export. Paper will need to be sorted to a single type, pulped, or processed with other materials into a product ready for use, in order to be exported.

There is insufficient paper and cardboard reprocessing infrastructure in Victoria to to meet projected end of life paper and cardboard tonnes from 2024 onwards.

3.5.5.2 2025: APCO target and interim National Waste Policy resource recovery targets

✗ Presently there is insufficient capacity to 'recover' paper and cardboard in Victoria meet a 70% recovery rate target to achieve the National Waste Policy target of 80% by 2030.

✗ However, it must be noted that the definition of recovery includes collection and sorting which would see the wording of the National Waste Policy target achieved. Infrastructure Victoria's analysis suggests that true reprocessing capacity falls short.

3.5.5.3 2030 National Waste Policy 80% resource recovery rate

✗ Presently there is insufficient capacity to 'recover' paper and cardboard in Victoria and achieve the National Waste Policy target of 80% by 2030.

3.5.6 Paper and cardboard infrastructure investment opportunities across Victorian regions

✓ There is a need for additional pulping, paper sorting and paper baling infrastructure in Victoria. As well as Metropolitan Melbourne, Regional Victoria has historically proven to be suitable for the reprocessing of paper and cardboard and may be suitable for further consideration of new or additional infrastructure.

Additional opportunities exist to leverage other paper and cardboard manufacturing operations in Victoria such as bespoke packaging manufacturers.

3.5.7 Infrastructure Recommendations – Paper and cardboard

In order to manage future paper and cardboard streams in Victoria, significant investment will be required to manage shrinking international demand and at capacity existing paper pulping facilities.

The COAG export ban will place strain on Victoria's paper recovery sector to meet the new requirements.

Further investment will be needed in pulp mills, improved paper sorting at MRFs and C&I paper recovery facilities. There may be opportunities for further investment in bespoke paper manufacturing products such as fibre moulded packaging. With a concerted push by some governments, the community and some brands, to move away from plastic packaging, there may be opportunities for paper and card products to meet changing packaging demands and expectations.

3.5.8 Forecast Required Infrastructure Capital Expenditure - Paper and cardboard

Based on the analysis of waste generation, reprocessing capacity and capability, infrastructure proximity to end markets, the SWRRIP and regional plans, statewide hubs of significance, stated government priorities, and the ability to meet a range of policy and resource recovery target scenarios by 2039, Infrastructure Victoria recommends the following paper and cardboard infrastructure facility types and locations. Indicative capital expenditure has been presented with a range of low cost and high cost infrastructure facility types.

Pulp mills have been recommended to meet the new COAG requirements and/or domestic production requirements. Alongside this, upgrades to MRFs and C&I paper facilities are also recommended.

There is an opportunity for niche and bespoke paper and cardboard products to be produced to meet shifting consumer sentiment and corporate shifts away from single use plastics in packaging.

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Reprocessing	Processing facility	2	Other e.g. food fibre packaging and tissue, paper towel	Other	20,000	$3,000,000	$3,500,000	MWRRG	Dandenong South
Reprocessing	Processing facility	2	Other e.g. food fibre packaging and tissue, paper towel	Other	20,000	$3,000,000	$3,500,000	MWRRG	Laverton North
Reprocessing	Processing facility	1	Pulp mill	Paper and pulp	300,000	$45,000,000	$52,500,000	MWRRG	Dandenong South
Reprocessing	Processing facility	1	Pulp mill	Paper and pulp	300,000	$45,000,000	$52,500,000	MWRRG	Laverton North
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	LMWRRG	Bendigo
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	MWRRG	Coolaroo
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	MWRRG	Dandenong South
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	GVWRRG	Echuca
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	MWRRG	Heidelberg
Recovery	MRF	1	Paper - Mechanical separation and optical	Trommels, Screens, Air knives, Optical	40,000	$1,500,000	$3,000,000	MWRRG	Laverton North

			sorting	scanners, etc.					
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	GWRRG	Lucknow
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	GWRRG	Morwell
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	MWRRG	Springvale
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	MWRRG	Truganina
Recovery	MRF	1	Paper - Mechanical separation and optical sorting	Trommels, Screens, Air knives, Optical scanners, etc.	40,000	$1,500,000	$3,000,000	NEWRRG	Wangaratta
Recovery	SMRCs	1	C&I paper recovery	Baling	50,000	$8,500,000	$10,000,000	GCWRRG	Ballarat
Recovery	SMRCs	1	C&I paper recovery	Baling	50,000	$8,500,000	$10,000,000	MWRRG	Coolaroo
Recovery	SMRCs	1	C&I paper recovery	Baling	50,000	$8,500,000	$10,000,000	MWRRG	Dandenong South
Recovery	SMRCs	1	C&I paper recovery	Baling	50,000	$8,500,000	$10,000,000	BSWRRG	Geelong
Recovery	SMRCs	1	C&I paper recovery	Baling	50,000	$8,500,000	$10,000,000	MWRRG	Laverton North
Recovery	SMRCs	1	C&I paper recovery	Baling	50,000	$8,500,000	$10,000,000	MWRRG	Truganina
Total		23			1,380,000	$163,500,000	$205,000,000		

Table 13: Paper and cardboard forecast indicative infrastructure type, costs, locations

3.5.9 Forecast Required Infrastructure Map – Paper and cardboard

The map below shows indicative locations that would be suitable for paper and cardboard recovery and reprocessing infrastructure based on Infrastructure Victoria's analysis. Note: the paper locations in yellow below, are where existing MRFs could benefit from improved paper sorting and separation.

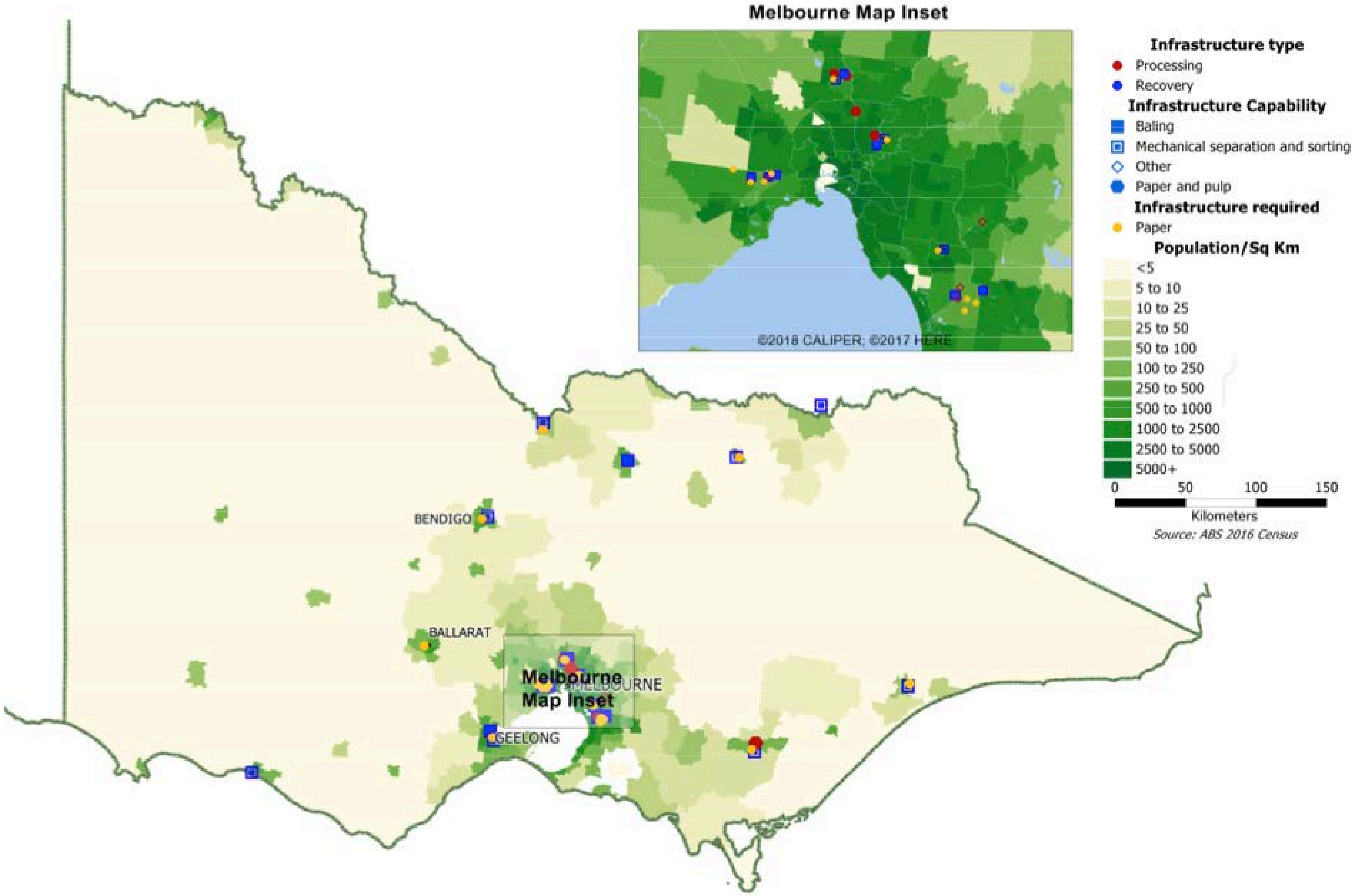

Figure 20: Paper and cardboard forecast indicative infrastructure locations

3.6 Plastics

Plastics are made from a range of different polymers, generally stemming from petrochemicals. The polymer composition and use of additives for different uses affects resource recovery outcomes.

There seven key plastic types which are used in different markets and applications and have considerably different resource recovery fates. Broadly, plastics can be described as being either rigid or flexible. Typical uses of each plastic type are illustrated below.

It is helpful to consider the typical uses of each plastic code in order to understand product sources, consumer behaviours, recovery options, recovery rates, resource recovery infrastructure technology, extended producer responsibility, fit-for-purpose uses and market development.

1 PETE	2 HDPE	3 PVC	4 LDPE	5 PP	6 PS	7 OTHER
polyethylene terephtalate	high-density polyethylene	polyvinyl chloride	low-density polyethylene	polypropylene	polystyrene	other plastics
soft drink bottles, mineral water, fruit juice containers, cook oil	milk bottles, cleaning agents, laundry detergeants, shampoo bottles, soaps	food trays, plastic packing, food wrap	plastic shopping bags, bread bags, film wrap	ice cream containers and lids, butter and margarine containers, furniture, luggage, toys, automotive parts including bumper bars, plant pots	foam cups, takeaway containers, moulded packaging, meat trays, butter margarine and yoghurt containers, toys, refrigerator trays, cosmetic bags, hard consumer goods packaging	including acrylic, fibreglass, nylon, polycarbonate, polyactic fibres

Figure 21: Plastics polymer codes and typical uses

3.6.1 Material reprocessing approaches – Plastics

In Victoria, the recovery of plastics in Victoria typically follows two pathways:

- MSW sources such as kerbside co-mingled recycling collection services that are transported to MRFs for sorting by plastic polymer type.
- Commercial and Industrial sources that include both pre-consumer plastics such as manufacturing off-cuts and post-consumer plastics such as packaging, agricultural films and wraps, horticultural products such as wraps and pots, automotive products, piping, and much more.

3.6.2 Current reprocessing

Plastics recovery and reprocessing relies on sorting by plastic polymer code at MRFs and/or other Waste and Resource Recovery facility (WRRF) for sorting. Reprocessing typically involves transforming sorted plastic into a new form ready for manufacturing.

3.6.2.1 MRF plastics sorting

MRFs recover and sort plastics in either of two ways:

I. Into three different streams comprising:
   a. PET (1) sorted bales
   b. HDPE (2) sorted bales
   c. Mixed plastics bales known as 2:2:6 bales (20% PET, 20% HDPE, 60% other)

II. Single mixed plastics bales (incorporating plastics 1 to 7)
   a. Mixed plastics bales known as 4:4:2 (40% PET, 40% HDPE, 20% other)

After plastics are sorted and baled at a MRF, the plastics are then sold either to a domestic reprocessor for secondary processing or are exported for further reprocessing overseas. For the last two decades, undertaking domestic sorting only has been the dominant pathway for recovered plastics as it has:

- Required a lower investment in local reprocessing infrastructure
- Required lower operating and labour overheads
- Delivered sorted plastics scrap to existing reprocessing infrastructure that is closer to the source of the majority of global plastics manufacturing in Asia where there is greater demand for plastics feedstocks

3.6.2.2 Reprocessing

After plastic has either been sorted via a MRF or sorted at source (such as by plastics stream at a commercial generation point e.g. at a manufacturing business) it is transported to a reprocessor for a physical change in composition from a recovered product to a new form as a feedstock for manufacturing.

This may take many steps including mechanical shredding, washing, granulating, flaking by single polymer type or pelletising by single polymer type. Once the plastic is reprocessed it is ready for use in the manufacturing of new products.

The reprocessing steps are illustrated in the chart below.

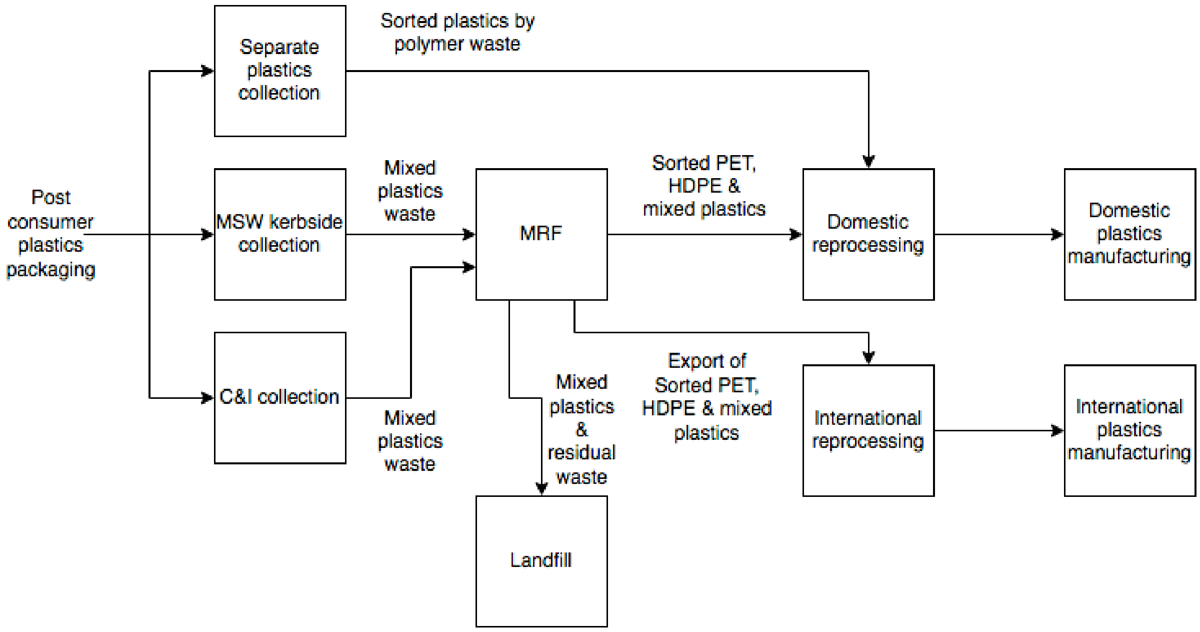

Figure 22: Plastics recovery and reprocessing steps

Presently, the vast majority of recovered Victorian plastic used as a recycled feedstock for remanufacturing in Victorian industry is sourced through C&I channels not from MSW. This is because it is typically a cleaner, more consistent source of plastics by code, free of contamination and available in consistent tonnages.

