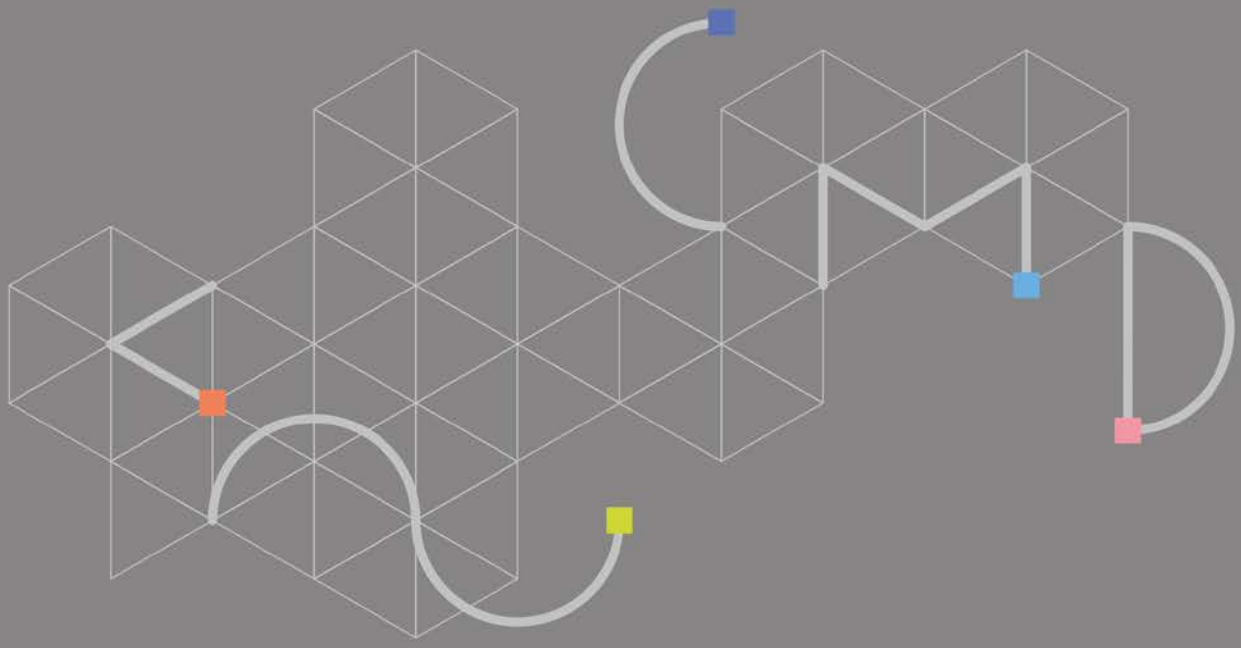
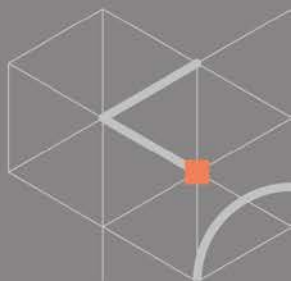
CENTRE FOR MARKET DESIGN

THE UNIVERSITY OF MELBOURNE



OPPORTUNITIES TO IMPROVE INFRASTRUCTURE INVESTMENT IN THE VICTORIAN WASTE ECONOMY

SEPTEMBER 2019



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THE CMD

The Centre for Market Design (CMD) is an innovative economic research centre hosted by the University of Melbourne. We support policy innovation by applying economic design techniques to public policy, procurement and resource allocation problems. We have particular expertise in mechanism design, auction theory, matching markets, experimental economics, and structural econometrics. The CMD was created specifically to build capabilities needed in economic design and to harness these ideas and techniques to create solutions to 'real world' public policy problems.

SUMMARY

The Centre for Market Design (CMD), with assistance from the BDA Group, was engaged by Infrastructure Victoria (IV) to assess the state of the waste resource recovery and reprocessing sector in Victoria, diagnose market failures and other inefficiencies in the system, and identify opportunities to optimise performance of the sector. The purpose of this approach is to understand how incentives, information problems and regulatory settings influence transactions that determine waste outcomes, and to identify possible solutions to waste sector challenges. This report is structured as follows.

- Section 2 provides a mapping of the Victorian waste 'lifecycle', identifying the major decision or transaction points in the cycle and actors involved at each point.
- Section 3 discusses the legislative, regulatory and other policy programs that influence the economic environment.
- Section 4 contains an analysis of where markets are missing or operating inefficiently.
- Section 5 outlines opportunities to optimise performance of the sector.

Below is an executive summary of this report.

Mapping of the Victorian waste 'lifecycle'

Decisions that determine the amount and type of waste produced and the activities needed to separate, sort, collect, process and dispose of solid wastes are performed by many, largely private, individuals and organizations who hold information, skills and capabilities needed to perform these tasks. These activities are delegated to the private sector because they have the skills, information and specialised capital needed to provide waste services at low cost. Waste outcomes, such as the level and type of waste disposed to landfill, are determined by choices that individuals and private organisations make through transactions. Transactions can be formal, for example when a recycling business purchases plastic waste material for recycling, or informal, such as when a householder separates waste at home. In the decentralised waste economy, major decisions or transaction points are spread across the waste lifecycle, as summarised below and discussed in detail in Section 2 of this report.

- **Production of waste.** The amount of waste produced is determined by the decisions of producers and consumers. Producers create waste as part of manufacturing processes and their production, packaging, and obsolescence strategies. While consumers do not always have a say over the level and type of waste produced, they create waste through their consumption and waste management decisions. For example, consumers influence waste outcomes through their decisions about their level of consumption, the type of goods or services purchased, and proportion of purchased goods that are consumed vs discarded (e.g., in the case of food), the extent to which goods are re-used before they are discarded, and how goods are discarded/replaced. The three major waste streams in Victoria include municipal solid waste (MSW), commercial and industrial (C&I) and construction and demolition (C&D) waste.

- **Waste services.** Once waste is produced, it is transformed through a range of waste services such as sorting, collection and transportation, and processing, before it can be re-used or disposed of.

- **Sorting:** Sorting is a process whereby effort is invested to reduce disorder in the waste stream. Sorting effort can be invested at source (i.e. household/waste producing businesses sort waste into separate bins or compartments); or delegated to private businesses i.e. a materials recovery facility (MRF) that separates mixed dry recyclables into individual materials to be made available for further processing; or a mix of these two strategies.

- **Collection:** Waste collection services for households are currently organised by local councils through timetabled collections that are sub-contracted to the private sector. Collection services for commercial and industrial establishments (C&I) and construction and demolition (C&D) take place via individually negotiated contracts with service providers and/or through internal service provision. While households and businesses could collect and transport wastes themselves, there are obvious benefits in coordinating waste collection and transport activities.

- **Recovery and re-processing:** Re-processing involves turning sorted waste into raw materials which can be used again for a completely new product (e.g., turning sorted plastic scrap into plastic pellets which can be used to make recycled plastic bottles).

- **Recycling or other end-of-life fates.** Once waste is generated and transformed by services such as sorting, collection and transportation, and re-processing, it can be either recycled or reach other possible end-of-life fates such as energy recovery, stockpiling, export, landfill or illegal dumping.

  - **Recycling.** Recycling involves the use of processed raw materials to make recycled products (e.g., turning plastic pellets into plastic bottles). Private firms determine the level and type of processing based on a commercial assessment of market prices for different types and grades materials and costs of recovering, processing and transporting these materials.

  - **Recovery of energy.** Waste-to-energy (WtE) or energy-from-waste (EfW) is the process of generating energy in the form of electricity and/or heat from the primary treatment of waste, or the processing of waste into a fuel source.

  - **Export.** In 2016-17, roughly 14% of Victoria's waste, primarily paper and plastic, was exported to countries such as China, Indonesia, Malaysia and India, which have low processing costs and lower environmental, health and safety standards compared with Australia. Following the *National Sword* initiative, whereby China introduced lower acceptable contamination standards for solid waste, including plastic from living sources and unsorted paper, international markets have experienced a significant fall in the prices of some types of scrap paper and plastics. These shocks in international waste materials markets have created both a transition and structural adjustment problem in the Victorian recycling industry.

  - **Landfilling.** The amount of waste material consigned to disposal (and therefore the demand for landfill capacity) is determined by both the level of waste generated and the extent to which the various waste processing activities, discussed above, recover and process waste materials. The supply of waste disposal capacity and the price at which landfill capacity is exchanged (referred to as the gate fee) is determined by the market. The number of landfills and their capacity are

regulated by the State Government but the gate fee is determined by competition between landfill operators and other uses of land; and by the regulatory requirements placed on landfill operators and sites.

- **Legal and illegal gaming.** The current economic environment in the waste sector creates a range of opportunities for strategic behaviour that is either illegal or legal but unwanted. An example of illegal gaming is the disposal of waste to non-approved sites. An example of legal, but unintended behaviour can be observed where wastes are stockpiled legally but this activity increases fire and other risks (which, in-turn, can lead to a breach of legal requirements related to safety and environmental protection).

Legislative and regulatory environment

The Victorian Government influences the waste economy through legislation and regulation, incentives, enforcement, grants and programs and education. Below is a brief summary of the legislative and regulatory environment in Victoria, which is discussed in detail in Section 3 of this report.

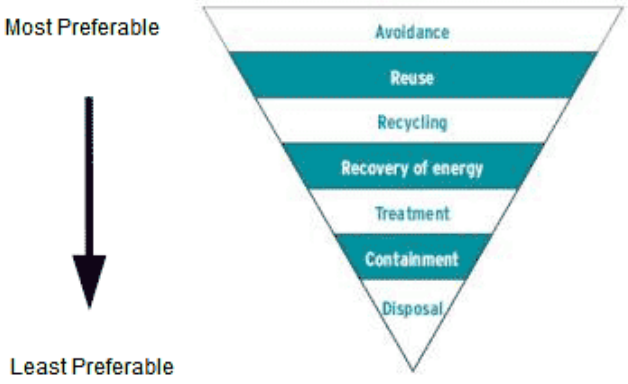
The *Environment Protection Act 1970* is the primary legislation that defines the public policy objectives, regulatory framework for individuals and private organisations, and the specific tasks to be performed by government. The Victorian Government recently passed the *Environment Protection Amendment Act 2018*. The objects of the *Environment Protection Amendment Act 2018* as they relate to waste are to:

(a) **minimise** litter and waste disposal by encouraging the management of waste in accordance with the waste management hierarchy;
(b) **promote** waste reduction, resource recovery and resource efficiency; and
(c) **minimise** the impact on human health and the environment from waste generation and waste disposal.

These objectives reflect community sentiment about the use of non-renewable resources, the amount and type of disposed waste, the level of recycling and impacts of waste on the environment. These goals are defined in legislation in terms of a waste hierarchy for Victoria. As shown in **Figure 1**, the waste hierarchy identifies activities and establishes preferences for avoidance (most preferred), reuse, recycling, recovery for energy, treatment and disposal (least preferred) management options.

The Victorian Government, using its legislative powers, has introduced incentives into the Victorian economy intended to align the behavior of households and businesses with stated policy objectives. The landfill levy is the main financial incentive created in Victoria and was first introduced as a levy on disposing municipal and industrial wastes (MILL) to landfill and to prescribed hazardous wastes (PIWLL) in 1999. The MILL and PIWLL place a levy on every tonne of waste that goes to landfill. The MILL and the PILL have both increased significantly over the last 20 years. For example, the levy rate for MSW metropolitan and MSW rural landfills have increased from $4/tonne and $2/tonne in 2002-03 to $64.30/tonne and $32.22/tonne by 2018-19, respectively.

Figure 1: The waste hierarchy



The Government's stated objective in introducing the MILL is to:

- act as an incentive to minimise waste and encourage greater re-use and recycling of resources while promoting investment in alternatives to waste disposal to landfill; and
- provide funds for waste management infrastructure, support programs for industry, education programs and the resourcing of the bodies responsible for waste planning and management in Victoria.

The government also intervenes in the waste economy through programs and grants such as the Research, Development and Demonstration Grants Program. This program supports projects that increase the quantity of recycled products sold in Victoria and aims to create jobs in the waste recovery sector, increase the rate of material recovery and divert waste from landfill. These programs are implemented by Sustainability Victoria through the Resource Recovery Infrastructure Fund and Research, Development and Demonstration grants.

Diagnosis of market failures and other inefficiencies in the system

Economic efficiency is a concept used to examine whether resources are employed in a way that maximizes welfare across all members of the community. A process is efficient if no changes can be made in the resources used, the level of consumption, or the matching of individual producers and consumers that would lead to a higher level of community wellbeing. Markets are the institutions that open economies rely on to allocate resources efficiently. Markets achieve this outcome because they create incentives through a process that reveals prices based on the information known only by market participants. In some situations, such as where information is unevenly distributed between buyers and sellers, markets will not allocate resources efficiently and in the extreme can cause markets to fail altogether (referred to as market failure). Where this occurs, the observed outcomes from transactions will not achieve the best outcomes for the community. In these situations, information, strategic and other complexities cause rational market participants to make decisions that are not aligned with outcomes that would maximise welfare across the whole economy.

In the context of the Victorian waste sector, observed outcomes are determined by the interplay between the legislative and regulatory environment, on the one hand, and the decentralized, self-interested decisions of producers, consumers and processors of waste, on the other hand. Evidence from reports

published by Sustainability Victoria (SV), the Australian Bureau of Statistics (ABS) and the Victorian Auditor General's Office (VAGO) shows that outcomes observed in the waste sector appear to fall short of stated policy intentions. For example:

- **Total waste generation in Victoria has steadily increased over time,** from 7.44 million tonnes in 2000, to 9.882 million tonnes in 2005, to 12.9 million tonnes in 2017. [1]

- **Waste generated per person has steadily increased over time, before declining in recent years.** The waste generated per head of population increased from 1.56 tonnes per person in 2000 to 2.2 tonnes per person in 2005 but has since declined to 2.03 tonnes per person in 2017[2].

- **While the rate of diversion from landfills has improved over time, the ultimate fate of this waste is uncertain.** The diversion rate, or the rate at which waste is diverted from landfill for reuse or recycling, increased from 55% in 2005 to 67% in 2017 (but the ultimate fate of this waste is uncertain). [3]

- **A third of total waste, and more than half of all household waste, is diverted to landfill.** Around 33% of the total level of waste generated, and more than half of all municipal solid waste (primarily waste generated from households) was disposed to landfill in 2017. [4]

- **Victoria is underperforming relative to other states.** Victoria is ranked third (after South Australia and New South Wales) in terms of the recycling percentage compared with other states. [5]

- **Some waste streams are still reliant on exports overseas.** – Around 14% of waste was exported overseas in 2017. [6] Materials streams reliant on overseas markets include paper/cardboard, metals, plastics, tyre and rubber, organics, glass and textiles.[7]

- **Waste stockpiling and illegal dumping have been identified as significant problem**, even though these issues are unaccounted for in the data that is collected at present.[8]

It is clear from the evidence above that outcomes observed in the Victorian waste sector are misaligned with stated policy intentions. In decentralised economic systems, such as the waste economy, alignment problems are common because the motivation of businesses and households does not necessarily accord with those of government. Below is a brief summary of some market failures and *complexities* that cause markets to allocate resources inefficiently. Section 4 of this report contains a more exhaustive discussion of the transaction complexities at different stages of the waste lifecycle.