3.6.3 Emerging reprocessing

Chemical and Thermal processing: Techniques such as chemical recycling to return plastics to their original monomer form or pyrolysis (thermal treatment in the absence of any reactive gases such as air or oxygen) to recover fuels are emerging as possible approaches for recovering plastics that yield high value feedstocks and have the potential to manage hard to recover plastics.

3.6.4 Infrastructure map current – Plastics

The map below shows the current plastics recovery infrastructure and the current plastics reprocessing infrastructure located and operating in Victoria.

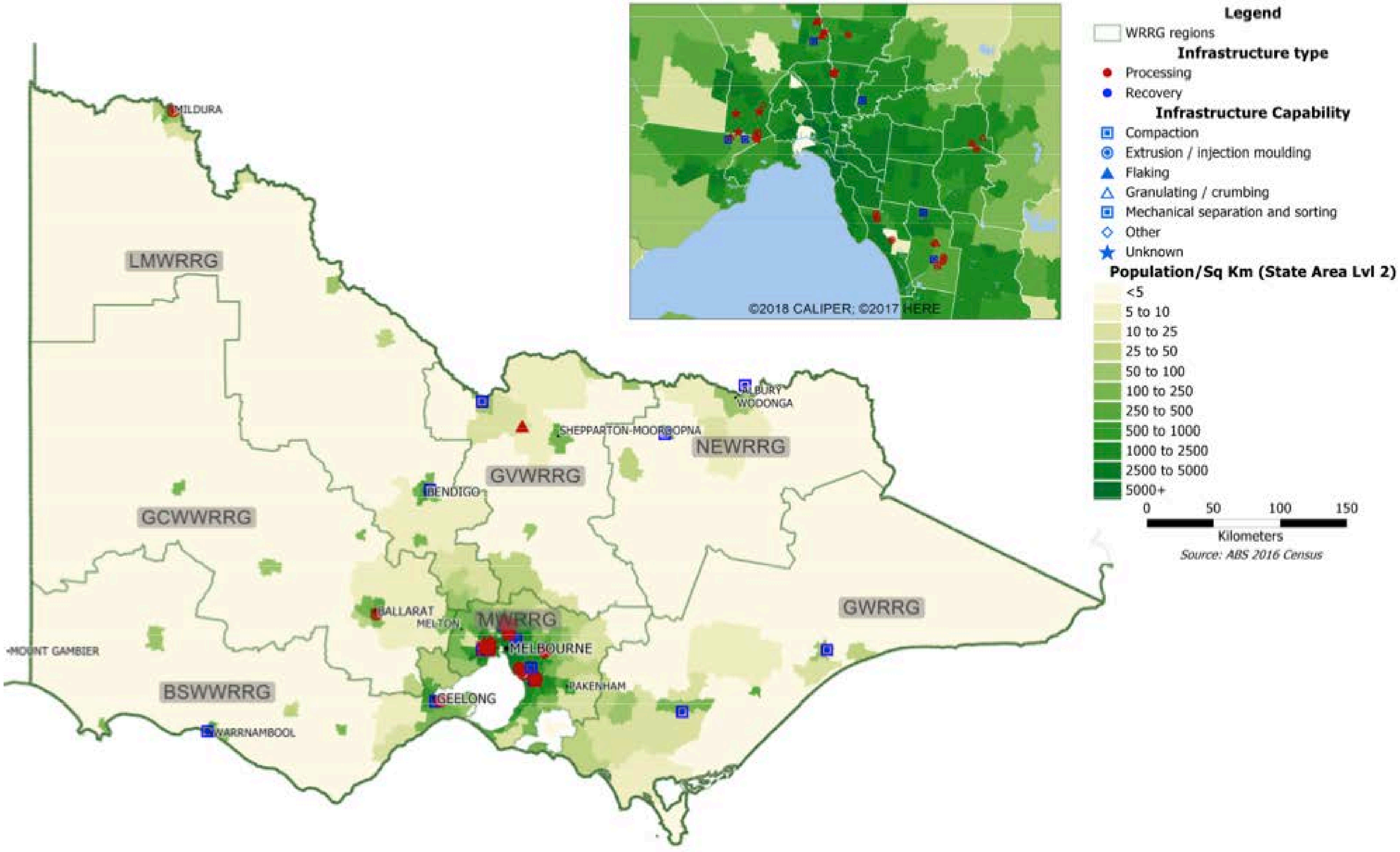

Figure 23: Plastics current recovery and reprocessing infrastructure

3.6.5 Capacity and capability – Plastics

Victoria's plastics recovery infrastructure predominantly focused on sorting by plastics polymer type.

Presently approximately 65% of plastics recovered in Victoria are exported, predominantly in one of sorted baled mixed plastics. These practices will no longer be viable if an export market is the preferred destination under the COAG export ban.

Additionally, mixed plastics bales are not reprocessed to a sufficient quality to leverage the existing capacity of domestic plastics reprocessing facilities and domestic manufacturers who typically require the material to be presented as a flake, granule or pellet. Effectively a major shift is required to re-orientate the plastics recovery sector from low-value exports to either higher value export or increased domestic production with recycled plastics.

	2022 (COAG Ban phased introduction)	2025 (COAG Ban fully implemented & 70% RR)	2030 (80% RR)	2039 (90% RR)
Generation	618,600	641,100	676,700	735,300
Current processing infrastructure capacity	160,050	160,050	160,050	160,050
Projected recovery required to meet policy settings	144,900	448,700	541,300	661,800
Excess or shortfall in capacity	15,150	-288,650	-381,250	-501,750
	✓	✗	✗	✗

Analysis based on tonnes managed alone is an insufficient measure to understand the capability of the plastics recovery sector in a fast moving space with significant market and regulatory changes occurring such as other countries introducing strict contamination requirements for the importation of wastes as well as the upcoming Australian Government export ban on waste plastics, paper and cardboard, glass and tyres. The capability of Victoria's recovery infrastructure to meet end market and regulatory requirements will be the key investment challenge.

3.6.5.1 2024: COAG Waste Export Bans

✓ Technically, there is initially sufficient capacity to reprocess recovered plastics in Victoria and meet COAG Export Ban requirements.

✗ However, whilst there is initially sufficient reprocessing capacity, Victorian collection systems and MRFs do not have the capability to sort the material sufficiently by plastics type to send to Victorian reprocessing facilities for flaking and pelletising. Without this, Victoria will not be able to meet the export ban requirements nor leverage existing plastics reprocessing capacity. And by 2025, plastics capacity will be exceeded by plastics recovery.

3.6.5.2 2025: APCO target and interim National Waste Policy resource recovery targets

❌ Presently there is insufficient capacity to recover and reprocess plastics in Victoria to meet the APCO 70% plastics recovery rate target by 2025.

❌ Resource recovery rates for plastics are very low at 23%, requiring significant behaviour change in people's recycling practices to complement any infrastructure upgrades in order to meet the APCO 70% recovery rate target by 2025.

3.6.5.3 2030 National Waste Policy 80% resource recovery rate

❌ Presently there is insufficient capacity to recover and reprocess plastics in Victoria to achieve the National Waste Policy target of 80% by 2030.

❌ As per above, this achievement is dependent on complementary behaviour change initiatives to drive higher resource recovery rates.

3.6.6 Infrastructure Recommendations – Plastics

There is an immediate for investment in improved plastics recovery infrastructure and plastics reprocessing infrastructure.

3.6.6.1 Plastics sorting

Current approaches to plastics sorting and reprocessing will be insufficient to manage future plastics generation due to export market demands, the draft COAG export ban and any local demand for recovered plastics at scale.

Infrastructure to recover plastics into the future will need to be capable of sorting by single polymer type and processing as into flakes, granules or pellets.

There is not a single MRF facility in Victoria that is able to meet the planned July 2022 export requirements at scale to meet all the plastics inputs they receive. MRFs will require improvements to operations to separate plastics by individual polymer code either through increased manual sorting, improvements to mechanical sorting and increased optical sorting. Without further upgrades, many MRFs would need to run plastics through recovery lines multiple times to separate plastics by polymer codes suggesting further investment in capacity may be required.

3.6.6.2 Plastics reprocessing

Further investment is required in plastics reprocessing infrastructure including to mechanically shred, wash, granulate, flake by single polymer type or pelletise by single polymer type. Investment in both metropolitan Melbourne and regional Victoria would be appropriate. Regional Victoria has historically proven to be suitable for the reprocessing of plastics and there are opportunities for regional flaking and pelletising infrastructure.

3.6.6.3 Leveraging Victoria's existing plastics resins manufacturing industry

It is worth noting that Victoria potentially has significant competitive advantage and existing plastics manufacturing infrastructure that could be leveraged to manage this challenge. Victoria is currently home to two major plastics resins manufacturing businesses.

Qenos has resins manufacturing production operations in NSW and in Altona, Victoria. Qenos is the sole manufacturer of polyethylene in Australia.

LyondellBasell has resins manufacturing production operations in NSW and Geelong, Victoria. LyondellBasell is the sole manufacturer of polypropylene in Australia.

The presence of these two major resins manufacturers in Victoria, with considerable market access, represents a significant opportunity to use recovered plastics in resins manufacturing in Australia.

There may also opportunities to leverage existing plastics extrusion infrastructure that was previously used to supply parts to Australia’s local car manufacturing sector.

3.6.7 Forecast Required Infrastructure Capital Expenditure - Plastics

Based on the analysis of waste generation, reprocessing capacity and capability, infrastructure proximity to end markets, the SWRRIP and regional plans, statewide hubs of significance, stated government priorities, and the ability to meet a range of policy and resource recovery target scenarios by 2039, Infrastructure Victoria recommends the following plastics infrastructure facility types and locations. Indicative capital expenditure has been presented with a range of low cost and high cost infrastructure facility types.

Further investment is required in plastics reprocessing infrastructure including to mechanically shred, wash, granulate, flake by single polymer type or pelletise by single polymer type.

Victoria potentially has significant competitive advantage and existing plastics manufacturing infrastructure (Qenos and Lyondell Basell) that could be leveraged to manage this challenge.

There are opportunities for infrastructure investment in both metropolitan Melbourne and regional Victoria.

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Reprocessing	Processing facility	1	Chemical processing	Chemical processing	20,000	$34,000,000	$40,000,000	MWRRG	Dandenong South
Reprocessing	Processing facility	2	Chemical processing & Flaking & pelletising plant (food grade)	Chemical processing	70,000	$67,350,000	$90,000,000	MWRRG	Altona
Reprocessing	Processing facility	4	Chemical processing, Pelletising plant, Flaking & pelletising plant (food grade)	Chemical processing	145,000	$104,850,000	$143,760,000	BSWWRRG	Geelong
Reprocessing	Processing facility	1	Flaking & pelletising plant - Small	Extrusion / injection moulding	10,000	$6,670,000	$10,000,000	GWRRG	Bairnsdale
Reprocessing	Processing facility	2	Flaking & pelletising plant - Small	Extrusion / injection moulding	20,000	$13,340,000	$20,000,000	LMWRRG	Bendigo
Reprocessing	Processing facility	1	Flaking & pelletising plant - Small	Extrusion / injection moulding	10,000	$6,670,000	$10,000,000	LMWRRG	Mildura
Reprocessing	Processing facility	1	Flaking & pelletising plant - Small	Extrusion / injection moulding	10,000	$6,670,000	$10,000,000	GWRRG	Morwell
Reprocessing	Processing facility	1	Flaking & pelletising plant - Small	Extrusion / injection moulding	10,000	$6,670,000	$10,000,000	GVWRRG	Shepparton
Reprocessing	Processing facility	1	Flaking & pelletising plant - Small	Extrusion / injection moulding	10,000	$6,670,000	$10,000,000	BSWWRRG	Warrnambool
Reprocessing	Processing facility	1	Flaking & pelletising plant - Small	Extrusion / injection moulding	10,000	$6,670,000	$10,000,000	NEWRRG	Wodonga
Reprocessing	Processing facility	2	Flaking & pelletising plant (food grade)	Extrusion / injection moulding	100,000	$45,850,000	$64,285,000	GCWRRG	Ballarat

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Reprocessing	Processing facility	1	Pelletising plant	Extrusion / injection moulding	25,000	$25,000,000	$39,475,000	MWRRG	Laverton North
Reprocessing	Processing facility	2	Pelletising plant & Flaking, pelletising plant	Extrusion / injection moulding	75,000	$37,500,000	$53,760,000	MWRRG	Campbellfield
Total		20			515,000	$367,910,000	$511,280,000		

Table 14: Plastics forecast indicative infrastructure type, costs, locations

3.6.8 Forecast Required Infrastructure Map – Plastics

The map below shows indicative locations that would be suitable for plastics recovery and reprocessing infrastructure based on Infrastructure Victoria's analysis.