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1 Sustainability Victoria, Waste Projection Model (2000-17)

2 Source: Essential Economics 2009 (data from Sustainability Victoria) and ABS population data.

3 Sustainability Victoria, Waste Projection Model (2016-17)

4 Sustainability Victoria, Waste Projection Model (2016-17)

5 ABS https://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/

6 Sustainability Victoria, Victorian Recycling Industry Annual Report (2016-17), Page 5.

7 Sustainability Victoria, SWRRIP, 2018. Page 91

8 VAGO, 'Recovering and Reprocessing Resources from Waste', June 2019; See page 14.

- **Missing markets for environmental goods and services, human health and amenity services.** Alignment problems such those observed in the Victorian waste economy principally occur because markets for environmental goods and services, human health and amenity services are missing. These goods and services have public good characteristics[9] and decisions made in the absence of prices for these services will reduce overall wellbeing in the economy.

- **Information asymmetry** is an important complexity that is almost universal to all stages of the waste lifecycle. It occurs in the waste sector because actors (consumers, producers and processors) privately hold information that is needed to make efficient decisions. Consumers hold information about the benefits of different consumption options; producers of goods and services hold information about costs and returns of producing different goods and services; and waste processors know about the costs and returns needed to determine the efficient level and type of processing of wastes. This information is hidden from governments and other agents and will not be revealed to others because this would compromise their competitive advantage in transactions (i.e. it is private information).

- **Contamination externalities** – Incorrect waste sorting can cause contamination of recyclable material reducing the value of batches of these materials. This is an important consideration because households/businesses who incorrectly sort waste streams can contaminate not only their waste but also reduce the value of others' wastes.

- **Site synergies** – Site synergies refers to the observation that costs of supplying a service can be reduced if the service is supplied to adjacent sites as a package. In the case of waste collection services, costs may be reduced if site synergies are permitted to influence the routes won in a competitive allocation process.

- **Coordination complexity –** Networks require consumers to coordinate their activities. For example, rail passengers coordinate departure times with other passengers to enable them to share the costs of travel. Participation in waste collection networks also requires coordination between households/business units.

- **Thin markets in waste processing –** Complexities may arise because of our reliance on a small number of large MRFs in Victoria. Such "thin market" problems can create market power problems.

- **Hidden information in waste disposal** – Information about the type of waste, volume, level of hazard etc. will need to be truthfully revealed before wastes can disposed of efficiently and effectively. This

[9] Public goods are freely accessible to all members of a given public, each being able to benefit from it without paying for it or diminishing its availability to others. A public good has two key characteristics: 1) Non-excludability, whereby it is impossible (or costly) to exclude a person from access to such a good if it is produced at all; and ii) Non-rivalrous consumption, whereby when one person uses a good, it does not prevent others from using it. Other examples of public goods include R&D and defence.

information is hidden from the regulator of the waste system and there are financial incentives to misrepresent this information.

- **Hidden action in waste disposal** – Hidden action problems arise when it is not possible to observe the actions of agents. In the waste disposal domain, hidden action problems arise when the attributes of waste are mis-represented and/or when wastes are disposed of illegally.

As described above, these and other *complexities* prevent markets from allocating resources efficiently. There is now a well-developed process by which institutions (also referred to as mechanisms) can be engineered to overcome these complexities so that the decisions of autonomous, self-interested actors are more likely to align with public policy objectives. A brief summary of the opportunities to improve alignment of waste sector outcomes is provided below. Broader issues relevant to the sector's longer-term performance are also identified below. Section 5 of this report contains a more exhaustive discussion of the opportunities to improve the economic efficiency and effectiveness in the waste economy.

Opportunities to improve mechanisms that determine waste sector outcomes and efficiency

In a decentralised decision environment such as that observed in the waste sector, economic theory shows that the rules, processes and incentives which collectively define the decision environment (referred to as institutions or mechanisms), must elicit information necessary to give economic agents the incentives to efficiently achieve the objective. Where mechanisms can be designed in this way, they reveal efficient prices. These prices influence everyday waste management choices, provide information needed to guide investment decisions in waste infrastructure, and reduce the cost of achieving waste outcomes. The mechanisms identified as opportunities to improve waste sector outcomes and efficiency are summarized below.

OPPORTUNITIES TO INTRODUCE INCENTIVES TO AVOID WASTE PRODUCTION

Producers of goods and services do not currently face the cost of waste created. Instead, the costs of waste created (for example, the costs of packaging and product redundancy strategies) are borne by those involved in later stages of the product's life cycle. By not taking these costs into consideration, manufactures of goods and services over-invest in packaging to attracts buyers' attention and/or reduce spoilage, and increase product redundancy by manufacturing goods that cannot be easily repaired. These strategies often involve complex trade-offs such as: reduced packaging waste vs. increased waste from spoilage of food and other goods; health and safety (e.g. "best before" labelling) vs. increased waste from discarded food; safety and other advantages from more frequent turnover of vehicles, mobile phones and other devices vs. increased residual waste. These and other tensions can be resolved if all benefits and costs relevant to different packaging and residual waste strategies can be revealed to the decision-space of manufacturers. There is a case to investigate mechanisms including, but not limited to, the following.

- A tax on waste creation, such as a tax on packaging, where the rate of tax is determined by the volume and type of packaging.
- An extended Producer Responsibility (EPR) policy, an approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle.
- A product stewardship scheme, which is similar to and often used interchangeably with the term 'EPR', as both concepts bring the onus of waste management for end-of-life products to the

manufacturers. Product Stewardship extends this responsibility beyond manufacturers to everyone involved in the life-cycle of the product (such as retailers, consumers and recyclers).[10]

Further research is needed to identify the "best" mechanism for introducing these incentives into the economy.

OPPORTUNITIES TO OPTIMISE HOW WASTE IS SORTED

As discussed above, the sorting of different waste streams (such as organic material, glass, plastics, paper, metals, chemicals etc.) can be:

a) performed at source (i.e. household/waste producing business sort waste into separate bins or compartments);
b) delegated to private businesses (i.e. a materials recovery facility MRF); or
c) a mix of these two strategies.

Each sorting strategy within this sorting continuum involves different types of skills, capital investment and operating costs. In commercial sorting businesses, such as a MRF, decisions about how much capital and effort to invest in sorting is influenced by the market price for recovered plastics, paper and metals etc. and the cost of sorting effort. Households, in contrast, are not exposed to these price incentives, and their decisions are determined by their sorting skills, inclination, type of dwelling, time available and many other factors.

The role of an efficient sorting mechanism is to elicit the information needed to give households and sorting businesses the incentives to select the optimal type and distribution of sorting effort. Such a mechanism must also take account of complexities such as the contamination of waste streams through incorrect or uninformed sorting, and the implications of sorting strategies on collection costs. This is a complex problem because households are heterogeneous with respect to sorting skills, preferences, type of dwelling, time available and many other factors; and sorting businesses have different costs, skills and technology. The broad class of mechanisms needed to resolve these information, incentive, contamination and coordination complexities is referred to as a menu of incentive-compatible contracts. This menu of contracts mechanism:

- sets out the technically feasible menu of sorting options (contracts) available;
- identifies the costs associated with each option; and then
- matches each household/business to the optimal contract.

The menu of contracts mechanism achieves this by:

- allowing households and businesses that generate waste to select the "best" sorting contract (strategy) based on their type (private information and preferences);

[10] Product stewardship is an approach that formalises 'shared responsibility' between industry, government and the community to manage the impact of products on the environment and human health. Typically, the costs of end-of-life product management or scheme operation are covered through an up-front levy (at the point of import or purchase) or an agreed financial liability rather than payment for waste management at the end of life (point of disposal).

- creating a market place (the supply-side) in which businesses or individuals who have expertise and ideas can offer to supply sorting services and reveal the cost of these services;
- facilitating the revelation of additional information into the market such as where there are additional costs or benefits (e.g. environmental or contamination externalities) not evident to others; and
- allowing for optimisation across all contracts where there are synergies between contracts.

In this way, the menu of contracts mechanism could be adapted to resolve coordination problems that arise because of the interaction between collection and transport services. This mechanism effectively determines the number of bins needed at each household and this defines the type and level of sorting to be completed at source.

This mechanism would be particularly valuable for the sorting of the following waste streams.

- **Organics.** Organic wastes make up around 35% of landfill. As organic wastes decompose in landfills, they create odorous methane, a potent greenhouse gas. However, if removed from general waste that goes to landfills, organic waste can be reused to create products such as compost. These products are typically bulky and have low economic value that is quickly eroded by transport costs. These attributes suggest there may be opportunities to remove organic material at or near source and the menu of contracts could be employed for this purpose.

- **Plastics, paper and cardboard materials.** The menu of contracts mechanism could also be expanded to provide consumers with an option that ensures their plastic and paper wastes are recycled. Anecdotal evidence suggests that households assume material placed in a recycle bin is recycled but this is not always the case because commercial sorting businesses base sorting effort on the market price for recycled materials. If guaranteed recycling were added to the menu of contracts, including the associated cost or benefit of doing so, high-conservation households could choose this option allowing them to implement their preferences for recycling. Where market prices for recyclable materials are low, as is currently the case, this contract option may involve a cost to the household that would fund the effort needed to recycle materials.

OPPORTUNITIES TO IMPROVE THE PROCUREMENT OF WASTE COLLECTION SERVICES

Waste collection services are provided through networks, rather than individually organised services, because of the opportunities created by networks to share infrastructure costs (amongst other advantages). There are two opportunities to improve value created from waste collection networks.

A. ***IMPROVED INCENTIVES, INFORMATION AND COORDINATION OF WASTE COLLECTION SERVICES*** - The first opportunity is to reward households for behavioural changes that enhance waste collection efficiency. For example:

- **There are opportunities to incentivise behaviour change through a pay-per-lift, or other user-pays approach.** Optimal sorting strategies, identified through the menu of contracts mechanism discussed above, interact strongly with waste collection services. For example, the removal of organic material at source determines the number and type of bins needed and the volume of waste to be collected for disposal to landfill, both of which influence collection services needed.

- **There are also opportunities to create incentives for households to reveal information and coordination possibilities that could further improve efficiency in waste collection.** This involves exploring opportunities to transform waste collection from a timetabled service to an on-demand, user-pays service. In other domains of the economy, such as personal transport services, modern communication technology has allowed gains from similar information and coordination possibilities to be exploited. In the waste sector mobile phone applications could allow households to reduce the number and frequency of collections required by revealing when different bins are full as an alternative to timetabled collection. It may also be possible to design coordination mechanisms that allow households to cooperate with other households to reduce collection costs (e.g. local collection points) and allow waste collection service providers to reveal their movements to households. Provided beneficial coordination can be reflected in the incentive structures for waste collection services, these innovations would be converted into economic efficiency gains and cost reductions.

B. ***IMPROVED PROCUREMENT OF WASTE COLLECTION SERVICES*** - It is now possible to design procurement processes in which specialised auctions harness competition between providers of networked services. These auctions, referred to as combinatorial or package auctions, establish a competitive environment in which waste collection providers can assemble synergistic collection regions and thereby reduce the payment required to provide these services. This auction format allows the market (waste collection service providers in this case) to assemble combinations of collection units through bidding activity in the procurement auction and this can reduce the cost of collection services.

AUCTIONS TO INCREASE THE LEVEL OF WASTE PROCESSING AND RECYCLING

Markets for waste materials are essentially commodity markets and there is no reason to suspect they do not reveal efficient prices. Prices for many waste materials are currently low but can be expected to return to a new equilibrium once international markets for these materials digest the shock arising from *National Sword* and other disruptions. There are limited opportunities to improve the way these markets operate in the waste processing and recycling sector in Victoria. Two opportunities have been identified.

A. ***SPECIFICATIONS FOR INTERNATIONAL TRADE IN WASTE MATERIAL*** – Like other commodity markets, waste materials are sold by description. *National Sword* has effectively redefined a minimum standard for exports of waste materials, but formal specifications of waste materials will be needed to revive export markets. The current process in which importers return unacceptable waste material to the country of origin is clearly inefficient. There is a case for government (i.e. the Commonwealth Government) to speed-up the creation of metrics needed to facilitate international transactions so that waste materials can be sold by description. These metrics would define quality and quantity attributes of waste materials as well as enforceable contamination standards.

B. ***INCENTIVES FOR RECYCLING AND WASTE MATERIALS PROCESSING*** – Markets create incentives that reward commercial businesses for effort required to recycle and reuse wastes. Although there is not a strong economic efficiency case for government intervention, public sentiment appears to support higher levels of recycling and reuse than that determined by the market. If government chooses to intervene to increase recycling and reuse of waste materials, it is best to rely on a mechanism that:

- minimises the cost of intervention;
- is transparent with respect to cost; and

- avoids picking winners based on subjective criteria.

The role of the mechanism, in this context, is to discover the minimum payment (from government) needed to achieve the recycling/reuse objective identified. An auction of recycling and reuse contracts should be considered for this purpose. Auctions are mechanisms that harness competition where there are few participants (thin markets) to allocate waste reuse contracts (in this context) efficiently. In this type of auction, waste processing businesses would bid an amount that they would need to be paid to increase processing/reuse of a specific type and volume of waste material. The winner(s) are those businesses that place the lowest bid (a descending-price auction) until the recycling/reuse target established by government is achieved, or the budget is exhausted. This mechanism could be funded from revenue collected by the existing landfill levy. Like all auctions, this mechanism will need to be designed from auction theory and tested in controlled laboratory conditions to ensure it performs efficiently.

OPPORTUNITIES TO INTRODUCE COMPULSORY INSURANCE ON WASTE RISK

Some waste activities, such as storage, transport and disposal of materials (particularly hazardous and flammable wastes), carry some probability that unintended events will expose private individuals, commercial businesses and the environment to losses. For example, it has been argued by BDA (2009) that while Victorian regulations and standards for landfill sites[11] largely mitigate environmental, health and amenity externalities, they may not fully price public liability and clean-up costs and other risks that could arise from bankruptcy. This suggests the market largely prices in externalities into gate fees, but may not fully price risk.

Waste risk is currently managed through a range of mechanisms. Some of this risk is insurable, some is mitigated through legislative and regulatory requirements, but some risk is transferred to the public as evidenced by recent fires, illegal disposal and waste business insolvencies. Waste-created risk is an insurable risk according to commonly accepted criteria[12] but the cost and availability of such insurance may be influenced by the uncertain economic and political environment that currently exists in the waste sector, and by the discretionary nature of such insurance. There is a strong case to mandate the purchase of waste-risk insurance for specific activities to counter the problem that the creators of risk do not bear the financial consequences. There are important economic efficiency gains from monetising waste-created risk through the purchase of actuarially priced insurance. Besides pricing risk efficiently, this mechanism creates an incentive to modify risky behaviours and reduces the prospect of these risks being transferred to the public balance sheet. The cost and availability of such insurance may be influenced by the uncertain economic and political environment that currently exists in the waste sector, and by the discretionary nature of such insurance[13].