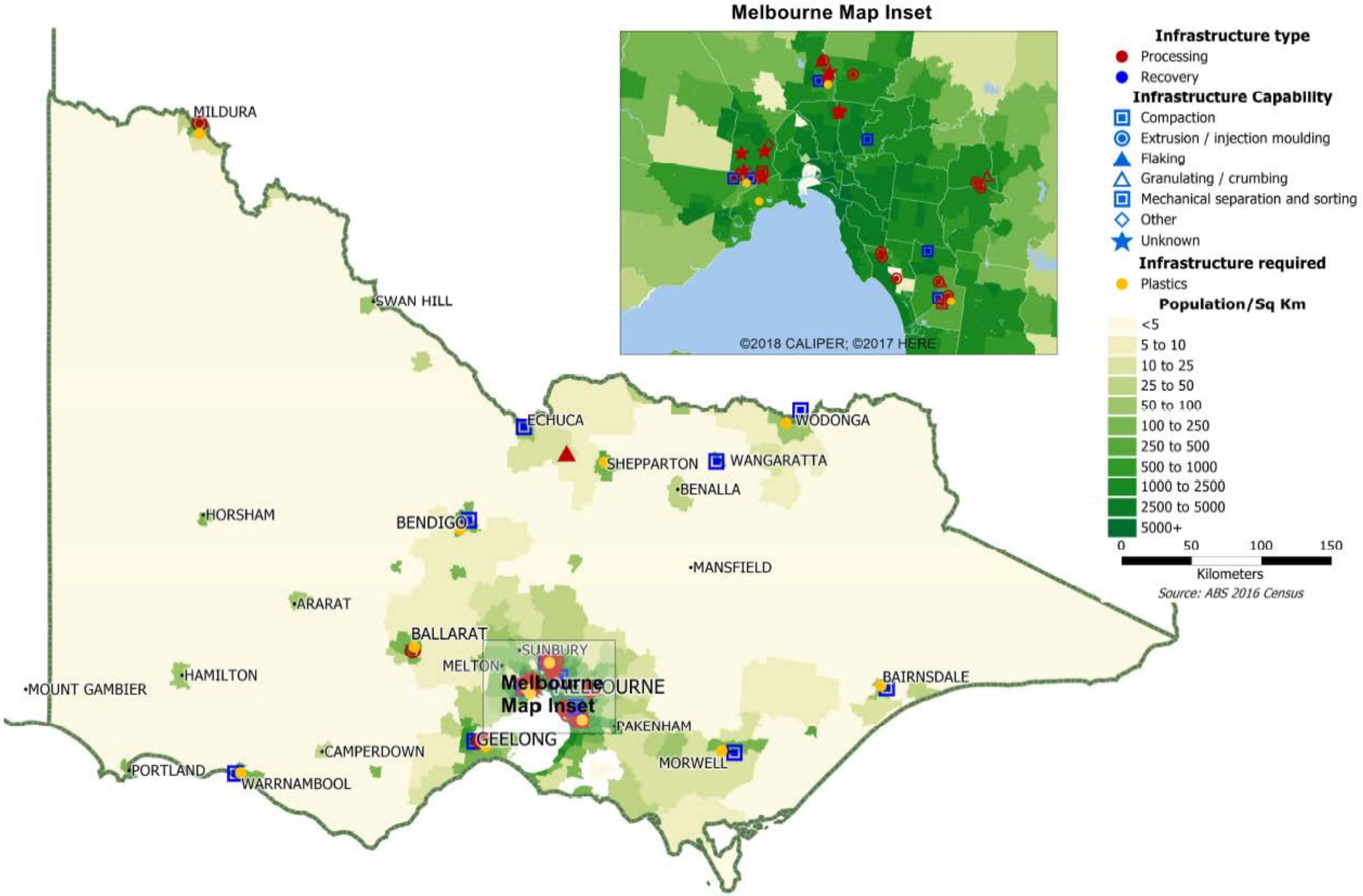

Figure 24: Plastics forecast indicative infrastructure locations

3.7 Tyres

Tyres have long been a challenge for resource recovery. There are several problems with the supply chain that can lead to the stockpiling of End of Life (EOL) tyres. Three specific problems with the stockpiling of EOL tyres are:

i. Stockpiled tyres that catch fire are difficult to extinguish and pose significant health risks to fire fighters and the local community through air pollution and contamination of waterways, ground water and soil.
ii. Large tyre stockpile sites pose a potential financial risk to the state if they are abandoned.
iii. Operators that are stockpiling only (i.e. no further processing) are receiving unfair market advantage over legitimate operators in avoiding the true cost of EOL tyre management.

Many barriers have been identified by government agencies throughout Australia, as well as Tyre Stewardship Australia, the national tyre product stewardship organisation to administer the Tyre Product Stewardship Scheme. Barriers to increasing EOL tyre recovery include:

- disparities in the current costs imposed by retailers for collection and disposal of EOL tyres
- high cost of infrastructure to reprocess EOL tyres
- the impact of cheap imported products (contributing to free riding in the national product stewardship scheme)
- limited acceptance of recycled-content products within specifications or tender documents
- barriers to energy from waste, and
- barriers to addressing existing stockpiles.

3.7.1 Material reprocessing approaches – Tyres

Tyres are managed in three broad categories:

i. Passenger
ii. Truck
iii. Off The Road (OTR)

3.7.2 Current reprocessing

Presently for Victorian End-of-Life Tyres (EOLTs), tyre collectors and reprocessors predominantly manage tyres in either of two ways:

Export as is:

- Whole tyres/casings
- Baled tyres

Mechanical reprocessing for both domestic and export markets:

- Shredded tyres for use as Tyre Derived Fuel (TDF)
  - Predominantly Passenger tyres, shredded to a TDF specification for export markets
  - Typically shredded to 50-80mm in size for use as fuel in cement kilns, paper and pulp facilities, and other industrial needs.
- Granule/buffings

- o Granules are typically processed to 2-15mm granules for use in soft-fall matting, synthetic sportsgrounds and athletics tracks, and playground bases.
  - o Buffings are less than 2mm (commonly 4,12 and 16 mesh) and can be used in equestrian surfaces, matting and athletics tracks.
- Crumb rubber
  - o Processing to a powder for use in high-value applications including roads construction and in other manufacturing needs such as adhesives.
- Steel is also removed at each stage of the recycling process.
- Textiles are also used in passenger vehicles tyres and nylon fabric can also be recovered during the recycling process.

The tyres recovery and reprocessing steps are illustrated below in the chart below.

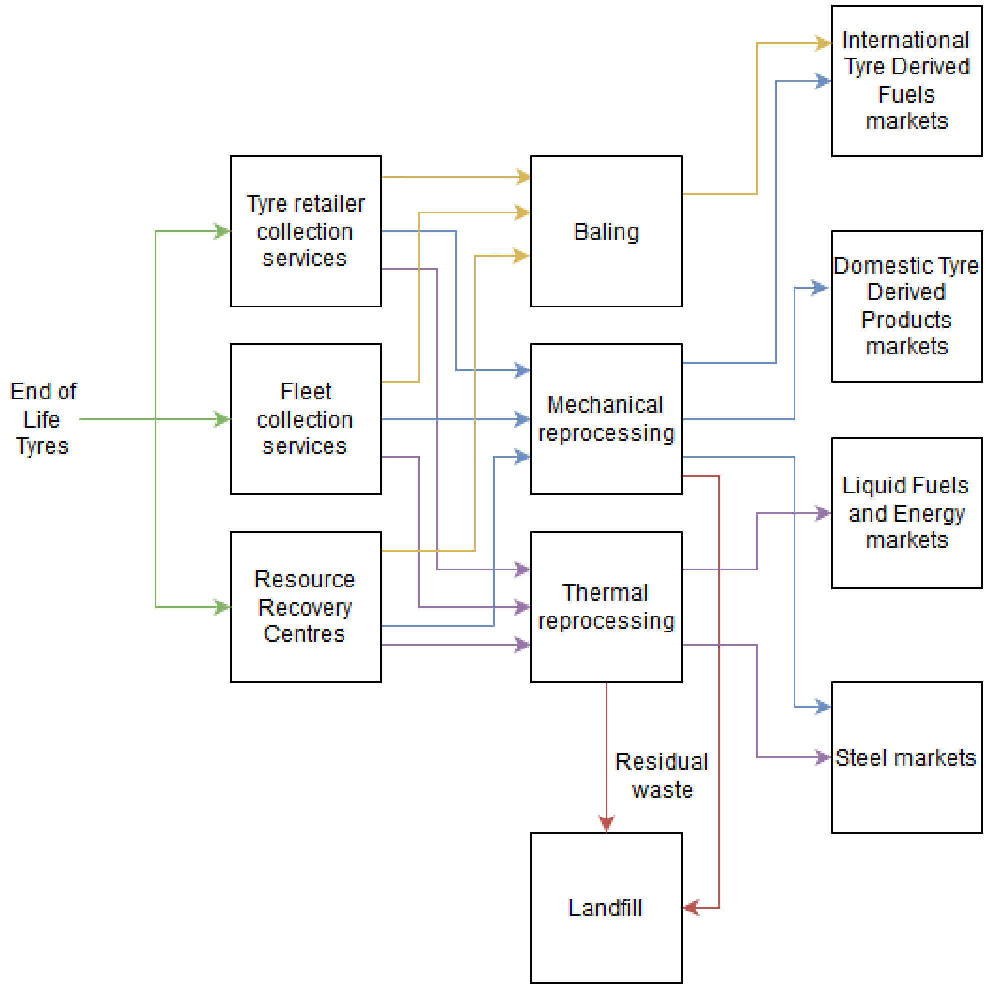

Figure 25: Tyres recovery and reprocessing steps

3.7.3 Emerging reprocessing

There are a range of thermal treatment technologies that whilst technically achievable, have not been successfully commercialised in Australia and globally has been limited. Pyrolysis and gasification are two methods of thermal tyre processing that have gained prominence. Both thermal methods use processes to decompose and separate the constituent tyre components to recover end products including oil, syngas, char and steel.

Additionally, there are other thermal treatment technologies for tyres reprocessing as detailed in the illustration below.

Pyrolysis and gasification

- Thermal desorption
- Carbon depolymerisation
- Solar assisted pyrolysis or gasification
- Thermal micronising
- Thermal decomposition
- Plasma gasification
- Destructive distillation

Other thermal processing technologies

- Incineration of shredded tyres
- Thermophilic treatment
- Co-gasification with biomass
- Torrefaction
- Liquefaction

Setting aside the technical challenges of establishing thermal tyre treatment technologies at a commercial scale, there are several commercial and market challenges that to date have prevented thermal tyre treatment from entering the market at scale. Challenges include:

- The high capital costs to construct a plant that can achieve Australian development and environmental compliance
- Tyranny of distance to collect tyres throughout Australia
- Access to feedstock at a commercially competitive rate
- Commercial uncertainty in a relatively unproven technologies at commercial scale

Additionally, proponents of tyres pyrolysis have a poor compliance record with planning and EPA requirements. In Victoria, several notable tyre stockpiles were amassed under the guise of pyrolysis developments that never eventuated.

3.7.4 Infrastructure map current – Tyres

The map below shows the current tyres recovery infrastructure and the current tyres reprocessing infrastructure located and operating in Victoria.

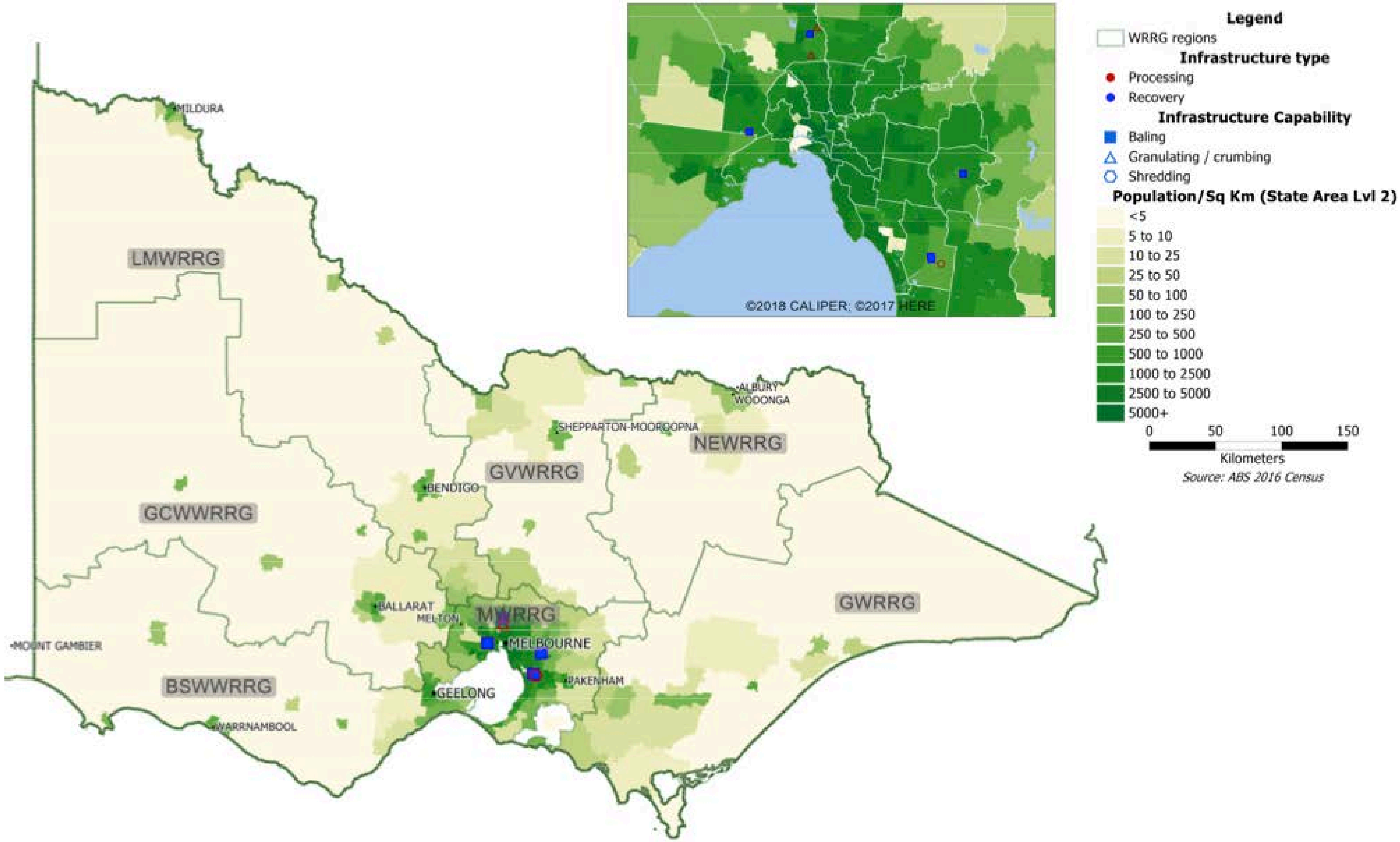

Figure 26: Tyres current recovery and reprocessing infrastructure

3.7.5 Capacity and capability – Tyres

The COAG waste export ban requires that by December 2021, all whole tyres, including baled tyres will be banned from export, with whole bus, truck and aviation tyres exempt. All other tyres will need to be either shredded for use as a tyre derived fuel, or further processed into crumb rubber, granules or powder.

Even with the removal of tyre baling capacity, there is still excess tyres reprocessing capacity from 2018 through to 2039 in Victoria with two existing Victorian tyre shredding businesses that can manage Victorian's end-of-life tyre generation and meeting domestic and export market requirements. However, it is noted that this will likely result in further market consolidation of tyre reprocessing in Victoria.

	2022 (COAG Ban phased introduction)	2025 (COAG Ban fully implemented & 70% RR)	2030 (80% RR)	2039 (90% RR)
Generation	96,400	99,700	104,900	113,600
Current processing infrastructure capacity	112,500	112,500	112,500	112,500
Projected recovery required to meet policy settings	83,400	69,800	83,900	102,200
Excess or shortfall in capacity	29,100	42,700	28,600	10,300
	✓	✓	✓	✓

Table 15: Summary of current infrastructure capacity to meet future generation and policy settings

3.7.6 Infrastructure capacity and capability 2018 to 2039

✓ Overall, there is sufficient infrastructure capacity and capability to manage End of Life tyres generation and recovery rates in 2018 through to 2039.

3.7.6.1 2024: COAG Waste Export Bans

✓ Presently there is sufficient capacity to reprocess recovered tyres in Victoria and meet the COAG Export Ban requirements.

The COAG waste export ban requires that by December 2021, all whole tyres, including baled tyres will be banned from export (except for those that are exempt – bus, truck and aviation). Tyres will need to be either shredded for use as a tyre derived fuel, or further processed into crumb rubber, granules or powder.

There is sufficient mechanical infrastructure in Victoria to shred or crumb tyres to meet a range of product specification requirements.

3.7.6.2 2025: APCO target and interim National Waste Policy resource recovery targets

✓ Presently there is sufficient capacity to reprocess recovered tyres in Victoria and meet a 70% recovery rate target to achieve the National Waste Policy target of 80% by 2030.

It is worth noting though that this is dependent on a continuation of shredding tyres for export as Tyre Derived Fuel. Presently all Passenger tyres are either baled or shredded for export. Crumb rubber in Victoria and Australia is only produced from Truck tyres. If demand increases for Tyre Derived Products, there may be an opportunity for further infrastructure investment for the removal of textiles/fluff from Passenger tyres to enable crumbing to occur.

3.7.6.3 2030 National Waste Policy 80% resource recovery rate

✓ Presently there is sufficient capacity to reprocess recovered tyres in Victoria and achieve the National Waste Policy target of 80% by 2030.

As per above, this achievement is dependent on a continuation of shredding tyres for export as Tyre Derived Fuel.

3.7.7 Tyre infrastructure investment opportunities across Victorian regions

✓ Metropolitan Melbourne for de-fluffing infrastructure to enable passenger vehicle tyres to be crumbed in future years.

✗ Regional Victoria is unlikely to be viable for mechanical reprocessing of tyres to comparatively low tonnages and the high capital investment required.

All tyre reprocessing in Victoria of note is located within metropolitan Melbourne. Given the high-level of investment required for mechanical reprocessing of tyres, either as shred or crumb, it is likely that any future investments will continue to occur in Melbourne.

Several attempts at regional reprocessing has occurred over the years, predominately under the guise of establishing tyres pyrolysis facilities. None of this have managed to be successful. In fact, the opposite has occurred with proposed pyrolysis facilities resulting in notable stockpiles such as Stawell and Numurkah, both of which have recently been cleaned up by EPA and the respective local governments.

It is worth noting, that one tyre reprocessing business, Tyrecycle, has invested in a mobile shredder that can be used in regional areas as required. However, the clean-up operations for the aforementioned Stawell and Numurkah tyre stockpiles, both undertaken by Tyrecycle, has seen all tyres removed and transported to Tyrecycle's Melbourne operations for reprocessing. This is understood to be due to the size of the stockpiles and condition of the stockpiled tyres which have required the larger capacity and capability of stationery reprocessing equipment.

3.7.8 Infrastructure Recommendations – Tyres

There is no immediate for investment in tyres reprocessing capacity however there are opportunities to improve domestic tyre recovery and reprocessing outcomes particularly for end of life passenger vehicle tyres.

3.7.9 Tyres infrastructure investment recommendations and forecast costs

✗ There is no immediate need for future investment in tyres reprocessing infrastructure in Victoria to meet a range of policy and target scenarios.

3.7.9.1 Mechanical fibre separation infrastructure

✓ There may be a need for further investment in Metropolitan Melbourne for de-fluffing infrastructure to enable passenger vehicle tyres to be crumbed in future years. However, there is sufficient reprocessing capability and capacity to meet any additional increases to the tyres resource recovery rate.

Passenger vehicle tyres are successfully de-fluffed, crumbed and blended with Truck tyres in Northern American markets such as California. There is an increasing interest from Victorian end markets such as the roads construction sector as to the viability of using crumb rubber from passenger vehicle tyres. Presently one small tyre crumbing operator in Melbourne has the capability to de-fluff passenger vehicle tyres.

A recent literature review by ARRB for Victoria's Department of Transport[4] determined that there are presently no specification barriers preventing the use of passenger vehicle tyres in roads, however, ARRB cautioned that further research may be required to determine optimal application of crumb rubber derived from passenger vehicle tyres. De-fluffing infrastructure is likely to require an investment of $6m to $8m.

3.7.10 Forecast Required Infrastructure Capital Expenditure - Tyres

Based on the analysis of waste generation, reprocessing capacity and capability, infrastructure proximity to end markets, the SWRRIP and regional plans, statewide hubs of significance, stated government priorities, and the ability to meet a range of policy and resource recovery target scenarios by 2039, Infrastructure Victoria recommends the following tyres infrastructure facility types and locations. Indicative capital expenditure has been presented with a range of low cost and high cost infrastructure facility types.

No further tyre reprocessing to shred tyres is required in Victoria to meet current domestic and export market demands. However, should there be interest in building domestic demand for Tyre Derived Products from passenger tyres, then there is an opportunity for investment in increased fibre separation infrastructure. It is recommended that such infrastructure be located in Melbourne's northern suburbs where Victoria's two major tyre reprocessing businesses are located.

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Reprocessing	Processing facility	1	Fibre separation plant	Other	15,000	$6,000,000	$8,025,000	MWRRG	Somerton
Total		1			15,000	$6,000,000	$8,025,000		

Table 16: Tyres forecast indicative infrastructure type, costs, locations

[4] ARRB, 2019, Literature Review on Passenger Vehicle Usage in Bitumen https://www.vicroads.vic.gov.au/-/media/files/technical-documents-new/technical-reports-and-bulletins/technical-report-tr-216-literature-review-on-the-use-of-passenger-vehicle-tyres-in-bitumen.ashx

3.7.11 Forecast Required Infrastructure Map – Tyres

The map below shows indicative locations that would be suitable for tyres recovery and reprocessing infrastructure based on Infrastructure Victoria's analysis.

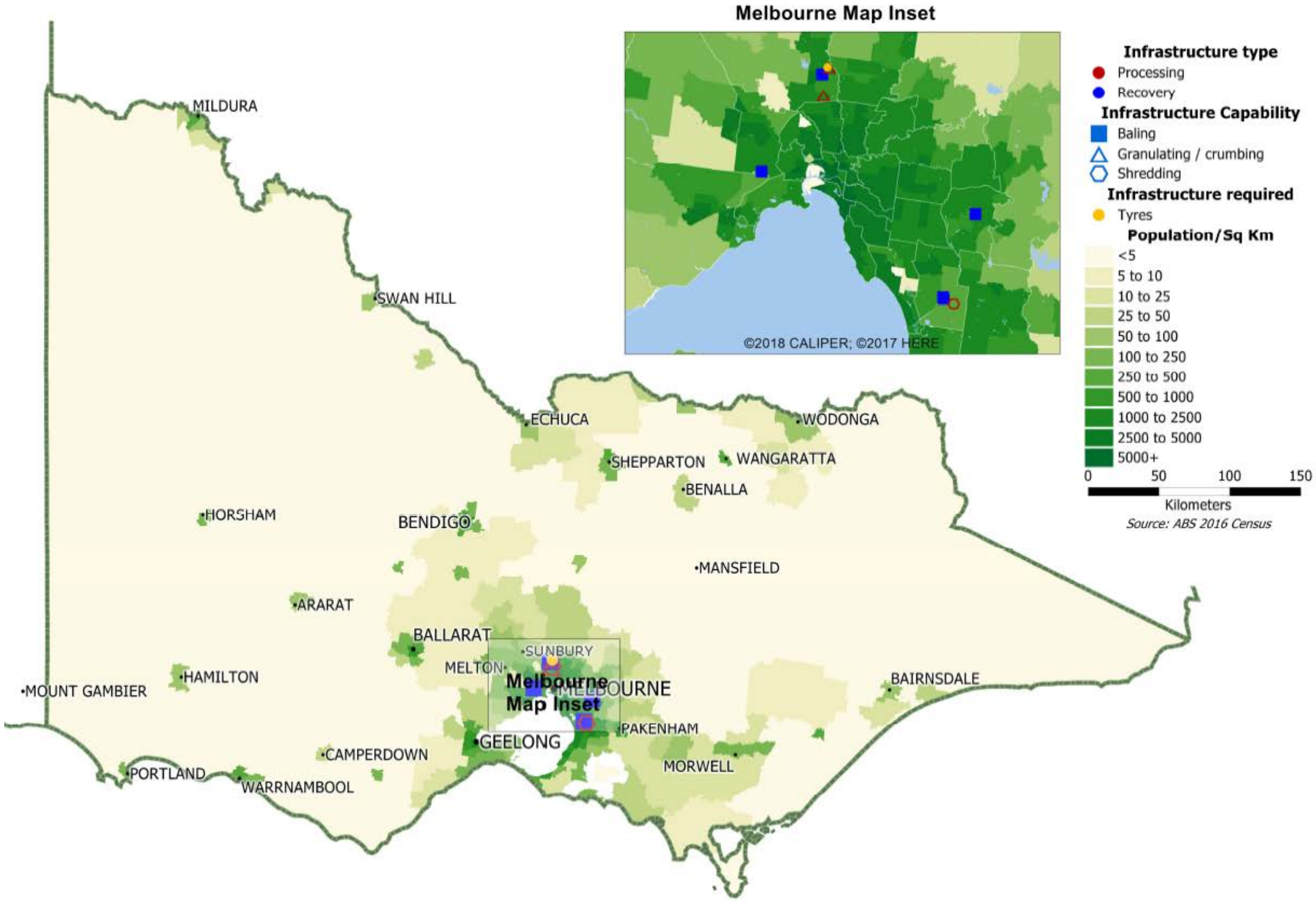

Figure 27: Tyres forecast indicative infrastructure locations

3.8 Additional Infrastructure

In addition to the priority materials specific infrastructure identified in this gap analysis, there are several infrastructure facilities that manage mixed waste streams where further investment is required to achieve improved outcomes for resource recovery in Victoria.

3.8.1 Materials Recovery Facilities

MRFs in Victoria sort recyclable material streams into single-material and mixed material streams which are then on-sold to dedicated materials reprocessors.

MRFs primarily manage glass, paper and cardboard, metals and plastics. MRFs recover materials to the best of their abilities through manual, mechanical and optical sorting approaches. Glass is sorted by colour, metals sorted by ferrous and non-ferrous, paper and cardboard sorted by type, and plastics are sorted by polymer type, predominately by PET (1), HDPE (2), and mixed plastics.

Technology / system	Target waste / material	Maturity	Barriers	Enablers	Current Victorian context and direction of travel
MRF (clean): *Sort recyclable material streams into single-material and mixed material streams.*	Commingled recycling from MSW, C&I sources to extract: Glass Paper and cardboard Metals Plastics	Well established in Victoria	Fluctuations in market demand can lead to stockpiling Contamination through incorrect disposal by waste generators and also problematic accepted materials such as glass fines OH&S risks with manual operation and picking Varying material acceptance and inconsistency Fire risks Large capital expenditure required for technology upgrades	Creation of infrastructure: i.e. networks or reuse centres Market development: development of alternative uses for glass recyclables Contractual changes that include recyclable materials and exclude difficult to recycle materials Education programmes Co-location with reprocessing facilities	The number of sorting and processing facilities in Victoria has increased by approximately 22% between 2012 and 2018 based on Sustainability Victoria data. However, market consolidation has seen decline in number of operators with significant market share. Stockpiling as a result of the collapse of export recyclables markets has led to some MRF operators going out of business, and many recycling contracts are currently facing uncertainty in Victoria. Stemming from this, there have been several fires at MRF sites throughout Victoria in recent years. Optical sorting technology is now mature and used in the majority of medium-large MRFs. This is an area of ongoing refinement and further investment will be required by MRF operators to meet changing market
MRF (dirty): *Also known as mixed-waste MRFs, process material which*	MSW / C&I / C&D residual waste to extract: Organics:	Well established globally	Market challenges Contamination Fire risks	Market: demand for end products Infrastructure Development: expand C&D	

Technology / system	Target waste / material	Maturity	Barriers	Enablers	Current Victorian context and direction of travel
cannot be cleaned sufficiently to access traditional materials recycling markets. Consequently, mixed-waste MRFs are linked to a lower-order recovery process which can accept the relatively contaminated material as feedstock	food Organics: garden Paper and cardboard Plastics Aggregates, masonry and soils Textiles Can be used to produce RDF.			reprocessing facilities Creation of infrastructure: i.e. networks or reuse centres Co-location / integration with MBT/MHT Thermal EfW (for RDF)	demands and import/export requirements. Robotic sorting, using a combination of sensors and machine-learning (including between different MRF facilities) for image recognition is a developing area, which may further improve the accuracy of waste identification and sorting in the future. Like optical sorting, it presents a trade-off between capital cost and output quality, and between throughput rate and output quality.
Mechanical biological treatment (MBT): *Sorting mixed residual waste and stabilising the organic fraction through in-vessel composting.*	MSW / C&I residual waste to extract: Organics: food Organics: garden Paper and cardboard Metals: mixed residual waste Wood and timber Can be used to produce RDF and compost.	Well established in other jurisdictions in Australia, with over 300 in Europe.	Safety: fire risks Contamination: chemical Policy: no existing sites in Victoria, regulation untested Concerns over risk of emerging contaminants	Creation of infrastructure: i.e. networks or reuse centres Investment: i.e. artificial intelligence, robotic sorting system Landfill diversion Thermal EfW (for RDF)	MBT facilities are operated in Australia by various major waste sector players in NSW and QLD, but there is are no MBT facilities in Victoria. Some facilities have faced operational challenges in producing recovered organic output that is at a sufficient quality standard. In NSW in 2018, NSW EPA banned the use of mixed-waste derived organics on agricultural land and suspended their use in forestry and site rehabilitation applications until further notice. This has resulted in organic outputs from MBT going to landfill. With increasing focus and concern regarding emerging contaminants, it is likely this trend will spread throughout Australia. MBT is unlikely to see significant interest in Victoria, and there is unlikely to be significant

Technology / system	Target waste / material	Maturity	Barriers	Enablers	Current Victorian context and direction of travel
					development of new MBT facilities in the EU.
Mechanical heat treatment (MHT): *Two main types; pressurised thermal autoclaving and non-pressurised thermal heat treatment. Autoclaving involves using pressurised steam to heat and sterilise waste in a sealed vessel. Non-pressurised thermal heat treatment involves heating mixed waste in a sealed vessel to dry it.*	Mixed residual waste Clinical and related waste Hazardous waste Can extract recoverable materials including metals, plastics and RDF	Reasonably mature internationally for treating specific clinical and related wastes as well as hazardous wastes. Limited track record in Australia, mainly used on a small scale for clinical and related hazardous wastes. Application of MHT to mixed wastes such as MSW is relatively unproven.	Market challenges Safety: explosion risk Air quality and emissions Regulatory change restricting outlet for recovered organics	Policy: stricter safety requirements Requirement to safely treat and sterilised some clinical and related wastes	EPA Victoria recognise that autoclaving is a suitable treatment process for some types of clinical and related waste.[5] Shoalhaven City Council, in NSW, is currently considering use of MHT type technology to process red-bin MSW. No proposals for MHT of mixed waste at current time for Victoria.

Table 17: Sorting and processing

[5] EPA Victoria, *Clinical and related waste – operational guidance*, available at: https://www.epa.vic.gov.au/~/media/Publications/IWRG612%201.pdf

3.8.2 Forecast Required Infrastructure Capital Expenditure - MRFs

Based on the analysis of waste generation, reprocessing capacity and capability, infrastructure proximity to end markets, the SWRRIP and regional plans, statewide hubs of significance, stated government priorities, and the ability to meet a range of policy and resource recovery target scenarios by 2039, Infrastructure Victoria recommends the following MRF infrastructure facility types and locations. Indicative capital expenditure has been presented with a range of low cost and high cost infrastructure facility types.

Generally, Victorian MRF infrastructure will need upgrading to increase the ability to sort and separate mixed materials. Presently, MRFs typically produce bales of mixed materials including paper and plastics. The market demand and in some cases, market authorisation, is seeing limited outlets for mixed baled materials. Further investment will be required in infrastructure to present sorted, clean streams of recovered materials.

Beyond this, there are notable gaps in the provision of MRF infrastructure in Victoria's south west and central western regions. IV sees opportunities for new MRF infrastructure to be located in Geelong and Ballarat to service these Victorian regions.