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11 At least for more recent and larger sites.

12 See Berliner's (1982) insurability criteria as an example.

13 Where waste risk insurance is not compulsory, the insurance pool may be reduced limiting the risk pooling potential for such insurance.

OPPORTUNITIES TO BETTER MONITOR ILLEGAL ACTIVITIES AND REDUCE OPPORTUNITIES FOR GAMING

The current economic environment in the waste sector creates a range of opportunities for strategic behaviour that is either legal but unwanted or illegal. An example of legal gaming is interstate trade in waste to take advantage of differences in landfill levies or disposal specifications. An example of illegal gaming is the disposal of waste to non-approved sites. The recent report by the Victorian Auditor General's Office identified these as important problem in the waste sector.[14] In this context, the landfill levy and differentials between jurisdictions create gaming opportunities that imposes costs on the environment, human health and amenity, and an uneven playing field that weakens incentives for investment in waste infrastructure. The CMD identifies two opportunities to address gaming problems in the waste sector.

A. ***OPTIMAL MONITORING AND ENFORCEMENT STRATEGIES*** - The first, more immediate, opportunity is to apply well-understood economic concepts, referred to as "the inspection game" to all aspects of the waste economy where there are incentives for illegal behaviour. This offers a relatively simple and intuitive framework in which bodies, such as the Environment Protection Authority, can formulate an optimal inspection and punishment strategy.

B. ***REDUCE OPPORTUNITIES FOR GAMING*** - The second, longer-term opportunity is to reduce the opportunity for illegal activities by designing mechanisms that are strategy-proof. This is a standard consideration in mechanism design. Strategy-proof mechanisms are those in which the dominant strategy of participants is to truthfully reveal private information that influences outcomes. Mechanisms that are strategy-proof are argued to protect participants from making strategic errors, prevent waste from rent-seeking behaviour and avoid unproductive behaviours such as spying on others. A second-price auction is an example of a strategy-proof mechanism. [15]

Opportunities for longer-term improvement in the waste sector

Three opportunities for longer-term improvement in the waste sector have been identified by the CMD.

OPPORTUNITY TO ADDRESS ISSUES WITH THE LANDFILL LEVY

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[14] VAGO, 'Recovering and Reprocessing Resources from Waste', June 2019; See page 14. .

[15] A second-price auction is strategy-proof because the highest bidder wins but the price paid is the second-highest bid. This mechanism is strategy-proof because each bidder has an incentive to truthfully reveal their valuation knowing that they will pay less than their bid (the value of the second-highest bidder) if they win. Markets are argued to be strategy-proof because they are second-price mechanisms

As discussed above, the primarily policy lever used by the Victorian Government at present is the landfill levy. The Government's stated objective in introducing the MILL is to:

- act as an incentive to minimise waste, encourage greater re-use and recycling of resources, and promoting investment in alternatives to waste disposal to landfill; and

- provide funds for waste management infrastructure, support programs for industry, education programs and the resourcing of the bodies responsible for waste planning and management in Victoria.

The landfill levy is, in effect, a tax imposed on landfill, which creates an incentive to reduce disposal of waste to landfill. The landfill levy, as it is currently designed, has two problems.

- First, it does not fulfil a number of the Victorian Government's stated objectives. For example, the landfill levy does not act as an incentive to minimise waste (as it does not create incentivise for manufacturers to optimise their level and type of packaging, or their product redundancy strategies).

- Second, it creates incentives for illegal and legal gaming. An example of illegal gaming is the disposal of waste to non-approved sites. An example of legal, but unintended behaviour can be observed where wastes are stockpiled legally but this activity increases fire and other risks (which, in-turn, can lead to a breach of legal requirements related to safety and environmental protection). These strategic behaviours are a response to the landfill levy. These activities impose environmental, safety and amenity costs but also create commercial risks for legitimate investments in waste infrastructure.

As an alternative mechanism, there is a case to investigate a levy/tax on waste creation, where the rate of the levy is determined by the volume and type of waste created (different levies for different types of packaging, for example). There is also scope to redistribute the revenue collected from a waste creation levy to: increase the use of recycled materials (if needed); invest in beneficial research; and fund infrastructure capacity gaps where there is a clear and material market failure. Alternative mechanisms to incentivise waste minimisation (which is a stated objective of the Victorian government) include extended producer responsibility (EPR) policies and product stewardship schemes. Further research is needed to identify the "best" mechanism for introducing these incentives into the economy.

On first principles, these styles of mechanism appear to display superior economic efficiency properties compared with a tax on disposal (because they directly address the cause of market inefficiency), and would appear to be less susceptible to legal and illegal gaming strategies.

In practice, the successful implementation of such a mechanism would require support from the Commonwealth government, and co-ordination between states (to prevent gaming opportunities arising from differential landfill levies between states)

INCREASED CHOICE OVER WASTE OUTCOMES

Individuals have different values and preferences with respect to waste. Some already invest a lot of effort to reduce waste produced while others do the minimum required. Government investment in the design and creation of mechanisms which create pathways that allow individuals to implement their preferences

with respect to waste recycling and disposal will reduce the alignment problem between waste outcomes and public policy objectives. These mechanisms will allow those members of society who feel strongly about reducing waste to landfill, recycling plastics or other materials would be able to do so.

CLARIFY WASTE POLICY OBJECTIVES

The final observation made by the CMD is that ambitious waste objectives can impose welfare costs on the economy. Waste programs need to be both efficient and transparent. To promote these objectives, it will be important to establish aspirational economic efficiency objectives in future waste legislation to complement the aspirational waste reduction objectives defined in current legislation. It will also be important to ensure that public funds allocated to waste programs are competitive with other public policy objectives including alternative environmental, human health, welfare and domestic violence programs – these services are also important to Victorians. To this end, it is widely accepted that hypothecation of public funds, such as occurs through the landfill levy, should be avoided in favour of a competitive allocation process.

1. INTRODUCTION

The Centre for Market Design (CMD), with assistance from the BDA Group, was engaged by Infrastructure Victoria (IV) to assess the state of the waste resource recovery and reprocessing sector in Victoria, diagnose market failures and other inefficiencies in the system, and identify market design opportunities to optimise the performance of the sector. The purpose of this approach is to understand how incentives, information problems and regulatory settings influence transactions that determine waste outcomes, and to identify possible solutions to waste sector challenges. This report summarizes an initial diagnostic analysis of the waste economy in Victoria. The remainder of this report is structured as follows.

- Section 2 provides a mapping of the Victorian waste 'lifecycle', identifying the major decision or transaction points in the cycle and actors involved at each point;
- Section 3 discusses the legislative, regulatory and other policy programs that influence the economic environment;
- Section 4 contains an analysis of where markets are missing or operating inefficiently and identifies complexities that impede efficient price revelation and resource allocation.
- Section 5 draws on modern microeconomic concepts, referred to as market/mechanism design, to identify the mechanisms needed to improve the performance of the waste sector in Victoria and the implications for waste infrastructure.

2. THE WASTE ECONOMY

Decisions that determine the amount and type of waste produced and the activities needed to separate, sort, collect, process and dispose of solid wastes are performed by many, largely private, individuals and organizations who hold information, skills and capabilities needed to perform these tasks. These activities are delegated to the private sector because they have the skills, information and specialised capital needed to provide waste services at low cost. Waste outcomes, such as the level and type of waste disposed to landfill, are determined by choices that individuals and private organisations make through transactions. Transactions can be formal, for example when a recycling business purchases plastic waste material for recycling, or informal, such as when a householder separates waste at home.

The following sub-sections provide a mapping of the Victorian waste 'lifecycle', identifying the major decision or transaction points in the cycle, and actors involved at each point.

- The amount of waste produced is determined by the decisions of producers and consumers. Section 2.1 discusses the major decisions or transactions made by producers and consumers that influence the production of waste.

- Once waste is produced, it is transformed through a range of waste services such as sorting, collection and transportation, and processing, before it can be re-used or disposed of. Section 2.2 outlines the major decisions or transactions made after waste is produced, and before waste is recycled or reaches other end-of-life fates.

- Once waste is generated and transformed by services such as sorting, collection and transportation, and re-processing, it can be either be recycled or reach other possible end-of-life fates such as energy recovery, stockpiling, export, landfill or illegal dumping. Section 2.3 outlines the major decisions or transactions made when waste is recycled or reaches other end-of-life fates.

2.1 PRODUCTION OF WASTE

The amount of waste produced is determined by the decisions of producers and consumers.

Producers create waste as part of manufacturing processes, and their production, packaging and obsolescence strategies. However, producers' decisions about waste created from packaging and product durability/repairability (residual product waste) do not take account of the costs of these sources of waste. In a competitive environment, producers will over-invest in packaging to attract buyers' attention and/or reduce spoilage because the cost of managing these wastes are passed to consumers.

Consumers do not always have a say over the level and type of waste that is produced. For example, much of the waste generated from households is inherited from the packaging and obsolescence strategies of manufacturers. However, consumers do influence waste management outcomes through their consumption and waste management decisions, such as their decisions about their:

- total level of consumption;
- the type of goods or services purchased;
- the proportion of purchased goods that are consumed vs discarded (e.g. in the case of food);
- the extent to which goods are re-used before they are discarded; and

- how goods are discarded or replaced.

Consumers' decisions are also influenced by other factors including:

- the rate of technology progress (e.g., mobile phone replacement is influenced by the availability and performance of the next generation device/service rather than by necessity);
- trends in fashion (e.g., clothing); and
- health and safety standards (e.g., "best before" information influences consumption decisions that influence the level of organic waste).

In Victoria, these decisions are also made in the absence of efficient price signals about the cost of waste disposal and the risks of disposal options on the environment and on human health. For example, final consumers, e.g. households, face only weak incentives for waste avoidance because they pay an annual fee for waste collection services, rather than a fee-for-service. Intermediate consumers on the other hand, such as commercial businesses that purchase inputs, do pay for waste disposal on a user-pays basis and will be motivated to consider packaging and residual waste in their purchase decisions.

There are often multiple, conflicting factors that influence the creation of waste. For example, rapid advances in motor vehicle technology make vehicles safer, more efficient and less polluting, suggesting there are advantages from more rapid turnover of the vehicle fleet. However, a disadvantage of such obsolescence strategies is that they also increase the amount of waste that is generated.

Data on the recycling and resource recovery sector in Victoria collected by Sustainability Victoria is based on three source sectors.[16]

- **Municipal solid waste (MSW)** includes materials generated and discarded from households and council activities. Materials recovered from the MSW sector include paper, glass, plastic and organics.
- **Commercial and industrial (C&I)** includes materials generated and discarded from business and industry, agriculture and manufacturing. Materials recovered from the C&I sector include paper/cardboard, metals, glass, plastic and organics.
- **Construction and demolition (C&D)** waste includes materials generated and discarded from building, construction and demolition activities. Most of the materials (93 per cent) from the C&D sector are aggregates, masonry and soils which includes a large component of used concrete.

As shown in the **Box 1** below, 12.9 million tonnes of waste was generated by Victorians in 2016-17, of which 24% was waste generated from households (MSW), 36% was commercial and industrial (C&I) waste and 40% was construction and demolition (C&D) waste. **Box 2** below shows that of the total 12.9 million tonnes of waste managed by Victoria's waste and resource recovery system in 2016-17, 4.2 million tonnes were sent to landfill, and 8.62 million tonnes were diverted from landfill for reuse or recycling, representing a 67% diversion rate. This diversion rate is higher for certain waste streams (81.4% for C&D and 68.4% for C&I) and lower for others (41% for MSW). **Box 3** below shows the composition of materials recovered in 2016-17 by materials stream. The four main materials streams that were recovered in 2016-

16 Source: Sustainability Victoria, SWRRIP 2018, Page 83.

17 include aggregates, masonry and soil, metals, paper/cardboard and organics which comprise 47.4%, 19.6%, 16.7% and 12.7% of total recovered materials, respectively. Other materials streams such as glass, plastics, rubber and textiles, each made up of less than 2% of total recovered materials.

Box 1: Waste was generated by Victorians in 2016-17

Sector	**Total waste** (tonnes)	**Waste streams a proportion of total waste (%)**
Construction and demolition (C&D)	5,181,168	40%
Commercial and industrial (C&I)	4,573,110	36%
Municipal Solid Waste (MSW)	3,110,676	24%
Total	**12,864,954**	**100%**

Source: Sustainability Victoria, Waste Projection Model (2016-17)

Box 2: Waste recovered vs sent to landfill in 2016-17

Sector	**Total waste** (tonnes)	**Waste recovered** (tonnes)	**Landfill** (tonnes)	**Diversion rate** (rate at which waste is diverted from landfill for reuse or recycling)
Construction and demolition (C&D)	5,181,168	4,217,056	964,112	**81.4%**
Commercial and industrial (C&I)	4,573,110	3,126,933	1,446,177	**68.4%**
Municipal Solid Waste (MSW)	3,110,676	1,273,928	1,836,748	**41.0%**
Total	**12,864,954**	**8,617,917**	**4,247,037**	**67.0%**

Source: Sustainability Victoria, Waste Projection Model (2016-17)

Box 3: Composition of materials recovered in 2016-17

The 8.6 million tonnes of materials recovered in 2016-17 comprise of the following materials streams.

- Aggregate, masonry and soil: 4.1 million tonnes (47.4% of total recovered materials)
- Metal 1.7 million tonnes (19.6%)
- Paper and cardboard 1.44 million tonnes (16.7%)
- Organics 1.10 million tonnes (12.7%)
- Glass 134,500 tonnes (1.6%)
- Plastics 130,695 tonnes (1.5%)
- Rubber 41,437 tonnes (0.5%)
- Textiles 3,465 tonnes (>1%)

The ratio of recovered waste to total waste increased from 55% (2005) to 67% (2017).

Source: Sustainability Victoria, Waste Projection Model (2016-17)

2.2 WASTE SERVICES

Wastes comprise a mixture of organic material, glass, plastics, paper, metals, chemicals etc., that can only be reused or disposed of safely when they have been transformed by services such as sorting, collection and transportation, and processing. These and other processes involve costly effort that increases the value of waste material. In this section we look at the waste services as transactions. Sorting, collection and processing services are discussed in Sections 2.2.1, 2.2.1 and 2.2.3, respectively.

2.2.1 Sorting services

Sorting is a process whereby effort is invested to reduce disorder in the waste stream. Sorting effort can be invested:

- at source (i.e. household/waste producing business sort waste into separate bins or compartments); or
- delegated to private businesses (i.e. a materials recovery facility or MRF); or
- a mix of these two strategies.

Each sorting strategy within this sorting continuum involves different types of capital investment and operating costs. For example, further sorting at source would require investment in additional bins (or segregation of bids) at the household/business level. Commercial MRFs require specialised investments in plant and equipment to separate waste materials depending on the requirements of waste materials processors. In some countries, particularly those with abundant low-skill labour, sorting is completed manually.