Recovery	Facility type	No. of facilities	Description	Capability	Capacity (TPA)	Low Capex $	High Capex $	WRRG	Indicative location
Recovery	MRF	1	Mechanical separation and optical sorting	Mechanical separation and sorting	40,000	$6,000,000	$10,000,000	GCWRRG	Ballarat
Recovery	MRF	1	Mechanical separation and optical sorting	Mechanical separation and sorting	40,000	$6,000,000	$10,000,000	BSWWRRG	Geelong
Total		2			80,000	$12,000,000	$20,000,000		

Table 18: MRF forecast indicative infrastructure type, costs, locations

Note: Additional paper-specific MRF capability upgrade recommendations have been detailed in the Paper and Cardboard chapter of this report.

3.8.3 Forecast Required Infrastructure Map – MRFs

The map below shows indicative locations that would be suitable for MRF infrastructure based on Infrastructure Victoria's analysis.

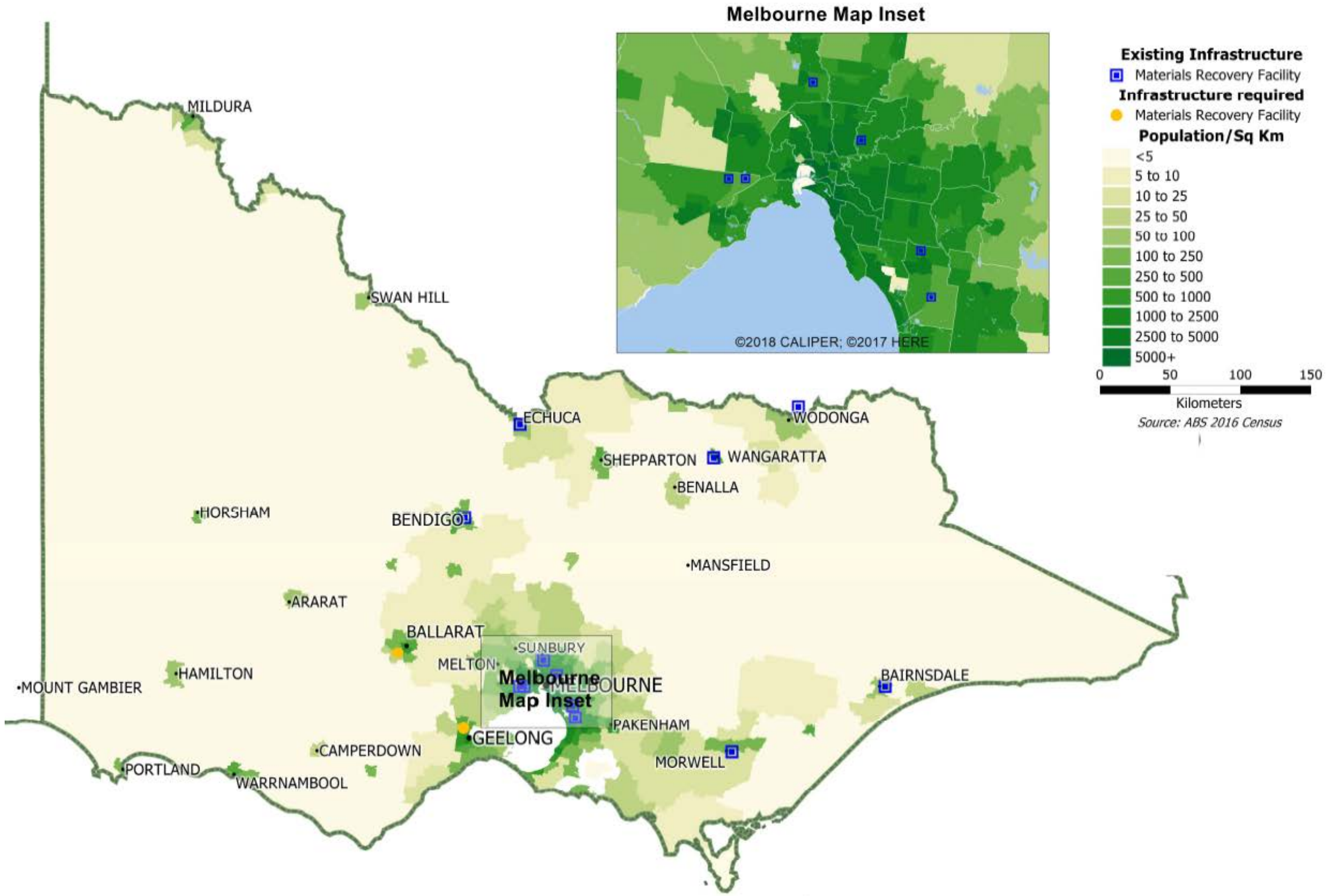

Figure 28: MRF forecast indicative infrastructure locations

3.8.4 Resource Recovery Centres and Transfer Stations

The supply chain overview chapter in this document highlighted the important role that Victoria's Resource Recovery Centres (RRCs) and Transfer Stations (TSs) play in aggregating and consolidating resources.

However, there are significant opportunities to improve the management of these centres throughout Victoria.

Infrastructure Victoria recommends optimising Victoria's extensive RRC and TS network to improve regional resource recovery and, where necessary, consolidate sites for better resourcing and more efficient transport.

Sustainability Victoria's *Guide to Better Practice at Resource Recovery Centres* identifies key benefits and opportunities to lift the performance and improve the service delivery of recovery centres.

Particularly in regional Victoria, a hub and spokes model has proven to be an effective way in which to manage resource recovery where materials from smaller sites are transported to hubs for aggregation.

However, there are presently limitations at many sites throughout Victoria. Limitations include:

- Lack of hardstand and cover with materials being left in the open where they are uncovered and exposed to the elements and have poor stormwater runoff management
- Environmental non-compliance in storage of some materials
- Poor visual amenity
- Little or no utilities
- Stockpile fire risks

Infrastructure Victoria recommends that further work be undertaken at RRCs and TSs to identify and optimise appropriate hub and spoke sites for further investment to:

- Improve infrastructure
- Improve site management practices
- Improve data management

3.8.5 Waste to Energy

Waste to Energy (also known as Energy from Waste) is the recovery of energy from waste materials. The energy recovered can be in the form of:

- Fuels (solid, liquid or gaseous)
- Electricity
- Heat

The energy can either be used on-site at the facility that recovers the energy, known as 'behind the meter', or supplied into the energy distribution network.

There are multiple technologies to recovery energy from waste. Broadly technologies these can be categorised as:

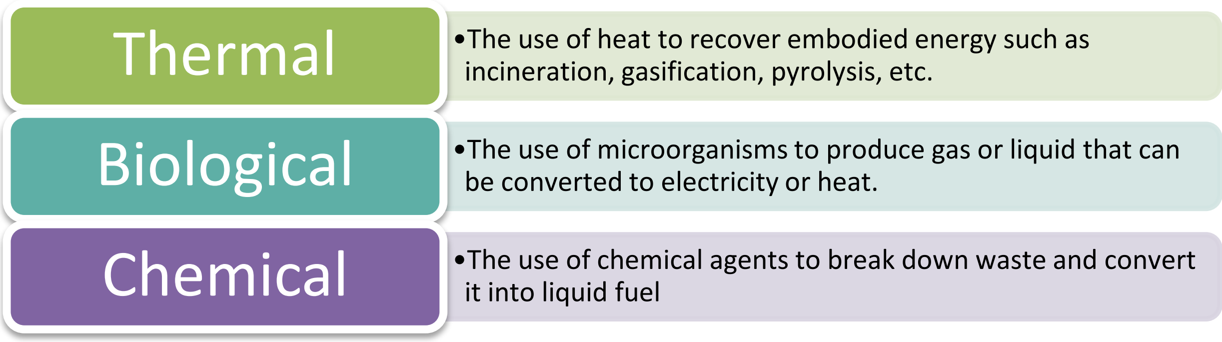

Figure 29: Waste to energy technology categories

In following the waste hierarchy, waste management should aim to achieve the highest level of the waste hierarchy where possible to achieve the best outcome environmental outcomes.

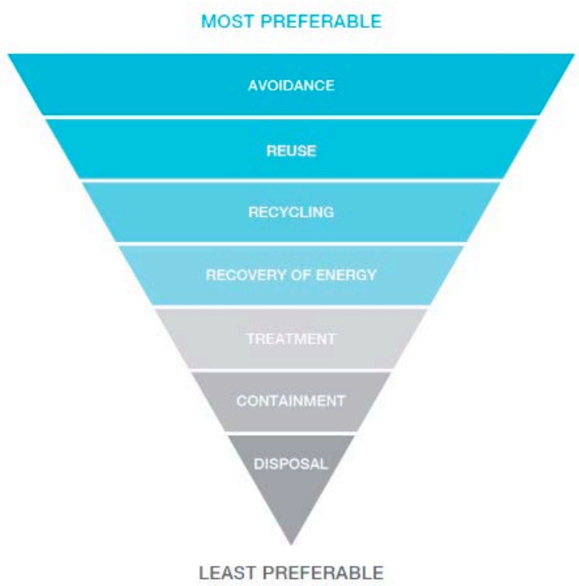

Figure 30: Waste hierarchy

Energy recovery is clearly a lower order outcome than waste avoidance, reuse or recycling of resources. However energy recovery is preferable to landfill in the waste hierarchy as it does recover some value from waste, reduces greenhouse gas emissions generated through landfilling organic waste, and, has the potential to prolong the capacity of existing landfills to be used for wastes that may be unsuitable for energy or resource recovery.

3.8.5.1 Thermal waste to energy technology summary

Key considerations	Moving grate incineration	Fluidised bed incineration	Rotary kiln incineration	Gasification of mixed residual	Pyrolysis of mixed residual
Suitable waste feedstock	Residual mixed waste from MSW and C&I sources RDF Biomass	Single source feedstock or RDF derived from MSW/C&I mixed waste that is homogenised and uniformly sized. Also suitable for some industrial, sewage, clinical and hazardous wastes. Biomass	Residual mixed waste from MSW and C&I sources Typically used for hazardous wastes that require high temperature combustion.	Single source feedstock or RDF derived from MSW/C&I mixed waste that is homogenised and uniformly sized.	Single source feedstock or RDF derived from MSW/C&I mixed waste that is homogenised and uniformly sized.
Technology maturity	Well established and mature on a global basis particularly in the EU, US and Asia. The most common combustion technology for waste. No operational facilities in Australia. Proposals in various states and one facility under construction in Kwinana, WA.	Well established and mature on a global basis, used extensively for RDF, sewage sludge and industrial waste. Less well proven for mixed waste streams that are not pre-treated. No rotary fluidised bed facilities operational or proposed in Australia.	Rotary kiln systems are well proven internationally at a smaller scale (<100,000 tpa). It is rarely used for the treatment of MSW or other large volume waste streams. No rotary kiln combustion facilities operational or proposed in Australia.	Commercial facilities in Europe, North America and Japan. Relatively un-proven on mixed wastes that have not been pre-treated. While gasification technologies exist in Australia, there are no operational gasification facilities for mixed waste. One historic failed facility in NSW and current proposals in WA and VIC.	Limited maturity. Largely unproven on mixed wastes such as un-treated residual MSW. There are no pyrolysis facilities or proposals for mixed waste in Australia.
Typical throughput	50,000 – 600,000	20,000 – 300,000	5,000-60,000	20,000 – 60,000	10,000 – 70,000
Indicative CAPEX ($/tpa capacity)	$900- $1,700	$900- $1,700	$1,400 - $1,600	$900- $1,700	$900- $1,700
Indicative OPEX ($/tpa capacity	$50-$100	$60-$100	$40-$80	$70-$120	Not available due to limited commercial track record
Key factors influencing OPEX	Labour Potential requirement for sorting or pre-treatment of waste Air-pollution control Availability of recovery outlets for ash	Labour Air-pollution control Availability of recovery outlets for ash	Labour Air-pollution control Availability of recovery outlets for ash	Availability of outlets for recovered fuel and solid by-products Air-pollution control	Availability of outlets for recovered fuel and solid by-products Air-pollution control
Landtake (m2/tpa)	0.05-0.1	0.05-0.15	0.05-0.1	0.03-0.2	0.03-0.2

Table 19: Thermal waste to energy technology comparison summary

3.8.6 Waste to Energy infrastructure planned in Victoria

Infrastructure Victoria's Terms of Reference direct it to investigate Waste to Energy infrastructure with consideration to "support a waste to energy sector that prioritises the extraction of recyclable material and recovers energy only from the residual waste (i.e. without diverting waste from reuse or recycling)".

Infrastructure Victoria has assessed current waste to energy proposals in Victoria and found that presently there are four significant waste to energy proposals that are progressing through EPA approvals processes and local council planning processes. These are detailed in the table below:

Proposed Waste to Energy facility	Proposed Location	Forecast TPA
Australian Paper	Maryvale	650,000
Recovered Energy Australia	Laverton North	200,000
Great Southern Waste Technologies	Dandenong South	100,000
Maddingley Brown Coal	Maddingley	120,000
Total Forecast TPA		**1,070,000**

Table 20: Proposed Victorian Waste to Energy facility capacity

The proposed capacity of these four facilities has been mapped against forecast waste generation and escalating resource recovery targets of 70% by 2025, 80% by 2030 and 90% by 2039.

Infrastructure Victoria forecast that if resource recovery efforts in Victoria are fully realised to achieve a 90% materials recovery rate for the six priority materials assessed (e-waste, glass, organics, paper and cardboard, plastics, and tyres), then a total of approximately 650,000 tonnes of these materials will be available for waste to energy as detailed in the table below

Priority Materials	Tonnes remaining
Paper	249,200
Plastic	73,500
Organics	312,800
Tyres	11,400
Total	646,900

Table 21: Remaining residual tonnes after achieving 90% materials recovery rate

The proposed combined capacity of these facilities is 1,070,000 tonnes per annum. Based on this forecast capacity, there will be sufficient waste to energy capacity to manage residual priority materials in Victoria if a resource recovery rate of 90% is achieved by 2039. However, the proposed waste-to-energy capacity in total will be insufficient to manage additional non-priority material residual waste.

3.8.7 Digital technologies

There are increasing technological innovations occurring in the waste and resource recovery sector. Many of these innovations stem from the development and application of digital technologies. Some of these technologies are applied in physical settings whilst other are in online or virtual environments.

3.8.8 Emerging digital infrastructure and technology

The table below provides a high level summary and overview of some key emerging digital infrastructure types and technologies.

Technology / service	**Target waste / material**	**Overview**	**Examples**
Smart bins	Multiple: can be applied to any waste stream Typically applied to MSW kerbside collections	Reimagining the pre-programmed kerbside waste collection practice through the live tracking of bin capacities to optimise collection frequencies and routes. Fewer waste collection trucks are utilised which reduces vehicle emissions, operational costs and road congestion. Smart bins are solar-powered and contain sensors to allow for the tracking of data and internal compactors which can increase bin capacity by 6-8 times.[6] One such smart bin can sort waste into recycling categories using sensors, image recognition and artificial intelligence.	BigBelly Solar, Ecube, Underground bins (Cascais, Portugal), Bin.E
Intelligent sorting machines	Multiple: can be applied to any waste stream Typically applied to MSW and C&I waste at sorting and recycling facilities	Machines which utilise robotic or optical sorters to pick and sort up to 65 items per minute from a mixed waste stream into individual streams.[7] These machines use machine-learning to improve productivity and adaptation to new materials. Unlike humans, these machines can work 24 hours day without needing a break, greatly improving the efficiency of waste sorting and processing. These machines can be retrofitted into existing facilities, allowing for easy uptake on a wide scale.	Max-AI
Waterway cleaning machines	Plastics Paper and card	Machine-learning robots which can autonomously clear waterways of plastic pollution. These machines are solar-powered, propel themselves and can navigate complex obstacles, using an array of sensors, cameras and GPS, a conveyor and compactor to manage waste. This technology focused primarily on plastic waste but could be adapted to suit paper and card.	Yindi Blue
Intelligent waste management systems / IoT	Multiple: can be applied to any waste stream Applied to MSW, C&I and C&D waste	Although smart cities have been a talking point for the past ten years, smart waste management solutions, enabled by internet of things (IoT) sensors and 4G / 5G mobile technology are still emerging technologies. The most common technology in this realm is based on the use of in-truck sensors and cameras, as well as cloud-based analytic systems to track, analyse and report on waste. Customers (often businesses and governments) and haulers are linked to optimise schedules and to monitor the fullness, content and location of their bins and dumpsters, with incentives in place for service providers to save their customers money. Similar technologies have also been used in the hospitality industry to minimise food waste, reduce over-production and ultimately save money. Data security and privacy issues of real-time data remain as issues today, resulting in slow R&D. Subsequently, the business case for IoT ecosystems continues to struggle.	Enovo, Winnow, Rubicon, Compology, IBM
On-demand waste pickup platforms	Multiple: can be applied to	Through a mobile app, construction and demolition sites can order waste collection and appropriate skip bins to be delivered and picked up, allowing contractors to order waste services on demand, saving	Wastebox.biz

[6] Solar Bins Australia, 2019, *BigBelly Solar Compactors*, available at: https://solarbins.com.au/features/big-belly-solar-bin/
[7] Recycling Today, 2018, *The evolution of Max-AI*, available at: https://www.recyclingtoday.com/article/the-evolution-of-max-ai/

Technology / service	Target waste / material	Overview	Examples
	any waste stream Typically applied to C&D waste	valuable site space. Trials of the technology originated in Austria and are now moving into German, UK and French markets.[8] This may be disruptive to the Australian construction industry – an industry that is generally considered to lack innovation when compared to others.[9] Hence, whilst this technology is promising, adoption in the Victorian context may be difficult to achieve.	
Materials databases	Multiple: can be applied to all material types	The goal of the key player in this space is to be the cadastre of materials – eliminating 100% of waste by providing all the materials within buildings a documented identity as well as a value. In this way, we can better understand where materials are, in which buildings and when they will be taken out, leaving the option to reuse always open. In terms of finance, every building becomes a bank of materials, because the technology monitors the material value of the building throughout time. This technology is best-suited to European ecosystems, with the scalability of this technology in an Australian context potentially being difficult due to our expansive land.	Madaster
Circular economy platforms	Multiple: can be applied to all material types Can be applied to all industry sectors	Building upon traditional reuse centres, online platforms for the listing of surplus items are an emerging space. These stewardships are effectively circular economy enablers which bring together specialist knowledge, software tools and networks to help organisations and individuals reduce environmental impacts, improve social engagement and create economic benefit. Such platforms have been successful in the C&D space in finding reuse of materials and at the household level, primarily with furniture and clothing. These efforts focus at the 'reduction' and 'reuse' levels of the waste hierarchy. Great levels of behavioural change would be necessary to increase the use of such stewardship programs in Australia.[10]	Loop Hub, Worn Again, Blocktexx
E-waste ATMs	E-waste	These kiosks provide a safe, convenient and easy way for people to trade in their used electronic devices for a financial reward. Online platforms allow customers to obtain price estimates for their devices and experience their kiosks virtually before traveling to their closest kiosk. Whilst this process is simple, the sale of stolen devices remains an issue, with approximately one out of every 1,500 devices exchanged reported as stolen.[11] Headshot photos, signatures for authorisation and thumbprint scanners work to reduce the likelihood of stolen goods being exchanged. This service is like that of a CDS scheme which has the potential for wide-scale rollouts.	EcoATM
Blockchain	Multiple: can be applied to all material types Can be applied to all industry sectors	Blockchain is a distributed, or shared, ledger that holds records of digital transactions in such a way that makes them accessible and visible to multiple participants in a network, while keeping them secure. The digital shared ledger is updated and validated with each transaction, resulting in a secure, permanently recorded exchange. The result is faster, permissioned and auditable B2B interactions between parties such as buyers, sellers and logistics providers. The use of blockchain has potential to manage and verify waste sector transactions and material flows.	BASF https://www.basf.com/ca/en/who-we-are/sustainability/Sustainability-in-Canada/reciChain.html Plastic Bank https://www.ibm.com/case-studies/plastic-bank Arep, SCNF French national rail operator blockchain pilot at railway station

Figure 31: Emerging digital infrastructure and technology summary

[8] Recovery Worldwide, 2018, *New company called Wastebox Germany introduced innovative business model at the NordBau*, available at: https://www.recovery-worldwide.com/en/news/new-company-called-wastebox-germany-introduced-innovative-business-model-at-the-nordbau_3231067.html

[9] McKinsey & Company, 2017, *Digital Australia: Seizing opportunities from the Fourth Industrial Revolution*, available at: https://www.mckinsey.com/featured-insights/asia-pacific/digital-australia-seizing-opportunity-from-the-fourth-industrial-revolution

[11] Today Show, 2013, *ecoATM Media Coverage Report*, available at: https://www.tacoma.uw.edu/sites/default/files/sections/CenterforLeadershipandSocialResponsibility/Media%20Coverage%20Report.pdf

3.9 Summary of overall infrastructure recommendations

The Infrastructure Gap Analysis has assessed the recycling infrastructure types required in future years, the capacity these facilities will likely need to manage and the capability of these facilities to take waste and reprocess it into a product suitable to enter end markets.

The table below summarises the infrastructure recommendations that will need to be in place by 2039 to manage future waste generation and resource recovery rates under current and emerging policy settings.

Infrastructure Victoria Recycling and Resource Recovery Infrastructure Facility Recommendations 2020 to 2039							
Supply Chain Role	Material type	Facility type	No. of facilities 2039	Capacity (TPA) 2039	Low Capex	High Capex	Indicative Location
Recovery	Mixed	MRF - Mechanical separation and optical sorting	2	80,000	$12,000,000	$20,000,000	Ballarat Geelong
	Organics	SMRC - Transfer stations dedicated to organics with hard stand, cover, bays	2	240,000	$18,000,000	$36,000,000	Epping Laverton North
	Paper	MRF – Paper separation upgrades	11	440,000	$16,500,000	$33,000,000	Bendigo Coolaroo Dandenong South Echuca Heidelberg Laverton North Lucknow Morwell Springvale Truganina Wangaratta
	Paper	SMRC – C&I paper recovery	6	300,000	$51,000,000	$60,000,000	Ballarat Coolaroo Dandenong South Geelong Laverton North Truganina
Reprocessing	E-waste	Manual disassembly & Mechanical processing - Batteries	2	4,000	$1,750,000	$2,200,100	Dandenong South
	E-waste	Mechanical processing - Batteries, Monitors, televisions	2	5,500	$2,775,000	$3,375,100	Campbellfield
	E-waste	Solar photovoltaic panel reprocessing	5	25,000	$7,500,000	$50,000,000	Bendigo Dandenong South Geelong Laverton North Morwell
	Glass	Beneficiation plant	1	108,000	$8,100,000	$13,338,000	Laverton North
	Glass	Sand/aggregate plant - Large	2	100,000	$4,250,000	$5,000,000	Clayton South

Infrastructure Victoria Recycling and Resource Recovery Infrastructure Facility Recommendations 2020 to 2039							
Supply Chain Role	Material type	Facility type	No. of facilities 2039	Capacity (TPA) 2039	Low Capex	High Capex	Indicative Location
	Glass	Sand/aggregate plant - Small	12	120,000	$5,160,000	$6,000,000	Bairnsdale Ballarat Bendigo Echuca Mildura Morwell North Geelong Wangaratta Warrnambool Wodonga
	Organics	Anaerobic Digestion	2	60,000	$15,000,000	$48,000,000	Dandenong South Girgarre
	Organics	In-Vessel Composting - Large & Medium	4	250,000	$137,500,000	$161,250,000	Ballarat North Geelong
	Organics	In-Vessel Composting - Medium	3	75,000	$41,250,000	$46,875,000	Mansfield Morwell Warrnambool
	Organics	Open Windrow composting	6	180,000	$18,000,000	$25,200,000	Bairnsdale Bendigo Mildura Swan Hill Wallan
	Paper & cardboard	Other e.g. food fibre packaging and tissue, paper towel	4	40,000	$6,000,000	$7,000,000	Dandenong South Laverton North
	Paper & cardboard	Pulp mill	2	600,000	$90,000,000	$105,000,000	Dandenong South Laverton North
	Plastics	Chemical processing	1	20,000	$34,000,000	$40,000,000	Dandenong South
	Plastics	Chemical processing & Flaking & pelletising plant (food grade)	2	70,000	$67,350,000	$90,000,000	Altona
	Plastics	Chemical processing, Pelletising plant, Flaking & pelletising plant (food grade & non-food grade)	4	145,000	$104,850,000	$143,760,000	Geelong
	Plastics	Flaking & pelletising plant - Small	8	80,000	$53,360,000	$80,000,000	Bairnsdale Bendigo Mildura Morwell Shepparton Warrnambool Wodonga
	Plastics	Flaking & pelletising plant (food grade & non-food grade)	2	100,000	$45,850,000	$64,285,000	Ballarat
	Plastics	Pelletising plant	1	25,000	$25,000,000	$39,475,000	Laverton North
	Plastics	Pelletising plant & Flaking, pelletising plant (non-food grade)	2	75,000	$37,500,000	$53,760,000	Campbellfield
	Tyres	Fibre separation plant	1	15,000	$6,000,000	$8,025,000	Somerton

Infrastructure Victoria Recycling and Resource Recovery Infrastructure Facility Recommendations 2020 to 2039							
Supply Chain Role	**Material type**	**Facility type**	**No. of facilities 2039**	**Capacity (TPA) 2039**	**Low Capex**	**High Capex**	**Indicative Location**
Total number of facilities and Total Capex			**87**	**3,157,500**	**$808,695,000**	**$1,141,543,200**	
Note: Locations are indicative only based on IV methodology. In some instances facilities are likely to be outside of the identified town centres in a neighbouring area. Capex costs are based on 2020 cost estimates only. Tonnes per annum are based on Waste Data Flows analysis. Number of facilities to manage projected TPA may be scaled up or down based on facility size design. Proposed scale is indicative only.							

Table 22: Resource Recovery Infrastructure Forecast Investment by 2039

3.10 Infrastructure Phasing

Based on the current and future waste generation and resource recovery rates and current and emerging policy settings, new or additional forecast infrastructure will need to be commissioned at different phases to manage Victoria's arising resource recovery management needs. The chart below highlights the year when additional forecast infrastructure will be required to be operational.

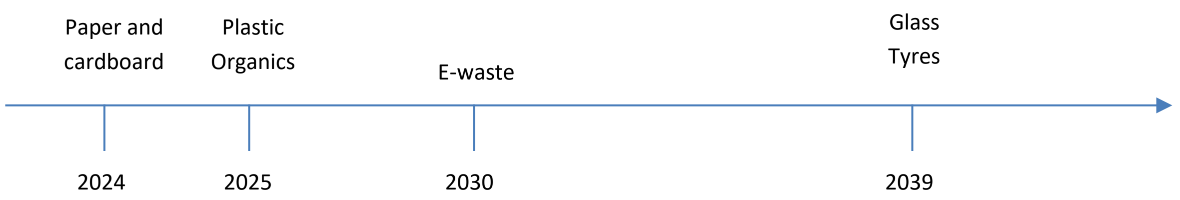

Figure 32: Year shortfall in infrastructure capacity will occur to meet future generation and policy settings

The tables below identify the forecast number of infrastructure types and year required for infrastructure to be commissioned and operational by to meet future waste generation and resource recovery trends and emerging policy settings.

Initial uplift will be required at the year of capacity shortfall however, further ongoing investment in additional recovery and reprocessing infrastructure will be required from 2022 through to 2039 to manage future waste generation and resource recovery projections.

The forecast infrastructure types are shown as *the cumulative total required per forecast year* to meet the forecast resource recovery rates.

3.10.1 E-waste

Reference facility	2022	2025	2030	2039
Mechanical processing - Monitors, televisions	-	-	1	1
Mechanical processing - Batteries	-	-	1	2
Manual dissassembly	-	-	1	1
Solar photovoltaic panel reprocessing	1	2	3	5
Total	1	2	6	9

Table 23: E-waste cumulative forecast infrastructure phasing

3.10.2 Glass

Reference facility	2022	2025	2030	2039
Beneficiation plant	-	1	1	1
Sand/aggregate plant - Large	-	-	-	2
Sand/aggregate plant - Small	-	6	12	12
Total	-	7	13	15

Table 24: Glass cumulative forecast infrastructure phasing

3.10.3 Organics

Reference facility	2022	2025	2030	2039
Open Windrow composting	-	1	4	6
In-Vessel Composting - Large	-	1	1	2
In-Vessel Composting - Medium	-	-	3	5
Anaerobic Digestion	-	-	1	2
Total	-	2	9	15

Table 25: Organics cumulative forecast infrastructure phasing

3.10.4 Paper and cardboard

Reference facility	2022	2025	2030	2039
Pulp mill	1	1	1	2
MRF Paper Separation	1	1	9	11
C&I Paper baling	3	3	3	6
Other – tissues, paper towel	2	2	2	2
Other – food fibre packaging	2	2	2	2
Total	9	9	17	23

Table 26: Paper and cardboard cumulative forecast infrastructure phasing

3.10.5 Plastics

Reference facility	2022	2025	2030	2039
Flaking & pelletising plant (food grade)	-	2	3	3
Pelletising plant	-	2	2	3
Flaking, pelletising plant	-	2	2	3
Chemical processing	-	1	1	3
Flaking & pelletising plant - Small	-	5	7	8
Total	-	12	15	20

Table 27: Plastics cumulative forecast infrastructure phasing

3.10.6 Tyres

Reference facility	2022	2025	2030	2039
Fibre separation plant	1	1	1	1
Total	1	1	1	1

Table 28: Tyres cumulative forecast infrastructure phasing

3.10.7 Materials Recovery Facilities

Reference facility	2022	2025	2030	2039
MRF - Mechanical separation and optical sorting	1	2	2	2
Total	1	2	2	2

Table 29: MRF cumulative forecast infrastructure phasing

3.10.8 Organics Special Materials Recovery Centre

Reference facility	2022	2025	2030	2039
SMRC - Transfer stations dedicated to organics with hard stand, cover, bays	-	1	2	2
Total	-	1	2	2

Table 30: SMRCs cumulative forecast infrastructure phasing

3.11 Managing fire hazards

In August 2017, the Victorian Government introduced an interim Waste Management Policy (Resource Recovery Facilities) to increase enforcement activities related to the stockpiling of combustible waste. This was replaced in August 2018 by the Waste Management Policy (Combustible Recyclable and Waste Materials). Compliance with the policy requires combustible recyclable and waste materials (CRWM) at waste and resource recovery facilities (WRRF) to be managed and stored in a manner that minimises risk of harm to human health and the environment from fire.