Where sorting is delegated to commercial operations, they determine the optimal level of sorting effort based on the returns that can be earned by selling processed waste materials in competitive markets. Sorting at source is not conducted in this commercial environment because households do not consider market prices for various types of glass, paper or metal when sorting wastes. Furthermore, households do not generally have the information and expertise to sort wastes to market specifications. The current source sorting mechanism varies between jurisdictions, and between the three different waste streams (MSW, C&I and C&D).

To facilitate the separation and collection of waste from households and small businesses, there are 79 local governments in Victoria, all of which offer household kerbside services.[17] The level and distribution of sorting effort at households is, to a large extent, determined by the source separation infrastructure (i.e., the number and/or compartments in bins) provided by local councils. This differs across jurisdictions and is determined by a government official within each jurisdiction through a largely centralised process. The current mechanism can broadly be categorised as follows.

- All 79 local governments offer a household kerbside recycling service, which covers 95% of Victorian households. The remaining 4% are generally located in remote areas where providing a kerbside recyclables service is not feasible. Households covered by kerbside collection are asked to sort general waste in the 'Garbage bin' (destined for landfill) from recyclable materials in the

[17] Source: Sustainability Victoria, Victorian Local Government Annual Waste Services Report (2016-17), Page 12.

'Recyclables bin'. The Victorian Recyclables bin can be described as a 'co-mingled recycling bin', as it is made up of a mix of everyday items including glass bottles and jars, plastic containers as well as aluminium and steel cans. In 2016-17, paper items were the largest category of Recyclables collected through kerbside recycling services accounting for 58%. Glass containers made up 29% and Plastic containers made up 9%.[18]

- Some jurisdictions have also introduced a third bin (in addition to the 'Garbage bin' and co-mingled 'Recyclables bin') for organic waste. In Victoria, 56 of 79 local governments offer household Organics bin collection services that cover 56% of Victorian households while a further three local governments offered only an on-call service. Of the 56 councils offering a bin service, 13 of those also offered residents an on-call service mostly annually or biannually. There were 15 Councils collecting both Food and Garden Organics (FOGO) from the kerbside system. The councils with FOGO services indicated that approximately 22% of the organics stream was composed of food organics. This represents 3% of the total kerbside waste stream collected from households. The majority of Councils which do not offer a kerbside Organics service are based in regional areas.[19]

- Some councils are currently conducting trials on the feasibility of a fourth bin. For example, the Macedon Ranges Shire Council is investigating additional waste separation options for glass in the town of Lancefield[20].

- In 2016-17, 43 of 79 local governments also provided a hard waste collection service. Hard waste is household waste not normally accepted or possible to fit into garbage bins e.g. white goods and timber. [21]

- In regional areas, materials dropped off and collected at resource recovery centres play a large role in supplementing kerbside collection systems, particularly for garden organics. [22]

C&I and C&D waste is largely outside the scope of kerbside sorting and collection services provided by councils. Individual businesses determine the level of sorting effort conducted at source in light of prices for scrap materials, such as metal offcuts, and the cost associated with sorting activities. Arrangements to collect and process these materials are determined through bilateral transactions.

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18 Source: Sustainability Victoria, Victorian Local Government Annual Waste Services Report (2016-17), Page 18.

19 Source: Sustainability Victoria, Victorian Local Government Annual Waste Services Report (2016-17), Page 19.

20 The Yarra Council is currently completing a food scraps collection trial – see https://www.yarracity.vic.gov.au/news/2018/07/17/food-scraps-collection-trial-reducing-waste

21 Source: Sustainability Victoria, Victorian Local Government Annual Waste Services Report (2016-17), Page 22.

22 Sustainability Victoria, SWRRIP, 2018. Page 131.

Finally, a number of jurisdictions also offer a Container Deposit Scheme (CDS), which is another form of infrastructure to support greater separation at source. While CDS specifications vary across jurisdictions, they generally offer a price incentive (such as a 10-cent refund) for the return of used and recyclable items, such as cans and bottles. Victoria does not currently have a container deposit scheme, unlike a number of Australian jurisdictions including South Australia, Northern Territory, Queensland, ACT and New South Wales.

2.2.2 Collection services

The mechanism for waste collection differs across jurisdictions and across the three waste streams (MSW, C&I and C&D).

Waste collection services for households (MSW) are currently organised by local councils through timetabled collection that are sub-contracted to the private sector. Current waste collection networks are managed via a posted timetable (e.g. general waste collected weekly and recycling wastes collected fortnightly). There are currently seven different combinations of garbage and recycling bin systems used by Victorian local governments (in the past there has been up to 14). The most common recycling /garbage bin combination is a 240L commingled fortnightly recyclables bin with a 120L weekly garbage bin. This system is used by 45 of 79 local governments.[23] Collection contracts for MSW waste are allocated through simple tender processes and costs are administratively determined (by local councils). Households pay a flat rate for the provision of waste collection services, through their local council rates.

As households do not have a price incentive to dispose of waste with care, poor sorting effort at source also results in contamination.[24] High contamination rates lower the market value of recyclable materials and increase the costs of sorting these materials at materials recovery facilities (MRFs). Poor sorting effort at source also results in recyclable material ending up in landfill. This is evidenced by the statistics in **Box 4** below, which show that in 2016-17, Garbage (which was sent straight to landfill) accounted for more than half (53%) of the 2.23[25] million tonnes of waste collected by local government household kerbside collection services. Recyclables and Organics on the other hand, accounted for only 26% and 21% of waste collected through household kerbside collection services, respectively. In other words, the state kerbside

[23] Source: Sustainability Victoria, Victorian Local Government Annual Waste Services Report (2016-17), Page 17.

[24] In 2016-17 contamination levels averaged 6.5% an increase of 1.2 percentage points from the previous year. Source: Sustainability Victoria, Victorian Local Government Annual Waste Services Report (2016-17), Page 18.

[25] Note that the discrepancy between total tonnes of MSW waste reported in Box 2 and kerbside garbage tonnes reported in Box 4 is owing to the discrepancy in figures reported by Sustainability Victoria's Waste Data Portal. While the total tonnes of MSW waste reported in the Waste Projection Model is 3.11mt (reported in Box 2), the kerbside garbage tonnes reported in the Victorian Local Government Annual Waste Services Report is 2.23mt (reported in Box 4).

diversion from landfill rate (incorporating recyclables and organics) was 46%.[26] This diversion rate is significantly lower, at 20%, for hard waste[27], 80% of which was disposed to landfill in 2016-17.

Box 4: Composition of waste collected by local government household kerbside collection services in 2016-17

Around 2.23 million tonnes of kerbside garbage, recyclables and garden organics are collected by local government in Victoria. Of the 2.23 million tonnes collected:

- 1.18 million tonnes, or 53%, was 'Garbage' (which was sent straight to landfill)
- 591,000 tonnes, or 26%, was Recyclables; and
- 463,000 tonnes, or 21%, was Organic material

In addition to the figures above, 103,396 tonnes of hard waste was collected by local government in 2016-17, 80% of which was disposed to landfill.

In 2016-17, the state kerbside diversion from landfill rate (incorporating recyclables and organics) was 46%.

The total cost of Kerbside waste collection was $405 million in 2016-17.

Source: Sustainability Victoria, Victorian Local Government Annual Waste Services Report (2016-17)

Collection services for commercial and industrial establishments (C&I) and construction and demolition (C&D) take place via individually negotiated contracts with service providers and/or through internal contracting. These collections are usually charged per bin pick-up (lift) and based on the volume of the bin. These services are provided at regular intervals or can be booked on demand. As commercial businesses do have a price incentive to dispose of waste with care, C&I and C&D recovery rates are significantly higher than MSW recovery rates in Victoria, as shown in Box 2 in Section 2.1.

Wastes are defined not only by composition and volume but by their spatial location. While households and businesses could collect, and transport wastes themselves, there are obvious benefits in coordinating waste collection and transport activities. Each point of waste generation (household/business) can be thought of as a node that could coordinate with other nodes to share waste collection costs. In nature and the built environment, networks evolve and are designed as branching and sub-branching systems because this architecture optimizes transport efficiencies that arise from sharing common infrastructure and increases the potential interactions (transactions) between nodes. To maximise synergies between neighbouring sites, local governments are looking to consolidate multiple contracts under fewer service providers. This has resulted in increased consolidation in the waste collection market, where a small number of large firms (such as Cleanaway, Veolia, J.J. Richards and Suez) currently account for a large share of the market in Victoria.

[26] Note that the discrepancy in diversion rates reported in Box 2 and Box 4 of this report is owing to the discrepancy in figures reported by Sustainability Victoria's Waste Data Portal. While the diversion rate reported in the Waste Projection Model is 41% (reported in Box 2), the diversion rate reported in the Victorian Local Government Annual Waste Services Report is 46% (reported in Box 4).

[27] Hard waste is household waste not normally accepted or possible to fit into garbage bins e.g. white goods and timber. In 2016-17, 43 of 79 local governments provided a hard waste collection service.

2.2.3 Re-processing

Re-processing involves turning sorted waste into raw materials which can be used again, usually for a completely new product (e.g. turning sorted plastic scrap into plastic pellets which can be used to make recycled plastic bottles).

Reprocessors use industrial processes to change the physical structure and properties of discarded materials so they can be used again by the community. Reprocessors are diverse in nature and range from facilities that dismantle and breakdown products like tyres, e-waste and mattresses into their different components to provide feedstock for further reprocessing, to facilities that melt, break up and reform materials like organics, plastics, glass and rubber to either make feedstocks for new products or reuse materials. In 2015–16, an estimated 8,489,000 tonnes of material were reprocessed in Victoria at more than 160 facilities.[28] **Box 5** below shows the distribution of these re-processing facilities by feedstock and estimated tonnes.

Box 5: Victorian re-processors and estimated tonnes managed (2015–16)

Feedstock	Estimated tonnes	Total Number of facilities in Victoria
Food organics	103,000	3
Garden organics	429,000	11
Combined food and garden organics (FOGO)	Data not available	6
Wood/ timber	204,000	10
Mixed/other organics	300,000	24
Paper and cardboard	1,551,000	8
Glass	173,000	2
Plastics	149,000	24
Tyres and rubber	Data not available	2
Metals	1,425,000	7
Aggregates, masonry and soils	4,093,000	51
Textiles	2,000	3
E-waste	Data not available	7
WtE (using a variety of feedstocks)	Data not available	9

Source: Sustainability Victoria, SWRRIP, 2018. Pages 140 – 142; Note: Table 6.10 of the SWRRIP also shows the split of these re-processing facilities by region and end-products.

28 Sustainability Victoria, SWRRIP, 2018. Page 140.

2.3 RECYCLING OR OTHER END-OF-LIFE FATES

Once waste is generated, recovered and transformed by services such as sorting, collection and transportation, and re-processing, it can be either be recycled or reach other possible end-of-life fates such as energy recovery, stockpiling, export, landfill or illegal dumping. Recycling, recovery of energy, export, landfilling and legal/illegal gaming are discussed in Sections 2.3.1, 2.3.2, 2.3.3, 2.3.4 and 2.3.5 respectively.

2.3.1 Recycling services

Recycling involves the use of processed raw materials to make recycled products (e.g. turning plastic pellets into plastic bottles).

Private firms determine the level and type of processing and recycling effort based on commercial assessment of market price for different types and grades materials and costs of recovering, processing and transporting these materials. As shown in **Box 6**, there are significant price differentials for different classes of recovered waste material. These prices also vary through time as market conditions change. The price for recovered materials interacts strongly with market prices for virgin materials. These prices influence the optimal level of processing, recycling and sorting effort.

Box 6: Prices for selected categories of recycled materials

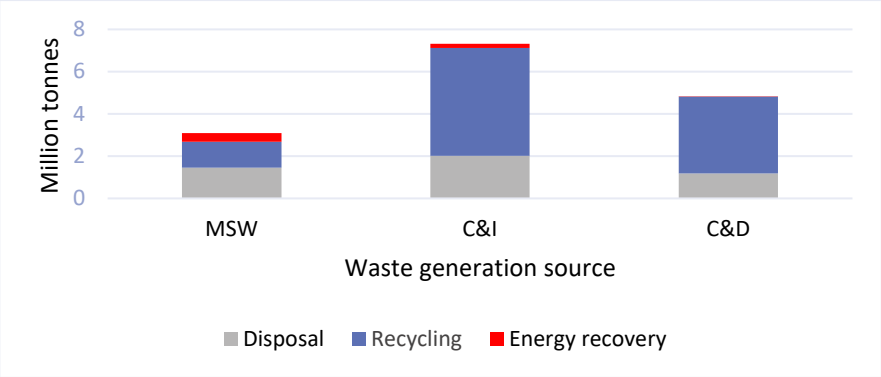
Commodity	Classification	Price April 2019/tonne
Paper and paperboard	Boxboard Mixed paper & paperboard Newsprint & magazine Old corrugated cardboard	$120 ~$0 $235 $245
Glass packaging	Mixed glass Source separated glass	-$30 $70
Plastic packaging	PET HDPE Mixed	$400 $600 -$20 to $110
Metal packaging	Steel cans Aluminium	$140 $1000

Source: Recovered Resources Market Bulletin April–May 2019, Victorian Market Intelligence Pilot Project (edition #02)

2.3.2 Recovery of energy

Waste-to-energy (WtE) or energy-from-waste (EfW) is the process of generating energy in the form of electricity and/or heat from the primary treatment of waste, or the processing of waste into a fuel source. As illustrated in **Figure 2**, only a small component of waste generated in Victoria is used for the recovery of energy.

Figure 2: Source and fate of waste in Victoria, 2015-16



Source: Source: Pickin, J & Randell, P (2017)

The Department of Environment, Land, Water and Planning (2017) notes that there are several waste-to-energy plants already operating in Victoria. There plants use thermal and biological methods to generate energy from: wood, sewage, food waste, agricultural residues and waste from industrial processes. No current facilities process mixed residual waste from households or businesses. Most facilities operate on a small to medium scale and primarily produce energy for on-site use. There are some larger landfill sites generating energy from landfill gas capture. Biological waste to energy technologies in Victoria are most prevalent at wastewater treatment plants where anaerobic digestion is used to generate biogas from sewage sludge. Organic material used for energy production is largely food waste and comes from commercial producers, such as markets, and food manufacturing companies. Several small-scale agricultural operations in Victoria use biological processes to turn bio-waste such as: piggery slurry, dairy production effluent, and other agricultural residues, into on-site power, with any excess being sent to the grid.

2.3.3 Export

Most material streams and waste generated in Victoria remains in the state for reprocessing and management. However, some streams are exported overseas and some move across state borders. [29] While there is limited data to accurately interpret the extent of material flows across state borders, there is evidence to show that around 50,000 tonnes of materials flow out of Victoria each year, including 31,400 tonnes of residual waste from the North East region and 16,000 tonnes from the Loddon Mallee region to landfills in New South Wales. A key driver of these inter-state movements is the prospect of lower gate fees offered by interstate service providers, relative to Victoria. For some towns, the closest service provider may also be across the border.