Specifically, the policy requires waste and resource recovery operators to:

1. Understand the fire hazards associated with their activities and take steps to reduce the fire risk associated with those hazards
2. Manage and store combustible recyclable and waste materials (CRWM) in a manner that protects the environment and human health from the risk of fire
3. Prepare an emergency management plan in response to a fire emergency.

To date the Waste Management Policy (Combustible Recyclable and Waste Materials) guidelines have predominantly focused on outdoor storage of CRWM. However, clarity and guidance for indoor CRWM storage is anticipated to be released in 2020. The new guideline aim to provide practical advice on the appropriate preventative measures in mitigating fire risk from storing CRWM indoors that is proportionate to the risks it poses.

3.11.1 Waste Management Policy (Combustible Recyclable and Waste Materials) Compliance Costs.

As a result of new and increased compliance requirements, there are raised expectations and requirements for waste and resource recovery sector businesses.

A Policy Impact Assessment conducted in 2018 calculated the likely costs to businesses to comply with the Waste Management Policy (Combustible Recyclable and Waste Materials). It determined that 886 such sites, excluding sites covered by the interim WMP but already licensed, would likely face increased compliance costs. It determined:

- The full range of compliance measures costs from around $500 for low-risk risk facilities (~550 facilities) to around $650,000 for completely non-compliant extreme-risk facilities (~250 facilities).
- The high-risk firms assumed to require compliance action following inspection are expected to incur costs of roughly $25,000-$225,000.
- These costs are upper bound estimates in the sense that they assume a non-compliant facility is non-compliant for all aspects of the guideline.
- The most costly overall compliance requirement is the costs incurred of disposing excess waste at landfill, in order to meet storage requirements.
- Overall, this accounts for $3.2 million of compliance costs.
- This is followed by the requirements for liquid run-off controls of around $1.5 million.
- The average cost of compliance across the 800+ resource recovery facilities is estimated to be around $8,500.
- This estimate averages the costs over all facilities in each risk category and is likely a better representation of costs that might be faced for an individual facility, given that many facilities are likely to be non-compliant relating to only some aspects of the guideline.
- Over 95% of total compliance costs relate to around 250 high and extreme-risk facilities, however, and the average compliance cost for the approximately 550 low and medium-risk facilities is $500 to $1,500.

3.11.2 Environment Protection Amendment Act 2018

New regulations for waste are being developed to give effect to the Environment Protection Amendment Act 2018 (the Act). The current legislative framework for waste has largely protected Victoria against hazardous wastes but is sometimes complex, inflexible and places disproportionate obligations on the management of some wastes. The current legislation (Environment Protection Act 1970 and the Environment Protection (Industrial Waste Resources) Regulations 2009) also provide suboptimal support for safe resource recovery and to reduce burden on landfill.

The Act establishes EPA powers and tools to deliver a new preventative, proportionate and tailored approach to better manage the risks of harm from pollution and waste. The Act will commence on 1 July 2020. Regulations to give effect to the Act are required by the commencement date.

Under the proposed regulations, permissions will be required (licences, permits and registrations) for all commercial quantity industrial waste. These will be scaled according to hazard, complexity and scale of each waste activity (for example, landfills requiring licences, large material recovery facilities requiring permits, and smaller/less hazardous receivers, including skip bins, requiring registration); or through a new instrument called a Declaration of Use (DoU). This would allow waste receivers to accept recovered and reused waste materials, and to allow waste generators to demonstrate they have sent this material to a lawful place. The DoU will be a self-assessed approach.

3.11.3 Implications for Waste and Resource Recovery Infrastructure

Current and future waste and resource recovery infrastructure facilities and operations will need to comply with the current requirements of the Waste Management Policy (Combustible Recyclable and Waste Materials) and the new requirements of the Environment Protection Amendment Act 2018.

Planning for new infrastructure facilities will need to consider these requirements. Similarly, any government grants or support will also need to be cognisant of these requirements and ensure that any government funded projects are designed to be compliant.

Ongoing risks for the sector include the:

- Increasing volumes of CRWM stored on sites
- CRWM stockpiles are not appropriately managed in a manner that minimises the risk of harm to human health and the environment from fireSheds on sites are frequently full and waste is stacked up against fences and walls preventing access for fire management
- Lack of suitable other fire controls in place amongst waste and resource recovery sector operators

New infrastructure designs should aim to respond to these risks.

4 Market Development

Market development activities are required that identify end market opportunities that have the potential to consume significant and reliable tonnes of recycled materials where markets are currently limited.

Market development is required for recycled products to address several current barriers. This includes developing confidence in the market that recycled products are fit for purpose and are authorised for use through standards and specifications.

Recycled products need to be cost effective. There are a range of factors that influence the cost effectiveness of recycled products such as transport costs, costs of reprocessing, competition with virgin or traditional existing products, economies of scale, etc.

And importantly, recycled products need to be available to the market with reliable, consistent supply that meets quantity demand at scale.

4.1 The challenges to end markets

Initiatives to recover resources in Victoria have been driven by the recognition of the environmental benefits of following the principles of the waste hierarchy. The overarching driver underpinning this is the objective of moving outcomes up the waste hierarchy and diverting waste from the lowest hierarchy level, disposal of waste to landfill.

4.1.1 Recycled product barriers

Beyond supply and demand issues, mentioned earlier in this analysis, several other factors influence the competitiveness and viability of recycled material markets including contamination of feedstocks, prohibitive transport costs, the costs of sorting, technical limitations to sorting equipment, ability to access commercial volumes of materials, and the low price of virgin commodities.

For regulatory enforcement of waste management policies to be effective, there needs to be healthy markets in place where there is strong, ongoing demand for recovered resources to ensure that recovered resources are traded as commodities rather than lamenting in risky and hazardous stockpiles.

Effectively there are two streams of challenges that may act to prevent the use of recycled materials and products entering the market. These can broadly be defined as the:

1. Technical feasibility
2. Structural barriers and enablers

4.2 Technical feasibility

The technical feasibility of recovering and recycling different material types is dependent on finding suitable new uses in the market for these items that are fit for purpose.

Once these performance characteristics have been addressed there is also a need to direct the tonnes of end-of-life (EOL) materials arising to ensure there is sufficient and reliable demand in the market for the tonnes of recovered materials.

Identifying suitable markets for recovered resources based on fit-for-purpose material uses will guide market development opportunities.

The chart below steps through some considerations for the viability of recycled products.

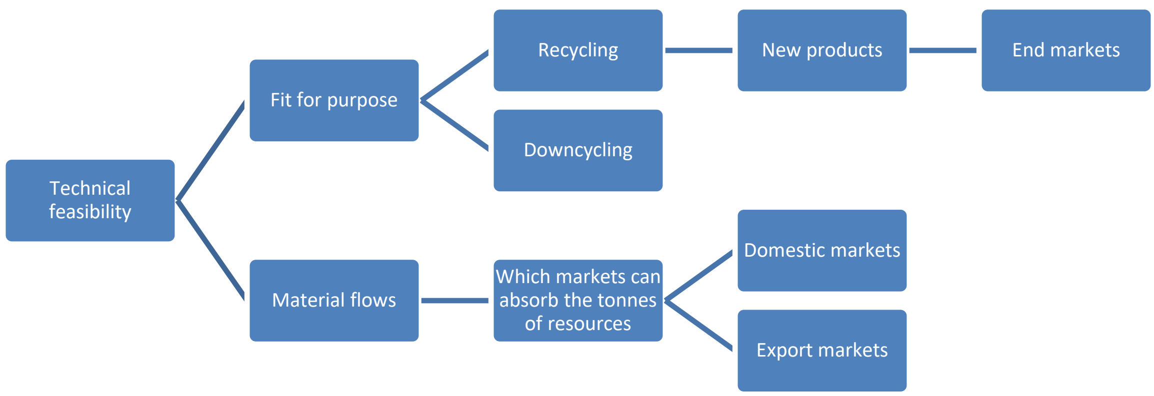

Figure 33: Technical feasibility of recycling

4.3 Structural barriers and enablers to the use of recycled products

The structural barriers and enablers are the industry characteristics that limit or open up the use of recycled materials in different industry settings.

These require multiple interventions to assist with overcoming these barriers ranging from research and development, project trials, stakeholder engagement, authorisation, industry training, infrastructure improvements, etc.

Infrastructure Victoria has identified several barriers to the development of reliable markets for recovered resources. The discussion below describes the issues, supply and demand interaction, and the associated infrastructure considerations. Based on these, recommendations are presented to overcome these barriers.

4.3.1 Barrier One: Confidence in products

Issue	Confidence in products
Issue description	As a starting point, there is a need to identify and undertake the necessary Research and Development that is required to commercialise the use of recycled products. A sound evidence base is required to give end-users confidence in using recycled products alongside conventional products. Essentially there needs to be confidence in the market that recycled products are fit for purpose.
Supply and demand interaction	Addressing confidence in recycled products will assist in addressing 'demand' for recovered resources.
Infrastructure considerations	High quality recycled feedstocks need to be produced in order to provide confidence to the market that recycled materials are fit-for-purpose. This will require domestic infrastructure is in place that provides locally sourced recovered feedstocks. At one end of the spectrum, there are examples of recovered resources businesses that have invested in high value added recovery infrastructure operations that are able to provide product to the market that meets the requirements such as recovered tyre crumb rubber or recovered glass, concrete and brick that meets VicRoads specifications. At the other end of the spectrum, there are numerous examples of Australian manufacturers using recycled PET (rPET) that is sourced from overseas as they have difficulty sourcing domestically produced rPET flakes or pellets ready to use as a production feedstock.
Recommendation 1: Conduct targeted research, development and demonstration activities for each material stream.	Recovered resources comprise of a vast range of material types. For recycling challenges to be overcome, and end markets to be developed for each material type, research and development investment is required for each material commensurate with the size of the problem. The size of the problem may not be limited to tonnages generated but to other considerations such as market failure, stockpile hazard, material hazard, material opportunity, market maturity, etc. To date, Victorian Government funding allocated research and development grants has often been included multiple material types. On the one hand, this gives responsible agencies some discretion in reviewing the merit of individual project proposals, but on the other, this may result in an ad-hoc or inconsistent allocation of resources to problem materials of the day.

Table 31: Barrier One: Confidence in products

4.3.2 Barrier Two: Authorisation to use products

Issue	Authorisation to use products
Issue description	Once confident in the performance of a recycled product, authorising agencies will be required to endorse the use of recovered resources through updating standards and specifications. This provides a range of stakeholders in the supply chain the 'green light' to use a product. Typical stakeholders who turn to authorisation for use through standards and specifications may include product designers, manufacturers, contractors, engineers, architects, consumers, etc.
Supply and demand interaction	Authorising the use of recycled products will enable demand for recovered resources.
Infrastructure considerations	Reprocessing infrastructure needs to be able to supply quality feedstock that is fit-for-purpose to the market.
Recommendation 1: Establish and facilitate research, development and demonstration working groups	Establish and facilitate separate working groups for material types comprising of authorising parties, recyclers/reprocessors, manufacturers, contractors, researchers, government agencies, etc. This approach has proven to be effective in the roads and rail sectors with several Victorian specifications permitting the use of recycled concrete, brick, glass, rubber and plastics now approved.
Recommendation 2: Victorian Government agencies conduct a specifications review	As major infrastructure asset owners, it is recommended that Victorian Government agencies review its overall specifications approach to fully embrace performance-based specifications that outline the performance requirements (e.g. fatigue, cracking, etc.). This would prescribe the desired outputs and allow industry to determine which inputs (including recycled products) it will use to achieve compliance.
Recommendation 3: Victorian Government agencies develop an interim approach to performance-based specifications	To encourage the use of recycled content and a move towards performance-based specifications, select Victorian Government agency specifications could be updated to include a clause that enables the use of recycled material that is currently not authorised. The purpose of the clause is to allow for industry to put forward non-conforming tender responses in such a way that risk is managed and shared between industry and the Victorian Government. For example, such a clause may state: *Use of recycled material is allowable, provided the supplier can demonstrate the modified product is equal to, or better, than the performance of the specified product.* And if confidence in such an approach is required, an independent testing regime could be developed with an appropriately qualified organisation. For example, in the roads sector, ARRB could be engaged, whereby the industry proponent could pay for independent testing to be conducted. If the ARRB

	testing is found to be favourable, then Department of Transport must permit the use. Additionally, this could be independently verified by ARRB through its TIPES process https://www.arrb.com.au/tipes
Recommendation 4: Facilitate the provision of product information	Increasingly the markets are demanding the use of declarations detailing the environmental credentials, usage directions and requirements, and general properties of a product. This may take a number of forms with popular approaches including Eco-labelling, Environmental Product Declarations, Standards, Product Specifications, and, Safety Data Sheets. There is a role for government to work with industry to develop clear and standardised approaches for communicating information about the recycled content used in products. There are a number of existing industry approaches for Product Disclosure that could be facilitated and promoted by government.

Table 32: Barrier Two: Authorisation to use products

Examples of product information guidance and disclosures include:

Eco-labelling Eco-labelling is a voluntary method of environmental performance certification and labelling that identifies the environmental credentials of products or services and are used to guide purchasing decisions. Unlike a self-declared environmental symbol or claim statement developed by a manufacturer or service provider, an eco-label is awarded by an independent third party to products or services that meet environmental leadership criteria.

Best practice eco-labels are awarded based on meeting international standards ISO 14024 (Type I Environmental Labels and Declarations)

Labelling should be meaningful, verifiable, consistent, transparent, independent and provide clear information detailing the environmental benefit

Environmental Product Declarations Environmental Product Declarations (EPDs) communicate credible environmental information An EPD is a verified document that requires measurement and transparent reporting of the environmental attributes associated with the life cycle of a product. EPDs are based on a life cycle assessment (LCA) methodology typically in accordance with the international standards ISO 14040 and ISO 14044 (Life Cycle Assessment) and ISO 14025 (Type III Environmental Labels and Declarations).

Standards Standards are voluntary documents that set out specifications, procedures and guidelines that aim to ensure products, services, and systems are safe, consistent, and reliable.

There are three categories of standards:

i. International
ii. Regional
iii. National

On their own, standards are voluntary. There is no requirement for the public to comply with standards. However, State and Commonwealth governments often refer to Australian Standards (AS) or joint Australian/New Zealand Standards (AS/NZS) in their legislation.

Product Specifications A specification document defines the technical requirements for a project, product, or system, and details what deliverables must be met or exceeded. Unlike standards, which are voluntary, often high-level and consistent across application and regions, specifications if in place will be a mandatory requirement, and will often vary from application and between regions.

There is increasing advocacy for performance-based specifications, as there is a perception, often amongst industry, that conventional specifications limit the use of innovative approaches, materials and technologies. A conventional specification sets out the required inputs to achieve a certain outcome. A

	performance-based specification defines the required outcomes rather than stipulating the required inputs.
Safety Data Sheets	Safety Data Sheets provide information about substances, and the hazards associated with those substances. They include information on: • the chemical's identity and ingredients • health and physical hazards • safe handling and storage procedures • emergency procedures • disposal considerations Businesses should use SDSs when they assess the risks of hazardous chemicals in the workplace. In Australia, manufacturers and imports of hazardous chemicals must prepare SDSs in accordance with the model Code of Practice for the Preparation of Safety Data Sheets for Hazardous Chemicals. Substances can be: • Mixtures (combination of substances) • Natural or artificial • In a liquid or solid form • A gas, vapour, fume, mist; and, • Dusts used in the workplace SDSs must provide information on the hazards of the chemical and how to handle it safely, including storage and disposal.

Table 33: Summary of product information guidance and disclosures

4.3.3 Barrier Three: Cost effective to use

Issue	5.3.1 Cost effective to use
Issue description	It is important to understand how cost-effective the use of recovered resources are compared to conventional products. And with this understood, we can look to see what additional interventions may be pursued to overcome any cost challenges. For example, we know that quite often the cost of the recovered resources will be similar to that of virgin materials but it is often the transport haulage costs that are prohibitive. In areas of availability, local recycled materials are cost competitive with and often cheaper than virgin counterparts. Therefore, if end-users have closer proximity to resource recovery infrastructure this will further enable the use of recycled products. Similarly, addressing any externalities not included in the cost of using virgin resources compared to the costs associated with resource recovery will play a role in making recycled products more cost effective.
Supply and demand interaction	Efficiency gains in recovery and reprocessing may be achieved through the supply of clean, uncontaminated materials. Additionally, appropriate and efficient infrastructure and processes to recover materials and supply to market as a suitable feedstock may enhance the cost-competitiveness of recovered resources. These efficiencies are likely to play a role in encouraging demand.
Infrastructure considerations	Infrastructure needs to be at scale for production efficiencies to be achieved and infrastructure needs to produce a product of a suitable quality that competes with similar products sourced from raw materials.
Recommendation 1: Develop an Infrastructure Capacity and Capability implementation plan	Encourage the appropriate location of waste and resource recovery through the development of Infrastructure Capacity and Capability implementation plan. Through developing and actioning an implementation plan, the objectives of the SWRRIP can be strategically realise to match land-use planning considerations, waste data projections, transport efficiencies for supply of recycled feedstock to meet demand.
Recommendation 2: Establish an inter-agency waste and resource recovery economic development working group	Facilitate the appropriate location of waste and resource recovery through the formal development of an inter-agency working group comprising of responsible Victorian resource recovery agencies, economic development agencies, and local governments. It is recommended that a similar approach be taken for those agencies involved in economic investment in the waste and resource recovery sector whereby there is improved communication and collaboration to facilitate strategic investment in the Victorian waste and resource recovery industry. The interagency working group for the CWRM taskforce has proven to be extremely effective in bringing together responsible regulating agencies to align efforts and improve communication and collaboration.

Table 34: Barrier Three: Cost effective to use

4.3.4 Barrier Four: Supply is reliable, consistent, and to scale

Issue	Supply is reliable, consistent, and to scale
Issue description	For recovered resources to be used by consumers there needs to be reliable, consistent supply that meets quantity demand at scale. The likes of large infrastructure projects such as road and rail construction move quickly and therefore projects need to ensure that material is available when required. Alongside this, recovered resources need to meet quality standards at all times. The products need to be relatively free of contamination which can be significantly aided by improved source separation, aligned with specification requirements and compete on performance characteristics.
Supply and demand interaction	A critical mass of waste materials that are recovered and reprocessed to a suitable quality that is fit-for-purpose as a feedstock for production will allow consumers of recovered resources to access consistent supply of material to ensure manufacturing production continuity can be achieved. Infrastructure needs to be capable of managing end-of-life quantities and able to produce a product that the market demands.
Infrastructure considerations	Reprocessing infrastructure needs to have the capacity to manage waste flows in and push recovered resources out into the market at scale. The infrastructure needs to be well maintained and supported by reliable processes to manage market demand.
Recommendation 1: Develop an Infrastructure Capacity and Capability implementation plan	Develop an Infrastructure Capacity and Capability implementation plan to support the strategic delivery of the SWRRIP to ensure infrastructure capacity gaps are managed to ensure the supply of recovered resources grows to meet demand.

Table 35: Barrier Four: Supply is reliable, consistent, and to scale

4.3.5 Barrier Five: Access and proximity to materials and products

Issue	Access and proximity to materials and products
Issue description	Recycled materials are generally limited by the location of recycling facilities and their proximity to a supply of suitable waste feedstocks, both of which can lead to uneconomic haulage costs. Through strategically locating resource recovery infrastructure, we can increase access to recovered resources.
Supply and demand interaction	The strategic location of reprocessing infrastructure will enable supply of recovered resources to meet manufacturing demands for cost effective, reliable quantities of feedstock.
Infrastructure considerations	Location of infrastructure needs to occur in appropriately zoned areas to ensure there is investment confidence. Infrastructure location needs to consider proximity to waste supply and recovered resources market demand.
Recommendation 1: Develop GIS capabilities to assess sector needs	Ascertain industry capacity and capability and develop a GIS layer to enable strategic assessment of the waste and resource recovery sector to occur. All Victorian waste and resource recovery infrastructure should be identified and assessed by both regulatory and non-regulatory agencies. Regulators need to understand the compliance status of industry operators and non-regulatory agencies need to understand the business operations of the waste sector industry operators to ensure waste and resource recovery programs are aligned with market conditions.
Recommendation 2: Develop an Infrastructure Capacity and Capability implementation plan	Develop an Infrastructure Capacity and Capability implementation plan to support the strategic delivery of the SWRRIP to ensure appropriate land use planning is embedded throughout state and local planning decision-making legislation.

Table 36: Barrier Five: Access and proximity to materials and products

4.3.6 Barrier Six: Environmentally beneficial

Issue	Environmentally beneficial
Issue description	Government, industry and the community need to be confident that any potential environmental impacts are managed in the same way as conventional materials and products.
Supply and demand interaction	Recovered resources need to perform well and be environmentally beneficial rather than detrimental for demand to be stimulated.
Infrastructure considerations	Operation of reprocessing infrastructure needs to comply with relevant environmental regulations and produce products that meet EPA Declaration of Use requirements.
Recommendation 1: Understand environmental performance in emerging applications.	Ensure environmental performance is considered in all Victorian Government funded research and development projects. It is important that consideration is given to whether or not there are any potential adverse environmental impacts of using recycled products (as per any other product). For example, understanding any dispersal of materials to the environment.

Table 37: Barrier Six: Environmentally beneficial

4.3.7 Barrier Seven: Safe to use

Issue	Safe to use
Issue description	Like any other material or product, we also need to ensure that they can be used safely by workers in application. We need to understand how these materials perform alongside conventional materials so that we don't cause any harm to people.
Supply and demand interaction	Recovered resources need to be safe and fit-for-purpose to generate demand.
Infrastructure considerations	Operation of reprocessing infrastructure needs to comply with relevant Occupational, Health and Safety regulations and produce products that are safe and fit-for-purpose uses.
Recommendation 1: Ensure OHS associated directly with the introduction of new uses of recovered resources is considered in all Victorian Government funded demonstration	The introduction of any new processes or materials needs to consider and manage any occupational, health and safety items.

Table 38: Barrier Seven: Safe to use

4.4 Resource Recovery Infrastructure Grants

Grants are widely used to encourage industry initiatives to align with government's strategic objectives. Grants can be used to provide stakeholders with an incentive to act through provision of non-repayable funding. However, the execution of grants may not always deliver the best outcomes or value for money. It is recommended that the current grants model be assessed for improvement and/or alternatives to grants be considered.

4.4.1 Recommendation: Explore current effectiveness of resource recovery grants.

Resource recovery grants have historically been capped at a maximum of $500,000 of government funding. It is recommended that this maximum allowable allocation be reviewed to consider if this limits government support for significant projects that, if supported, may result in substantial benefits for the Victorian community. It is worth noting that in 2018, Sustainability Victoria released the Recycling Industry Transition Support fund in response to the impacts of the China National Sword Policy. This fund saw applicants able to apply for grants of up to $1m. However, the maximum grant allocated through this fund was $500,000. This was based on applications received.

Benefits of grants	Limitations of grants
Grants are relatively straightforward to deliver and provide a good mechanism to encourage early adopters to pursue activities that support a government policy agenda.	Grants can be difficult to link to genuine policy outcomes, often focusing on simplistic, high-level objectives rather than ongoing systemic change.
Grants are often a good way to 'share' both risks and success between government and grant recipients from industry and the community.	Grants are also only as good as the proposals that are submitted.
Grants are well received by industry and generally receive positive media.	If a commitment to grants expenditure is made, but only low-quality grant proposals are submitted, there is a risk that low-quality projects will be funded to ensure grant expenditure commitments are upheld. This may then result in projects that do not adequately achieve the aspirations or objectives of the original intent.
	Similarly, grants may take time to develop, release, evaluate, agree to contract terms and then be delivered over a range of timeframes. This then locks government agencies delivering grants into very fixed conditions of operation and can constrain flexible or agile responses to new or emerging issues.

Table 39: Grants benefits and limitations

4.4.2 Recommendation: Consider alternative incentives to grant funding

Grants are currently the most common form of financial assistance offered by the Victorian Government to the waste and resource recovery sector. However, to achieve the objectives of other environmental policy matters, the Victorian Government and other governments throughout Australia and around the world, have used a range of other financial support approaches that could be considered for suitability to drive improved resource recovery outcomes in Victoria.

4.4.3 Rebates

Rebates, subsidies and feebates can be used to provide a financial incentive to help cover the costs of fitting in with a policy objective. For example, a rebate that provides a financial incentive payment for the use of a nominated recycled material would encourage consumer shifts in align with any objective to develop end markets for recovered resources.

Rebates are employed to encourage purchasing decisions and typically rely on a consumer redeeming the cost of purchase to a defined amount.

Benefits of rebates	Limitations of rebates
Rebates are used extensively by governments for healthcare, childcare and have been used successful for many environmental programs. For example, there have been rebates available for rainwater tanks, solar hot water, and most recently, Solar Victoria's roll-out of solar panels is a rebate-based model that is seeing large uptake across the Victorian community.	May not be equitable across the community. For example, wealthier members of the community will be in a better position to afford newer, emerging technologies that are typically more compliant with policy intent. Less wealthy community members may not be able to afford latest technology and therefore may not be in a position to access rebate unless the rebate program provides concessions, loans, etc.

Table 40: Rebates benefits and limitations

4.4.4 Subsidies

Subsidies are used widely to reduce the cost of a purchase, often to close the financial gap of a product or service, which in its early deployment, may not yet compete effectively on price against traditional competitors in an established market.

For example, a subsidy that provides a financial incentive by reducing the cost of using a nominated recycled material would encourage consumer shifts in align with any objective to develop end markets for recovered resources.

Benefits of subsidies	Limitations of subsidies
Through the provision of a subsidy, government can intervene to support changes in the market to align with a policy position. For example, CalRecyle in California, USA, uses a levy scheme to fund rebates to subsidises the use of recycled tyres in road, transport, landscaping and civil construction projects. This encourages the use of recycled content to be preferenced over the use of virgin materials.	May not be equitable across the community. For example, wealthier members of the community will be in a better position to afford newer, emerging technologies that are typically more compliant with policy intent. Less wealthy community members may not be able to afford latest technology and therefore may not be in a position to access subsidies unless the subsidy program provides concessions, loans, etc.

Table 41: Subsidies benefits and limitations

4.4.5 Feebates

Feebates are essentially a fee on an inefficient technology and a rebate on an efficient alternative technology.

This is used around the world on cars where there are fees to pay for an inefficient vehicle but rebates available to purchase a more efficient vehicles. This is currently being used in several nations to support the transition from vehicles with internal combustion engines to electric vehicles.

For example, placing a price on using virgin material (a fee) whilst providing a rebate for using recycled materials would encourage consumer shifts in align with any objective to develop end markets for recovered resources.

Benefits of feebates	Limitations of feebates
Pricing signal on undesirable behavior to support transition to policy objectives.	May not be equitable across the community. For example, wealthier members of the community will be in a better position to afford newer, emerging technologies that are typically more compliant with policy intent. Less wealthy community members may not be able to afford latest technology and therefore may be most likely to incur said fees.

Table 42: Feebates benefits and limitations

4.4.5.1 Finance, Investment and Loans

Finance, investment and loans can be used to support leading industry practice instead of grants. Many of the financial checks and balances associated with loans are already in place for when government enters into grants contracts with grant recipients e.g. financial due diligence, insurance certifications, etc.

For example, the Australian Government established the Clean Energy Finance Corporation (CEFC) in 2012 to invest in clean energy projects in several sectors including energy, agriculture, manufacturing, property, as well as waste. Most recently in 2019, the CEFC established the Australian Recycling Investment Fund to fund recycling projects that use clean energy technologies. To date the CEFC has invested in projects for Organics Reprocessing, Process Engineered Fuel, Thermal Waste to Energy, and, energy efficiency upgrades of waste and resource recovery facilities.

Benefits of finance, investment and loans	Limitations of finance, investment and loans
Because a loan needs to be repaid (unlike a grant that is a gift) loans offer considerable efficiencies for government who can reinvest the repaid money back into further loans (or other programs).	There are higher overheads to running a loans program compared to a grants program and greater financial diligence is likely required than a grants program to ensure repayments can be met. However, similar levels of scrutiny either are applied, or really should be applied, to grant recipients to ensure they can meet the financial commitments of any grant co-payment requirement.
Additionally, as a loan recipient needs to repay the debt, there is additional incentive to ensure that any project that is granted a loan is successful.	
There is likely to be greater stakeholder ownership of the financed project due to the debt repayment requirements.	

Table 43: Finance, investment and loans benefits and limitations

4.4.5.2 Recommendation: Set targets and use an auctions process to procure recycled content for Victorian infrastructure projects

Reverse auctions are used widely to stimulate renewable energy markets around the world. They are widely used in Australia by states, territories and the Commonwealth.

The Victorian Government has established the Victorian Renewable Energy Auction Scheme (VREAS) to support achievement of the Victorian Renewable Energy Targets (VRET). These targets seek to ensure that 25 per cent of the State's electricity generation comes from renewable sources by 2020, rising to 40 per cent of generation by 2025. Successful projects of the scheme were announced on Tuesday 11 September, 2018.

A similar approach could be explored to consider the design of a reverse auction scheme that sets a target of how much recycled product the Victorian Government decides it wishes to procure and then facilitates a process for the market to respond with appropriate technological outcomes at the most competitive market rate. This focuses on the purchase of recycled content where there is an opportunity for use.

Sustainability Victoria has worked with Departments of Treasury, Transport, Education, Health, to estimate the potential tonnes of recycled content per material type that could be consumed through sustainable procurement initiatives. Such a reverse auction scheme would enable to industry to respond with genuine market-led proposals.

In many respects, the allocation of grant funding sets out to achieve a similar outcome i.e. the greatest amount of tonnes of resource recovery. However, the grants approach does not work towards a specific target of tonnes recovered, rather sees what comes its way. The benefit of setting a recovery target and working backwards is that the cumulative impact of projects can be assessed to ensure the target is met and government expenditure to achieve this is efficient and optimised.

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