[29] Sustainability Victoria, SWRRIP, 2018. Page 90.

In 2015–16, an estimated 1,214,000 tonnes, or 14 per cent, of the materials recovered in Victoria were exported overseas [30] to countries such as China, Indonesia, Malaysia and India. Exporting paper and plasticwastes to these destinations has been a profitable commercial activity because these countries have low processing costs and lower environmental, health and safety standards compared with Australia. **Box 7** below shows the main materials recovered that were exported from Victoria in 2015-16. These include paper/cardboard, metals, plastics, tyre and rubber, organics, glass and textiles.

Box 7: Main recovered materials exported from Victoria (2015–16)

Materials	Estimated tonnes
Paper/cardboard	720,000
Metals	358,000
Plastics	97,000
Tyre and rubber	22,000
Organics	14,000
Glass	3,000
Textiles	186
Total	1,214,000

Source: Sustainability Victoria, SWRRIP, 2018. Page 91

Following the *National Sword* initiative, China introduced lower acceptable contamination standards for certain types of solid waste including plastic from living sources and unsorted paper because these materials were found to be contaminated with dirty and hazardous material. China has also commenced a program to improve sorting of domestic waste. Envisage works (2018) report these changes have resulted in saturation of some types of scrap paper and plastics in international markets, causing a significant fall in prices. For example, **Table 1** below shows that the price of mixed paper scrap fell drastically from $124 per tonne in March 2017 to virtually $0 following China Sword in March 2018.

Table 1: Prices of selected waste material

Waste commodity	Price ($/tonne) March 2017	Price ($/tonne) March 2018
Mixed paper scrap	$124	$0
Mixed plastic scrap	$325	$55
Old corrugated containers	$210	$125

Source: Envisage works (2018)

30 Sustainability Victoria, SWRRIP, 2018. Page 90.

Export volumes of scrap paper and cardboard have declined and sales of scrap plastics to China have virtually ended over the 2017-18 year. For example, sales of waste material to China fell from 98,000 tonnes (71% of total exports from Australia) to 25,300 tonnes (24% of total) over the 2017-18 year. More recently, some modest recovery in prices has been observed (WMRR 2019), however, other countries including Malaysia and Indonesia have started to follow China's lead in tightening waste import specifications. These market shocks have reduced the value of kerbside materials, which have declined from around from around $150/tonne (March 2017) to around $70/tonne (March 2018), see Envisage works (2018).

These shocks in international waste materials markets have created both a transition and structural adjustment problem in the kerbside recycling industry, which generates most of the mixed paper and mixed plastic scrap and the associated waste materials processing sector in Victoria; and in the domestic waste materials processing industries. To some extent, changes in export market specifications can be accommodated by MRFs able to modify sorting practices needed to remove more undesignated and contaminant materials to meet the new standards introduced in the international waste market. *National Sword* effectively introduces new (higher) waste product standards that define waste products and grades (e.g. bales of cardboard and old newsprint, rather than a single mixed paper bale) but conventions to monitor these standards have not yet fully emerged other than the practice of returning non-compliant consignments.

There also appears to be a structural problem in the waste processing and recycling sector that stems from reliance on overseas countries for waste sorting and processing capacity. The Victorian-based MRFs are experiencing difficulties in sorting mixed paper or cardboard, or recovered plastic packaging streams, to the new Chinese contamination thresholds. Local MRFs are typically not able to produce a mixed paper stream that meets local fibre-based product manufacturers' sorting and contamination requirements. Large, reported increases in storing of sorted (but unsaleable) and unsorted Victorian kerbside recyclables, are symptoms of the underlying structural problems in the waste sector (WMRR 2019).

2.3.4 Landfilling

The amount of waste material consigned to disposal is determined by both the level of waste generated and the extent to which the various waste processing activities, discussed above, recover and process waste materials. Residual waste is disposed to landfill such that the volume and type of this material represents the demand for waste disposal capacity. In Victoria, regulations categorize landfill as: putrescible, inert, hazardous category B, hazardous category C. As shown in Box 8 below, 33% of total waste was disposed to landfill in Victoria in 2016-17. The rate of disposal to landfill was significantly higher for MSW (59%) then C&I (32%) and C&D (19%). Organics and aggregate masonry comprise the largest proportions of landfill materials, 34.8% and 22.7%, respectively.

The supply of waste disposal capacity and the price at which landfill capacity is exchanged (referred to as the gate fee) is determined by the market. The gate fee is determined by competition between landfill operators, other uses of land, and by the regulatory requirements placed on landfill operators and sites. At least for more recent and larger sites, it has been argued by BDA (2009) that Victorian regulations and standards for landfill sites largely mitigate environmental, health and amenity externalities. Gate fees may not fully price public liability and clean-up costs and other risks that could arise from bankruptcy. This suggests the market largely prices in these externalities into gate fees but may not fully price risk.

Box 8: Total disposal and composition of disposal to landfill in Victoria (2016–17)

Total disposal to landfill in Victoria was 4.25 million tonnes (2017)

- Average landfill per person has decreased from 0.98 tonnes per person (2005) to 0.67 tonnes per person (2017).
- 33% of total waste is disposed to landfill
    - MSW - 59% disposed of as landfill
    - C&I – 32% disposed to landfill
    - C&D – 19% disposed to landfill

Composition of landfill material:

- Organics 34.8%
- Aggregate masonry 22.7%
- Other 13.8%
- Paper and cardboard 11.3%
- Plastics 10%
- Glass 1.9%
- Rubber 0.2%

Source: Source: Sustainability Victoria, Waste data portal (2016-17). Waste projection model

2.3.5 Legal and illegal gaming

The current economic environment in the waste sector creates a range of opportunities for strategic behaviour that is either legal but unwanted or illegal.

- An example of legal, but unintended behaviour can be observed where wastes are stockpiled legally but this activity increases fire and other risks.
- An example of illegal gaming is the disposal of waste to non-approved sites.

Laws and regulations define the boundary between legal and illegal activities. Some individuals and organisation choose illegal activities because they offer higher returns than legal activities. Gaming and strategic behaviour are relevant both within Victoria and between states. The landfill levy, for example, can be argued to create an incentive for illegal activities including illegal dumping and for legal interstate disposal of wastes. Illegal dumping avoids the landfill levy and interstate disposal takes advantage of differentials in landfill costs (gate fees plus levies) and/or differentials in landfill standards between landfill sites.

In the same way, regulations impose additional costs on legal operators because requirements to treat, handle and dispose of waste correctly are costly activities. The VAGO Report identified another class of strategic behaviour that arises because of differences in monitoring and enforcement strategies between states. VAGO argues that strict and effective regulations in other Australian jurisdictions meant that it has been cheaper to transport waste materials to Victoria than to dispose of them to licensed sites in either South Australia or New South Wales. This was argued by VAGO to contribute to the state's growing stockpiles—particularly recovered recyclables (prior to 2018) and end-of-life waste tyres (prior to 2014).

In a game theoretic context, both illegal activities and legal (but unintended waste management activities) are another branch in the decision tree faced by individuals and businesses. For these activities there are rewards, costs and risks.

- For illegal waste activities, the rewards are in the form of payoffs that are above market rates, and risks in the form of financial or other punishments if the decision-maker is caught. There are other costs (externalities) that occur with many forms of illegal behaviour such as the environmental, safety or human health risks/cost associated with illegal dumping.

- For legal, but unintended activities, the payoff is in higher returns and the costs arise from unintended consequences of activities. An example of legal, but unintended behaviour can be observed where wastes are stockpiled legally but this activity increases fire and other risks – see VAGO Report p19. Both illegal and legal behaviours are a form of strategic behaviour that can be included in standard economic frameworks. In this environment, the decision-maker assesses the expected return from illegal activities against the severity of punishment and the probability of being caught and punished. This problem is formalised as the "inspection game" in economics – see Avenhaus *et al*. (2002).

The *Environment Protection Act* includes provisions against improper waste management, which carry substantial penalties. The EPA is responsible for monitoring activities in the waste sector and enforcing these penalties. The VAGO argues that "*more frequent use of these provisions could have served as a strong disincentive to irresponsible and illegal practices that have resulted in large-scale waste stockpiles across Victoria. However, EPA advised that the post-harm or post-damage focus of these provisions made it difficult to successfully prosecute cases against waste operators. Because of perceived limitations of the Act's provisions to address current improper waste management practices, the government worked to give EPA new legislation that focuses on a general environmental duty—with a preventative focus—to protect human health and the environment. EPA advised that these 2018 amendments to the Act, which will take effect in 2020, give it more power to better address waste issues*".[31]

2.4 OTHER FACTORS INFLUENCING THE WASTE SECTOR

Waste-created risk is a significant factor that influences the efficiency of the waste sector. This is briefly described in the sub-section below.

2.4.1 Waste-created risk

All sectors of the economy are exposed to risk arising from commodity prices, exchange rate fluctuations, natural and other disasters. A range of mechanisms including insurance, derivatives, swaps, options markets etc. are available to manage these risks. Waste activities also introduce risk into the economy. In addition to the commercial risks relevant to all business activities; storage, transport and disposal of waste materials, particularly hazardous and flammable wastes, carry some probability that unintended events will expose private individuals, commercial businesses and the environment to losses. Much of the legislative regulatory framework established by the Victorian Government has been developed to minimize such risks. The VAGO (2019) report into recovery and reprocessing waste concluded: "*waste management….warrants high levels of risk assessment and management to address factors that: result in unacceptable risks to the Victorian community and environment, threaten the viability of the sector and the*

[31] VAGO (2019), p. 18

continuity of kerbside services, and heighten Victoria's exposure to international waste market fluctuations".[32] The Resource Recovery Facilities Audit Taskforce, following the Coolaroo fire, noted that "*stockpiles of combustible recyclables pose serious and unacceptable risks to the Victorian community and environment".*[33]

Waste risk is currently managed through a range of mechanisms. Some of this risk is insurable[34], some is mitigated through legislative and regulatory requirements, but some risk is transferred to the public as evidenced by recent fires, illegal disposal and waste business insolvencies. For some activities, the EPA requires financial assurances or bonds from businesses engaged in higher risk activities. Some of these measures monetize waste risk.

2.5 OVERVIEW OF WASTE TRANSACTIONS

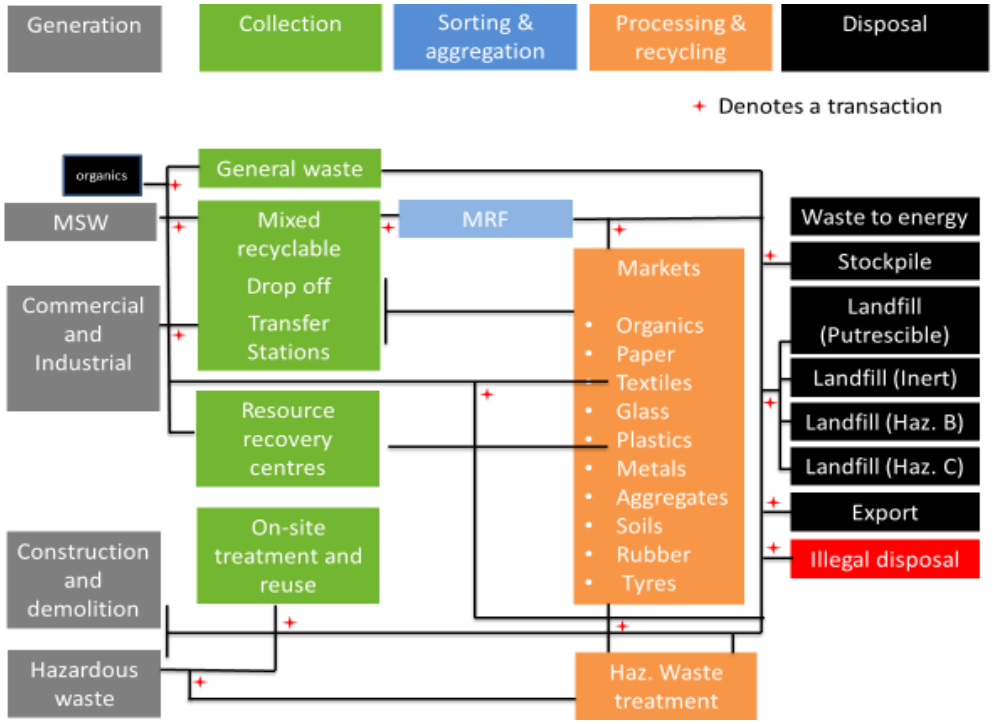
Figure 3 below summarises the main waste pathways in Victoria and also indicates transaction points that determine the fate of wastes, as discussed in detail in this section. In this decentralised environment described in this section, producers of waste, suppliers of waste services and consumers are assumed to make rational decisions. These decisions are influenced by rules, processes and incentives created both by markets and government policies. Section 3 below describes the legislative, regulatory and other intervention strategies established by the Victorian Government that influence waste related transactions.

32 VAGO (2019), p. 59

33 VAGO (2019), p. 17

34 See https://laib.com.au/waste-management-business-insurance/ for an example of waste-risk insurance.

Figure 3: Overview of waste pathways and transactions



3. GOVERNMENT AND THE WASTE SECTOR

Section 2 above provided a mapping of the Victorian waste 'lifecycle', identifying the major decision or transaction points in the cycle, and actors involved at each point. These decisions are influenced by the way government implements public policy objectives and by the institutions employed to facilitate transactions. The Victorian Government influences the waste economy through four broad types of intervention: legislation and regulations, incentives, grants and programs and education. These are summarized in the sections below.

3.1 LEGISLATION AND REGULATION

The *Environment Protection Act 1970* is the primary legislation that defines the public policy objectives, regulatory framework and specific tasks to be performed by government. The Victorian Government recently passed the *Environment Protection Amendment Act 2018*. The objects of this Act as they relate to Waste are to:

> (a) **minimize** litter and waste disposal by encouraging the management of waste in accordance with the waste management hierarchy;
>
> (b) **promote** waste reduction, resource recovery and resource efficiency; and
>
> (c) **minimize** the impact on human health and the environment from waste generation and waste disposal.[35]

These objectives reflect community sentiment about the use of non-renewable resources, the amount and type of disposed waste, the level of recycling and impacts of waste on the environment. These goals are defined in legislation in terms of a waste hierarchy for Victoria. As shown in **Figure 4**, the waste hierarchy identifies avoidance of waste as the most preferred activity, reuse, recycling, recovery for energy, treatment; and disposal as the least preferred activity. Under the Act, the EPA can create subordinate legislation such as waste management polices (WMPs), State environment protection policies (SEPPs) and Regulations.

3.2 INCENTIVES IN THE WASTE ECONOMY

The Victorian Government, via legislative powers, has introduced incentives into the Victorian economy intended to align the behavior of households and businesses with stated policy objectives. The landfill levy is the main incentive created in Victoria and was first introduced as a levy on disposal of municipal and industrial wastes (MILL) to landfill and to prescribed hazardous wastes (PIWLL) in 1999. The MILL and PIWLL place a tax[36] on every tonne of waste that goes to landfill.

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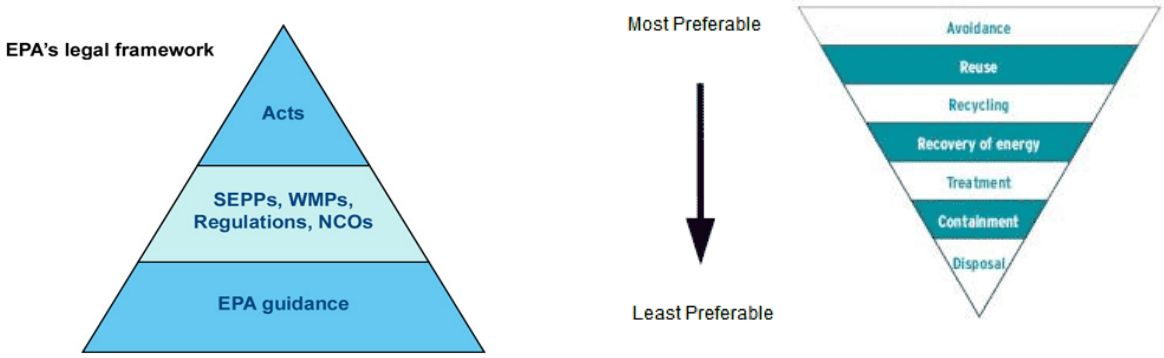
35 Environment Protection Amendment Act 2018, Part 6.2

36 In economic terms a tax is a price above the efficient market price.

Figure 4: Waste hierarchy and intervention framework in Victoria



3.2.1 Municipal and Industrial Waste Landfill Levy

The Municipal and Industrial Waste Landfill Levy (MILL) has increased significantly over the past 20 years as shown in **Table 2**. In 2010-11, a step change in levy rates was introduced which saw the levy rate for MSW and C&I metropolitan landfills increase from $9/tonne in 2009-10 to $58.50/tonne by 2014-15. This levy is now indexed each year. The Government's stated objective in introducing the levy is to:

- *act as an incentive to minimise waste and encourage greater re-use and recycling of resources while promoting investment in alternatives to waste disposal to landfill;* and
- *provide funds for waste management infrastructure, support programs for industry, education programs and the resourcing of the bodies responsible for waste planning and management in Victoria.*

As shown in Table 2 below, the current MILL levy rate in 2018-19 is:

- $64.30/tonne for metropolitan and provincial municipal and industrial waste;
- $32.22/tonne for rural municipal waste; and
- $56.36/tonne for rural industrial waste

3.2.2 Prescribed Industrial Waste Landfill Levy (PIWLL)

The prescribed industrial waste (PIW) levy seeks to provide a financial incentive to industry to accelerate waste avoidance, reuse and recycling[37]. Prior to 2008, a flat levy rate was charged for PIW disposed as landfill. The rate was $10/tonne before 2002 and increased to $26/tonne by 2007. From 2008, the *Environment Protection (Amendment) Act 2006* introduced higher and differential levies on the disposal of PIW to landfill. Differences in the levy were introduced to reflect the level of hazard posed by different categories of PIW (**Table 3**). The objective of the PIW is to:

[37] https://www.epa.vic.gov.au/business-and-industry/guidelines/landfills-guidance/landfill-and-prescribed-waste-levies#Rates

- *make landfill disposal of hazardous waste a last resort. The reinvestment of this levy will help the waste industry find innovative alternatives and transform waste from a business cost into a resource opportunity.*[38]

When the *Environment Protection Amendment Act 2018* comes into effect, the PIWLL rate will be subject to annual indexing by the Treasurer.

Table 2: Municipal and Industrial Landfill Levy: Victoria

	Metropolitan and provincial		Rural	
	Municipal waste	**Industrial waste**	**Municipal waste**	**Industrial waste**
	$/tonne	$/tonne	$/tonne	$/tonne
2002-03	4.00	5.00	2.00	3.00
2003-04	5.00	7.00	3.00	5.00
2004-05	6.00	9.00	4.00	7.00
2005-06	7.00	11.00	5.00	9.00
2006-07	8.00	13.00	6.00	11.00
2007-08 to 2009-10	9.00	15.00	7.00	13.00
2010-11	30.00	30.00	15.00	25.00
2011-12	44.00	44.00	22.00	38.50
2012-13	48.40	48.40	24.20	42.40
2013-14	53.20	53.20	26.60	46.60
2014-15	58.50	58.50	29.30	51.30
2015-16	60.70	60.70	30.42	53.20
2016-17	62.03	62.03	31.09	54.37
2017-18	63.28	63.28	31.71	55.46
2018-19	64.30	64.30	32.22	56.36

Note: 'Metropolitan and provincial' landfill sites later referred to as Schedule C premises under Schedule C of *the Environment Protection Act*. 'Rural' sites referred to as Non-Schedule C premises.
Source: DELWP and Municipal Association of Victoria

Table 3: PIWL Levy rate

PIW	Rate ($/tonne)
Category A	NA
Category B – includes wastes from manufacturing industries and contaminated soils	250

[38] https://www.governmentnews.com.au/vic-funding-for-hazardous-waste-reduction/

Category C – includes wastes which pose a low hazard from manufacturing industries and contaminated soils	70
Packaged waste asbestos – levy remains as previously scheduled to encourage safe handling and disposal of asbestos	30

NA: Prohibited from disposal to landfill – the levy does not apply

Source: DELWP

3.3 GOVERNMENT GRANTS AND PROGRAMS

The government also intervenes in the waste economy through programs and grants such as the Research, Development and Demonstration Grants Program. This Program supports projects that increase the quantity of recycled products sold in Victoria and aims to create jobs in the waste recovery sector, increase the tonnage of material recovery and divert waste consigned to landfill. These programs are implemented by Sustainability Victoria through the Resource Recovery Infrastructure Fund and Research, Development and Demonstration grants. The Resource Recovery Infrastructure Fund provides grants: to boost jobs in the resource recovery industry and increase the recovery of priority materials; fund infrastructure projects that purchase, install, commission or upgrade infrastructure or equipment to recover and reprocess higher value priority materials to a commercial grade; and upgrade production lines to allow recycled content to be diverted from landfill. The Research, Development and Demonstration grants support activities such as: R&D to develop new markets for recovered glass fines and flexible plastics; targeted RD&D grants including field trials to demonstrate R&D in a real-world application and support commercialisation; field trials to develop new markets for recovered materials.

3.4 EDUCATION

A number of waste education programs have also been developed by the Victorian Government under the Waste Education Strategy. This program supports education programs directed at: kerbside and recycling, litter and illegal dumping, household waste and composting, sustainable shopping, food waste, e-waste etc. There are also a range of grants (i.e. Waste Education Grants) available through Sustainability Victoria, and other programs that support waste education, community engagement and behaviour change activities.

4. DIAGNOSIS OF MARKET FAILURES AND OTHER INEFFICIENCIES IN THE SYSTEM

Section 2 above provided a mapping of the Victorian waste 'lifecycle', identifying the major decision or transaction points in the cycle, and actors involved at each point. Section 3 outlined the public policy objectives of the Victorian Government, and the policy levers that are currently being used to achieve these objectives. In this section, we demonstrate how the outcomes from the waste sector are determined by interplay between the Victorian legislative and regulatory environment on the one hand, and the decentralized, self-interested decisions of producers, consumers and processors of waste, on the other hand.

- Section 4.1 below provides a brief assessment of the economic efficiency of the Victorian resource recovery and recycling sector, demonstrating that observed outcomes are misaligned with the Victorian Government's objectives.

- Section 4.2 provides a detailed discussion of transaction complexities in the sector that prevent the sector from achieving these intended outcomes efficiently.

4.1 ECONOMIC EFFICIENCY OF THE VICTORIAN RESOURCE RECOVERY AND RECYCLING SECTOR

Economic efficiency is a concept used to examine whether resources are employed in a way that maximizes welfare across all members of the community. A process is efficient if no changes can be made in either the resources used, the level of consumption, or the matching of individual producers and consumers that would lead to a higher level of community wellbeing. Conversely, a 'market failure' is a term that refers to circumstances in which markets will not achieve the best outcomes for the community. This is a situation where free markets fail to allocate resources efficiently. This is because the individual incentives for rational behavior do not lead to rational outcomes for the group. Put another way, each individual makes the correct decision for him/herself, but those prove to be the wrong decisions for the group.

In the context of the Victorian waste sector, observed outcomes are determined by the interplay between the legislative and regulatory environment, on the one hand, and the decentralized, self-interested decisions of producers, consumers and processors of waste, on the other hand. Evidence from reports published by Sustainability Victoria (SV), the Australian Bureau of Statistics (ABS) and the Victorian Auditor General's Office (VAGO) shows that outcomes observed in the waste sector appear to fall short of stated policy intentions.

- **Total waste generation in Victoria has steadily increased over time**. Waste generation increased from 7.44 million tonnes in 2000, to 9.882 million tonnes in 2005 to 12.9 million tonnes in 2016-17. [39]

[39] Sustainability Victoria, Waste Projection Model (2000-17)

- **Waste generated per person has steadily increased over time** - Waste generated per head of population increased from 1.56 tonnes per person in 2005 to 2.03 tonnes per person in 2017. [40]

- **While the rate of diversion from landfills has improved over time, the ultimate fate of this waste is uncertain.** The diversion rate, or the rate at which waste is diverted from landfill for reuse or recycling, increased from 55% in 2005 to 67% in 2017 [41]. However, data collected at present does not report on the movement of the materials that have been diverted from landfill, and there is uncertainty about the extent to which these materials are recycled. Concerns have been raised about the lack of data collected at present on other end-of-life fates (such as the nature and extent of stockpiles, permitted or otherwise, across the state). [42]

- **A third of total waste, and more than half of all household waste, was diverted to landfill in 2017.** Around 33% of the total level of waste generated, and more than half (59%) of all municipal solid waste (primarily waste generated from households) was disposed to landfill in 2017. [43]

- **Victoria is underperforming relative to other states.** ABS data indicates that Victoria is ranked third (after South Australia and New South Wales) in terms of the recycling percentage compared with other states. Waste generation per head in Victoria is second to Queensland, which has the lowest waste generated per person (ABS). [44]

- **Some waste streams are still reliant on exports overseas.** – Around 14% of waste was exported overseas in 2017. [45] Materials streams reliant on overseas markets include paper/cardboard, metals, plastics, tyre and rubber, organics, glass and textiles.[46]

- **Waste stockpiling and illegal dumping have been identified as significant problem.** As mentioned above, data collected by SV at present does not report on the movement of the materials that have been diverted from landfill. However, the VAGO report has reported illegal dumping and stockpiling of waste, such as used tyres and hazardous wastes, to be a significant problem.[47]

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40 Source: Essential Economics 2009 (data from Sustainability Victoria) and ABS population data.

41 Sustainability Victoria, Waste Projection Model (2016-17)

42 VAGO, 'Recovering and Reprocessing Resources from Waste', June 2019; See page 14.

43 Sustainability Victoria, Waste Projection Model (2016-17)

44 ABS https://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/

45 Sustainability Victoria, Victorian Recycling Industry Annual Report (2016-17), Page 5.

46 Sustainability Victoria, SWRRIP, 2018. Page 91

47 VAGO, 'Recovering and Reprocessing Resources from Waste', June 2019; See page 14.

It is clear from the evidence above that outcomes observed in the Victorian waste sector are misaligned with stated policy intentions. In decentralised economic systems, such as the waste economy, alignment problems are common. These outcomes may not align with public policy objectives because the motivation of businesses and households does not necessarily align with those of government. Below is a brief summary of some *complexities* that, at present, prevent markets from allocating resources efficiently. We note that our assessment below is corroborated by the Productivity Commission (PC)'s detailed inquiry into the Australian Waste Management sector, published in October 2006.[48] We note that the PC's inquiry was conducted more than 10 years ago and was not specifically focused on Victoria. However, in our view, it provided a comprehensive set of recommendations on how to improve economic, environmental and social outcomes in Australia. Below is CMD's assessment of *complexities* in the Victorian resource recovery and recycling sector that prevent markets from allocating resources efficiently.

4.2 TRANSACTION COMPLEXITIES IN THE WASTE ECONOMY

As discussed in detail in Section 2, decisions that determine the creation of solid waste and the level and type of effort invested in waste services are made in a decentralized environment. For example,

- profit maximizing businesses make decisions that determine the level and type of waste generated from production, packaging, and obsolescence strategies;
- households make consumption and waste management decisions that maximize their well-being; and
- businesses provide waste management services that maximize value to shareholders.

These activities are delegated to the private sector because they have the skills, information and specialized capital needed to provide waste services at low cost and the collective decisions of these actors determine outcomes including:

- the total amount and type of waste produced,
- the level of recycling of waste material; and
- the amount of waste disposed of as landfill.

These outcomes may not align with public policy objectives because the motivation of businesses and households does not necessarily align with those of government. Alignment problems such as this principally occur because markets for environmental goods and services, human health and amenity services are missing. These goods and services have public good[49] characteristics and decisions made in the absence of prices for these services will reduce overall wellbeing in the economy.

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[48] Productivity Commission (2006) p.p. XXV-LVI

[49] Public goods are not able to be appropriated (non-appropriable) and once created consumption by one agent does not preclude consumption by others (non-rival).

Beyond the existence of public goods and externalities, a range of complexities can also impede transactions because they interfere with the way prices are revealed. Information asymmetry is an important complexity that is almost universal. It occurs in the waste sector because actors (consumers, producers and processors) privately hold information that is needed to make efficient decisions. Consumers hold information about the benefits of different consumption options; producers of goods and services hold information about costs and returns of producing different goods and services; and waste processors know about the costs and returns needed to determine the efficient level and type of processing of wastes. This information is hidden from governments and other agents and will not be revealed to others because this would compromise their competitive advantage in transactions (i.e. it is private information).

There are also a range of other complexities that also cause markets (transactions) to allocate resources inefficiency including:

- synergies (some goods and services have higher values if they are combined with others);
- timing complexities (goods or services may not be available at right time);
- strategic complexities (individuals employ strategies that are not immediately obvious);
- policy complexities (where the rules and regulatory processes established by government are so complex that their intent is not fully implemented in transactions);
- thin markets (few participants diminish competition); and
- coordination complexities (additional value can be created where individuals are able to coordinate activities).

Where markets are missing, and transaction complexities impede the efficiency of markets, the observed outcomes from the decentralized decision-making environment will not maximize welfare. This creates scope to improve welfare through some form of intervention. In this section we commence the process of identifying opportunities to improve both the alignment of waste outcomes with public policy objectives and efficiency in the waste sector.

The first step in this process is to identify *complexities* that, if unattended, prevent markets from allocating resources efficiently. This represents the diagnostic process in mechanism design because the mechanism needed to achieve public policy objectives must be designed to specifically overcome transaction complexities. It must also address a range of common information and incentive problems (discussed in the next section) before efficient prices can be revealed and resources allocated efficiently.

4.2.1 Production and consumption complexities

There are two complexities that define the economic environment in which producers and consumers make decisions that impact on waste.

Externalities – Where producers and consumers of goods and services do not face all the costs and benefits of alternative waste strategies, they will make decisions that are not efficient or effective. Externalities exist where markets are missing such that prices for services are not revealed; and where property rights are missing or incomplete. Two types of externalities influence waste created from production and consumption decisions.

- *Environmental externalities* - Markets for environmental services impacted by waste decisions are missing such that prices for these services are not considered in production and consumption decisions.
- *Production externalities* - Manufacturers do not necessarily consider the impact of packaging and obsolescence strategies embodied in the products they sell because they do not face the disposal costs created by packaging and residual wastes.

Information asymmetry – Efficient and effective waste decisions rely on revelation of all relevant information at each transaction. This includes information about the type of waste generated both at the point of consumption and when residual waste is created. Asymmetric distribution of this information will influence consumption decisions (the mix of goods and services consumed) and disposal decisions.

4.2.2 Sorting services complexities

Three complexities can lead to selection of the "wrong" level and distribution of sorting effort. These include:

Information asymmetry – Information about the type of materials that make up waste is not immediately obvious. Specialized skills and technology are needed to separate wastes into homogeneous streams. The skills and technology needed for sorting are not evenly distributed across households and professional sorting businesses. For example, households generally do not have the information and skills needed to separate plastics, glass, paper, metals or other materials into the product descriptions needed by materials processors. Significant investments in materials recovery processes are required to overcome this information asymmetry problem.

Contamination externalities – Incorrect waste sorting can cause contamination of recyclable material reducing the value of batches of these materials. This is an important consideration because households/businesses who incorrectly sort waste streams can contaminate not only their waste but also reduce the value of others' wastes. Poor sorting causes a negative externality. Envisage works (2018) site the impact of glass fragments on other materials, particularly paper grades where the glass itself is of much lower value when collected through co-mingled kerbside systems. This has prompted stakeholders to suggest either a separate paper and cardboard collection or a separate glass collection.

Collection and transport cost externalities – The distribution of sorting effort has an important impact on the collection/transport costs of wastes. In general, more sorting at source will increase the number of bins and this will increase the cost of waste collection because of the requirement for more collection services per household/business. The choices made by other households/businesses will also influence collection and transport costs (positive network externality).

4.2.3 Collection service complexities

Despite the obvious advantages of networks, markets do not evolve to price and allocate network resources efficiently. Markets are missing in this environment, and specifically in waste collection networks, because of the following complexities:

Information complexity – Networks function best when consumers and suppliers of network services reveal information that defines the type, location, timing etc. of services required or able to be provided.

Site synergies – Site synergies refers to the observation that costs of supplying a service can be reduced if the service is supplied to adjacent sites as a package. In the case of waste collection services, costs may be reduced if site synergies are permitted to influence the routes won in a competitive allocation process.

Coordination complexity – Networks require consumers to coordinate their activities. For example, rail passengers coordinate departure times with other passengers to enable them to share the costs of travel. Participation in waste collection networks also requires coordination between households/business units.

Network externality – The cost of using a network services for one user depends on the number of other users. The cost of providing the service reduces as the number of users increases (a positive network externality). Costs begin to increase once a point of congestion is reached (a negative network externality).

Optimisation complexity – To optimise value created from networks it is necessary to compute value created from all possible transaction opportunities. There are computational capacity constraints that limit the scale of network optimisation because the number of computations required increases exponentially with increases in the number of nodes and quality dimensions to be considered.

4.2.4 Processing and recycling complexities

Transactions in waste materials for processing and recycling are influenced by the efficiency of international markets for these materials and by the domestic processing sector. There are two complexities that could influence transactions in waste materials.

Information asymmetry (waste materials metrics and enforcement processes) – Waste materials are commodities. Commodity markets evolve as efficient institutions and metrics co-evolve to define the quantity and quality attributes that determine value – an information asymmetry problem. These markets also rely on mechanisms to enforce transactions to ensure that buyers receive what was described.

Thin markets in waste processing – A second complexity may arise because of the small number of MRFs in Victoria and our reliance on one large player. Thin market problems can create market power and exposure problems if one player exits the industry.

4.2.5 Waste disposal complexities

Two complexities have been identified that influence transactions relevant to waste disposal decisions.

Information complexities – Two types of information asymmetry are relevant to the disposal of wastes:

- *Hidden information* – Information about the type of waste, volume, level of hazard etc. will need to be truthfully revealed before wastes can disposed of efficiently and effectively. This information is hidden from the regulator of the waste system and there are financial incentives to misrepresent this information.
- *Hidden action* – Hidden action problems arise when it is not always possible to observe the actions of agents. In the waste disposal domain, hidden action problems arise when the attributes of waste are mis-represented and/or when wastes are disposed of illegally.

Environmental externalities – Markets for emissions from landfill sites and other waste disposal facilities are missing and this leads to inefficient allocation of resources. BDA (2009) estimates that externalities not mitigated by regulatory and licencing requirements for landfill sites are generally small.

4.2.6 Risk complexities

Waste-created risk is influenced by an important externality.

Risk externality - Waste-created risk is an insurable risk and waste risk insurance can be purchased from risk markets[50]. Unlike many other types of risk, firms that create waste-related risks do not bear the financial consequences of this risk. For this reason, there is currently no incentive for waste-risk creators to take out insurance despite the advantages of this mechanism.

4.2.7 Gaming complexities

Complexities relevant to illegal and legal gaming include:

Information asymmetry hidden action – Illegal activities cannot be readily observed, and this allows individuals and firms to avoid costs associated with legal waste management pathways.

Strategy-proof institutions – Where institutions are not well-designed, they are susceptible to strategic behaviour that leads to unwanted outcomes.

50 See https://laib.com.au/waste-management-business-insurance/ for an example of waste-risk insurance.

5. OPPORTUNITIES TO IMPROVE ECONOMIC EFFICIENCY AND EFFECTIVENESS IN THE WASTE ECONOMY

Section 4 above demonstrated that there are a number of complexities in the Victorian resource recovery and recycling sector that prevent markets from allocating resources efficiently. This Section draws on modern microeconomic concepts, referred to as market/mechanism design, to identify the mechanisms needed to improve the performance of the waste sector in Victoria and the implications for waste infrastructure.

Recent advances in microeconomic theory provide the ideas and methods needed to design policy interventions (institutions/mechanisms) needed for decentralized environments. Mechanism design is a process that relies on a "reverse game theory" approach in which the goal (e.g. a government policy objective) and the economic environment in which autonomous actor make decisions are taken as *given* and the mechanism to achieve the stated goal is *to be determined*. This is the reverse of traditional economic analysis in which the 'game' (i.e. a competitive environment with regulation) is given and the analyst seeks to predict or explain the observed outcomes.

The mechanism design methodology has had a profound impact on the framing of economic problems. It has led to the creation of new mechanisms for problems as diverse as:

- the allocation of mobile phone spectrum (Cramton, 1995);
- energy market design (Wilson, 2002);
- allocation of airport landing slots (Rassenti, Smith & Bulfin, 1982);
- processes to determine university admissions (Roth & Sotomayor, 1989) and school choice (Abdulkadiroğlu & Sönmez, 2003);
- matching markets for human organs (Roth and Sönmez, 2004); and
- selection of medical interns by hospitals (Sönmez, 1997).

These mechanisms are designed but have the economic efficiency properties normally observed in evolved markets. Roth (2002) provides a summary of the mechanism design methodology and applications.

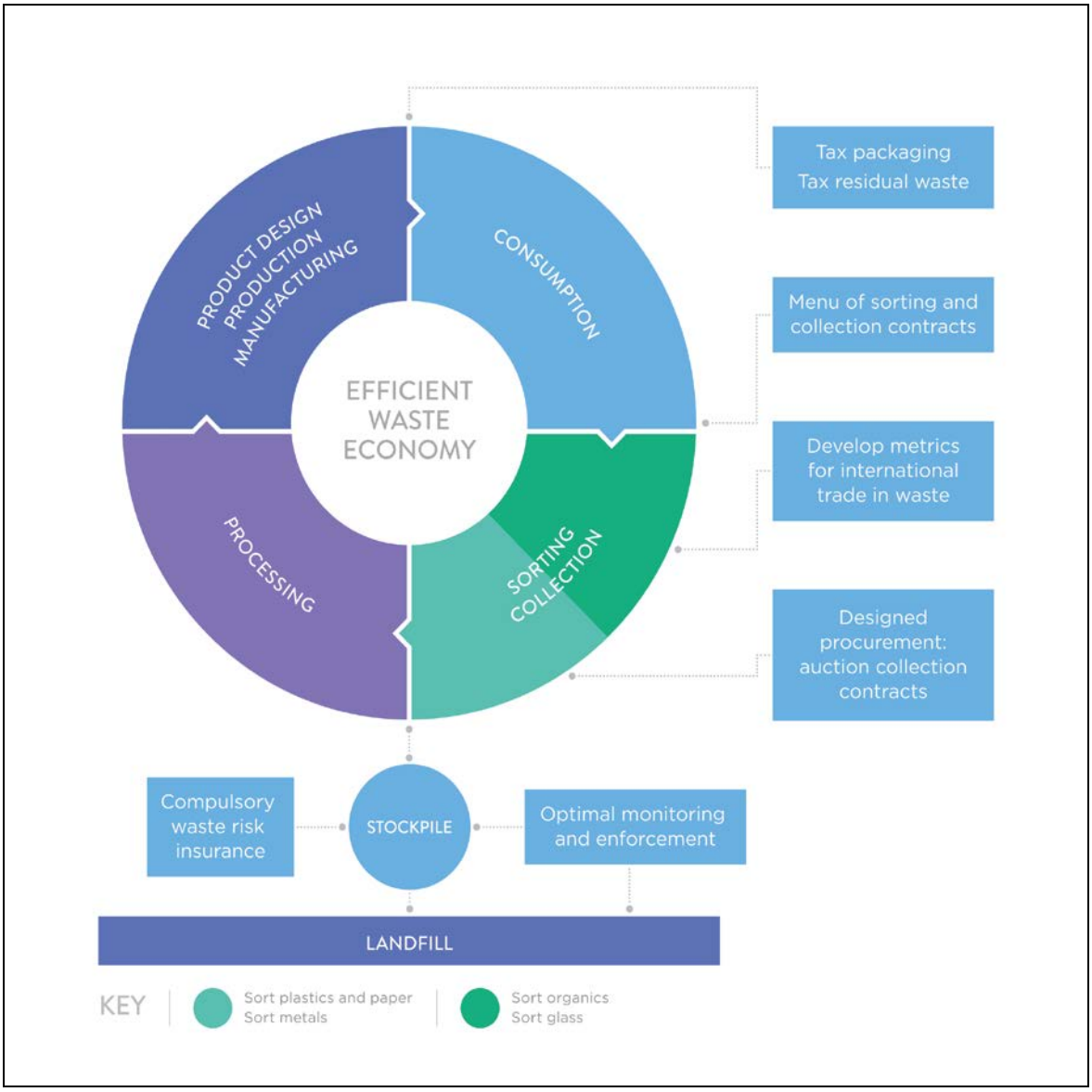
The ideas and methods collectively referred to as mechanism design (see Hurwicz and Reiter 2006) identify a number of characteristics that must be designed into institutions/mechanisms if they are to be efficient and effective. Mechanisms must be:

1. *Information efficient* – the mechanism must be designed so the dominant strategy of decision-makers is to truthfully reveal information needed to facilitate efficient and effective transactions;
2. *Incentive compatible* – the mechanism must contain incentive structures that cause independent actors to make decisions that align with defined objectives; and
3. *Strategy-proof* – the mechanism must be robust to unwanted and unanticipated outcomes that could arise if self-interested actors attempt to game the system.

These essential principles and our earlier diagnosis of transaction complexities are combined in this section to identify opportunities to improve the economic efficiency and effectiveness of institutions

employed in the waste sector. The opportunities to improve economic efficiency in the waste sector are summarised in **Figure 3** below and **Table 4**. These are explained in more detail in the following sections.

Figure 3: Opportunities to improve economic efficiency in the waste sector



5.1 OPPORTUNITIES TO AVOID WASTE PRODUCTION

Transaction complexities:

• Externalities – Manufacturers do not necessarily consider the impact of packaging and obsolescence strategies embodied in the products they sell.

• Information asymmetry –Information about the type of waste generated both at the point of consumption as well as the residual waste created will need to be revealed.

Producers of goods and services do not currently face the cost of waste created. Instead, the costs of waste created (for example, the costs of packaging and product redundancy strategies) are borne by those involved in later stages of the product's life cycle. By not taking these costs into consideration, manufactures of goods and services over-invest in packaging to attracts buyers' attention and/or reduce spoilage, and increase product redundancy by manufacturing goods that cannot be easily repaired. These strategies often involve complex trade-offs such as: reduced packaging waste vs. increased waste from spoilage of food and other goods; health and safety (e.g. "best before" labelling) vs. increased waste from discarded food; safety and other advantages from more rapid turnover of vehicles, mobile phones and other devices vs. increased residual waste. These and other tensions can be resolved if all benefits and costs relevant to different packaging and residual waste strategies can be revealed to the decision-space of manufacturers. There is a case to investigate mechanisms including, but not limited to, the following.

- A tax on waste creation, such as a tax on packaging, where the rate of tax is determined by the volume and type of packaging.
- An extended Producer Responsibility (EPR) policy, an approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle.
- A product stewardship scheme, which is similar to and often used interchangeably with the term 'EPR', as both concepts bring the onus of waste management for end-of-life products to the manufacturers. Product Stewardship extends this responsibility beyond manufacturers to everyone involved in the life-cycle of the product (such as retailers, consumers and recyclers as well).[51]

Further research is needed to identify the "best" mechanism for introducing these incentives into the economy.

[51] Product stewardship is an approach that formalises 'shared responsibility' between industry, government and the community to manage the impact of products on the environment and human health. Typically, the costs of end-of-life product management or scheme operation are covered through an up-front levy (at the point of import or purchase) or an agreed financial liability rather than payment for waste management at the end of life (point of disposal).

5.2 OPPORTUNITIES TO IMPROVE THE SORTING MECHANISM

Transaction complexities:

• Information asymmetry – Information about the type of materials that make up waste is not immediately obvious

• Contamination externalities – Incorrect sorting of wastes can cause contamination of recyclable material, reducing the value of batches of these materials

• Collection and transport cost externalities – The distribution of sorting effort has an important impact on the collection/transport costs of wastes

The role of an efficient sorting mechanism is to elicit the information needed to give households and sorting businesses the incentives to select the optimal sorting effort. Optimal sorting effort is defined by the type and distribution of effort and the sorting mechanism must lead to efficient matching between households of different types (with respect to skills, inclination, type of dwelling, time available and many other factors) and a sorting strategy provided by commercial businesses - also made up of a distribution of types with respect to costs, skills, technology etc. The selection process must also take account of complexities such as contamination of waste streams through incorrect or uniformed sorting, and the implications of sorting strategy on collection costs. This is a complex problem partly because the strategic behaviour of the various actors is difficult (if not impossible) to predict.

The broad class of mechanisms needed to resolve these information, incentive, contamination and coordination complexities is referred to as a menu of incentive-compatible contracts. This mechanism:

- sets out the technically feasible menu of sorting options (contracts) available;
- identifies the costs associated with each menu option; and
- then requires each households/business to select the "best" contract by mapping their private information and preferences (types) into the decision space.

The menu of contracts mechanism creates a market place in which businesses or individuals who have expertise and ideas can offer to supply sorting services and consumers can choose which services to contract. The menu of contracts mechanism reveals the technical sorting options available and the price at which these services can be supplied. For example, a MRF could offer to sort all wastes for the household (one contract on the menu). Alternatively, the MRF could offer to sort only recyclable materials (an alternative contract on the menu). Provided each menu includes all costs and benefits, this mechanism allows each household to choose the "best" contract, according to their "type", and this selection will identify the optimal allocation of sorting effort and the efficient price for sorting activities.

Each contract offered has a corresponding sorting obligation on the household whose members have different sorting skills, time or interest in sorting at source. The menu of contracts mechanism also allows a regulator to reveal additional information into the market such as where there are additional costs and benefits (e.g. environmental or contamination externalities) not evident to others. In some cases, the regulator may disallow menu items where they have detrimental impacts (e.g. options that cause irreversible outcomes). The mechanism also allows for optimization across all contracts where there are synergies between contracts. In this way, the menu of contracts mechanism can resolve coordination problems that arise because of spillovers to collection and transport services.

This mechanism will determine the optimal level and distribution of source-sorting effort because it causes households to reveal information about their type (only known by households) and reveals information about the alternative sorting pathways and costs that would not otherwise be known by households. This process effectively determines the number of bins needed at each household and how waste is to be sorted at source. The menu of contracts can be designed to be incentive-compatible by sharing the benefits of different sorting contracts on the menu with the household – this idea is discussed in Section 5.3.2. Advances in technology will change the optimal level and distribution of sorting effort. For example, digital sorting could allow households, using an application, to sort accurately and quickly. If this were to eventuate, it could change the optimal sorting strategy.

5.2.1 Opportunities to remove organic material from general waste

A total of 2.6 million tonnes of organic waste is produced in Victoria each year of which around 1.48 million tonnes is disposed to landfill. Organic materials make-up about 35% of total landfill volume. They create odorous methane gas through anaerobic decomposition (e.g. in landfill), but if removed from general waste can be reused to create products such as compost. These products are typically bulky and have low economic value that is quickly eroded by transport costs. These attributes suggest that there may be opportunities to remove organic material at or near source and the menu of contracts could be employed for this purpose.

Removing organic material at or near source would involve expanding the technically feasible pathways (contracts) to cater for a wide range of household types (i.e. apartments, households with gardens amongst other variables that determine type). For example, the menu of contracts mechanism could include options such as: removal of organics at source (home composting/processing with no organic bin); installation of an InSinkErator that allows organic material to be removed at a waste water treatment plant; local disposal of organics (e.g. to a neighbourhood processing facility); a separate organic bin for collection; or other feasible options.

The supply-side of the menu would be open for entrepreneurs to offer organic processing services to the market. Incentives are introduced into the mechanism partly because of the private benefits that households gain from removing organic material at source, and by returning the benefits that arise from reduced collection and disposal costs (because of reduced waste to landfill) to households. The economics of processing/transporting organic material creates a range of interesting opportunities for the emergence of neighbourhood markets in which households with excess supply of organic material can formally or informally transact with local households (or other local entrepreneurs) with excess organic processing capacity (i.e. a large compost bin). It is noted that modern technology[52] can readily address the information asymmetry problem (who has excess demand or supply and spatial information) needed to facilitate these transactions.

[52] Sharewaste: https://sharewaste.com/

5.2.2 Opportunities to improve sorting of plastics, paper and cardboard materials

The menu of contracts mechanism could also be expanded to provide consumers with an option that ensures their plastic and paper wastes are recycled. Anecdotal evidence suggests that households assume material placed in a recycle bin is recycled but this is not the case because commercial sorting businesses base sorting effort on the market price for recycled materials. If guaranteed recycling were added to the menu of contracts, including the associated cost or benefit of doing so, high-conservation households could choose this option allowing them to implement their preferences for recycling. Where market prices for recyclable materials are low, as is currently the case, this contract option may involve a cost to the household that would fund the effort needed to recycle materials.

Although the broad architecture of the mechanism needed to resolve the sorting problem is evident, this mechanism would benefit from both laboratory test-bed and real-world pilots to ensure this can be implemented in the real world.

5.3 OPPORTUNITIES TO IMPROVE THE WASTE COLLECTION MECHANISM

Transaction complexities:

- *Information complexity – Networks function efficiently and information that defines the type, location, timing etc, of services is revealed*
- *Site synergies – The costs of supplying a service can be reduced if the service is supplied to adjacent sites as a package*
- *Coordination complexity – Networks require consumers to coordinate activities*
- *Network externality – The cost of utilising network services for one user depends on the number of other users*
- *Optimisation complexity – Network efficiency can only be achieved by computing all possible transaction opportunities between all combinations of nodes and identifying the optimal sets of transactions*

Waste collection networks are currently implemented via a mechanism in which coordination is managed through a posted timetable (i.e. general waste collected on nominated day and recycling wastes collected every fortnight). Collection contracts for municipal waste are allocated through simple tender processes and service costs do not reward households for minimising waste produced. This approach takes advantage of some, but not all, of the benefits of coordination and cooperation between households and does not fully harness the benefits of competition between waste collection service providers.

Collection services for commercial and industrial establishments (C&I) and construction and demolition (C&D) are transacted through a market and/or through internal contacting. The CMD has identified two opportunities to improve economic efficiency in waste collection transactions.

5.3.1 Opportunities to improve procurement of waste collection contracts

Complexities associated with the way networks are established, their branching architecture, the existence of network externalities, information, and coordination problems mean that the standard economic paradigm (i.e. price theory) cannot be used to price, allocate, administer and regulate network services. Furthermore, concepts such as unique market clearing price, do not apply to networks because efficient prices, in a network context, are defined by the contribution that each node makes to value creation across the network.

While it has been possible to design and create markets for network services in laboratory environments (Plott *et al.* 2017), these institutions are limited to situations where there are relatively few nodes and other dimensions to be considered in the allocation of resources. These mechanisms cannot be scaled to a rail network, for example, because they are non-computable (the optimisation complexity noted above) and it would be difficult (perhaps impossible) to implement a coordination mechanism – even with smart phones. Efficient network pricing principles can, however, be applied to improve the way waste collection services are procured and to harness information and coordination opportunities.

A combinatorial procurement auction - It is now possible to design procurement processes in which specialized auctions more effectively harness competition between service provided from networks. These auctions, referred to as combinatorial, or package, auctions establish a mechanism in which waste collection providers can assemble synergistic collection regions and competition, through bidding in the auction, identifies the efficient price for these services and the efficient aggregation of regions. This auction format allows the market (waste collection service providers in this case) to assemble combinations of collection units (packages of collection districts – the site synergy complexity) through bidding activity in the procurement auction. It employs algorithms that compute all combinations of bids on all spatial regions (the optimisation complexity) to determine the winners that minimise overall collection costs for waste and dissipates monopoly rents to consumers (network externality complexity). These auctions are used in other domains of the economy to both sell and buy goods and services, such as mobile phone spectrum, real estate, inputs to food manufacturing processes where there are spatial and other synergies between the items/contracts offered.

5.3.2 Opportunities to improve incentives, information and coordination of waste collection services

The second opportunity to improve waste collection services is to reward households for behavioural changes that enhance the efficiency of waste collection services. The mechanism needed to implement this idea has two components.

Pay per collection service – An incentives structure will be needed to reward households for behaviour change that improves the efficiency of collection services. For example, households that remove organics from general waste will require fewer, less frequent collection services, and this could provide incentives that lead to beneficial behaviour change. This suggests some type of pay-per-lift, or other user-pays approach to collection services. Further research will be needed to design such an incentive structure.

Coordination mechanism - There are significant opportunities to harness coordination possibilities between households and to incorporate these into the collection incentive structure. Coordination between households, and between households and service providers, is technically feasible and if they can be implemented in the waste collection domain, would improve waste collection efficiency. For example, mobile phone applications could allow households to reduce the collections required by revealing when different bins are full as an alternative to timetabled collection services. Alternatively, there may be ways for the waste collection provider to inform households about the next available services. New processes can also be imagined that would allow households to coordinate with other households to reduce collection service costs (e.g. local collection points, and technology that allows waste collection services to reveal their movements to households). In addition to the user-pays approach, proposed above, additional structures will be needed to convert these technical innovations

into economic efficiency gains. Further research would be needed to design a coordination mechanism in which households and businesses would reveal information to each other.

5.3.3 Opportunities to improve interactions between sorting and waste collection services

Optimal sorting strategies interact strongly with waste collection services. For example, the selection of sorting contracts (from a menu) determines the number and type of bins and this will influence both the volume of waste collected and the number of bins required. Furthermore, the introduction of incentives to promote efficient waste collection could change the optimal size of bins or other attributes that interact with the collection service. Although the basic architecture of the mechanism needed is clear, there are complex and poorly understood behavioural responses to be considered in the design of this mechanism. Designing the incentive structures needed to create an efficient and implementable mechanism is not a trivial task partly because the strategic responses of different types of households is unpredictable. Laboratory testing, and then well-designed field trials, will be needed to refine and implement the menu of contracts approach.

5.4 Opportunities to improve the mechanism for waste processing and recycling

Transaction complexities:

- *Information asymmetry (hidden information) – Markets for waste materials rely on defining the quantity and quality attributes that determine value*
- *Information asymmetry (hidden action) - These markets rely on mechanisms to enforce transactions to ensure that buyers receive what was described*
- *Thin markets in waste processing – Thin market problems can create market power and exposure problems if one player exits the industry*

Markets for waste materials are essentially commodity markets and there is no reason to suspect they do not reveal efficient prices. Prices for many waste materials are currently low but can be expected to return to some new equilibrium once the international markets for these materials digest the shock arising from *National Sword* and other disruptions (see Department of Environment/Deloitte 2018). There are limited opportunities to improve the way these markets operate in the waste processing and recycling sector in Victoria. Two opportunities to improve reuse and recycling have been identified.

5.4.1 Establish accurate and enforceable metrics in international markets for waste materials

Like other commodity markets, waste materials are sold by description. *National Sword* has effectively redefined a minimum standard for exports of waste materials but formal specifications that describe the quality and quantity of waste materials (including the definition of contaminants) will be needed so that waste materials can be sold by description. The current process in which importers return unacceptable waste material to the country of origin is clearly inefficient. Establishing the metrics needed for international trade in waste materials will speed-up the revival of export markets.

5.4.2 Incentives for recycling and waste materials processing

Markets create incentives that reward commercial business for effort required to recycle and reuse wastes. Government intervention beyond that needed to address the transaction complexities relevant to this aspect of the waste economy will come at a cost to overall economic performance. The Department

of Environment/ Deloitte (2018) report argues that interventions such as measures to increase demand for recycled materials and measures to increase sorting effort and support for technology upgrades "*are not likely to lead to an improvement in market outcomes and may worsen outcomes in oversupplied markets*".[53] This report identified a preference for research to support trials into innovative recycled products and uses of recycled materials for problematic materials such as organics, plastics and glass.

The CMD cannot see any complexities that impede the allocation of resources and private investment in recycling activities. Provided environmental and other externalities are taken into account, such as through regulations that minimise pollution from landfill sites, government intervention to increase recycling effort will reduce overall economic performance. This is because funds needed to increase recycling effort would need to be diverted from higher returning activities. If there were a second-best case for intervention, arising from policy short-comings, it will be best to rely on a mechanism that: minimizes the cost of intervention; is transparent with respect to cost; and avoids picking winners based on subjective criteria.[54]

The role of the mechanism, in this context, would be to discover the minimum payment (from government) needed to achieve the recycling/reuse objective identified. An auction of recycling and reuse contracts could be considered for this purpose. Auctions are mechanisms that harness competition where there are few participants (thin markets) to allocate waste reuse contracts efficiently. In this type of auction, waste processing businesses would bid an amount that they would need to be paid to increase processing/reuse of a specific type and volume of waste material. The winner(s) are those businesses that place the lowest bid (a descending-price auction) until the recycling/reuse target established by government is achieved, or the budget is exhausted. This mechanism could be funded from revenue collected by the landfill levy. Like all auctions, this mechanism will need to be designed from auction theory and tested in controlled laboratory conditions to ensure that it performs efficiently.

5.5 OPPORTUNITIES TO IMPROVE WASTE-RISK MANAGEMENT

Transaction complexities:

Risk externality – The creator of waste-risk does not necessarily bear the financial cost of this risk.

Some waste activities such as; storage, transport and disposal of materials, particularly hazardous and flammable wastes, carry some probability that unintended events will expose private individuals, commercial businesses and the environment to losses. Some of this risk is insurable, some is mitigated through legislative and regulatory requirements, but some risk is transferred to the public as evidenced by recent fires, illegal disposal and waste business insolvencies. Waste-created risk is an insurable risk and

53 Department of Environment report completed by Deloitte Access Economics (2018), p. vii

54 In auction theory, the term "beauty contest" is used to describe selection of winner(s) on subjective criteria.

can be purchased from risk markets[55]. Waste-risk insurance reveals the efficient price for risk as defined by Laffont and Martimort (2002) because the mechanism employed to price this risk takes advantage of risk pooling (i.e. risk pooling reduces unsystematic risk) and actuarial pricing of risk (i.e. insurance premiums based on individual risk level and type). When risk is priced in this way, it creates an incentive for individuals to modify their behaviour, so they optimize their strategy for managing risk. By monetizing risk in the waste sector, through the purchase of insurance, managers of businesses are exposed to financial incentives that reflect the cost of risk associated by different commercial strategies. In addition to reducing the cost of risk bearing (i.e. through risk pooling); insurance frees-up capital (compared with self-insurance), allowing firms to grow faster and ensures that loss exposure from catastrophic risk events, such as a fire in a major waste storage facility do not end up on the public balance sheet.

Given that waste-created risk appears to be insurable[56] the role for government, with respect to waste-created risks, is defined by the risk externality. Unlike other types of risk, firms that create waste-related risks do not bear its financial consequences. For this reason, there is currently no incentive for waste-risk creators to take out insurance despite the advantages of this mechanism. This negative externality can be addressed by mandating the purchase of insurance by waste-risk creators. Under this approach, businesses that stockpile paper, cardboard, plastic, hazardous wastes etc. would be required to purchase waste-risk insurance to cover the environmental, human health and safety costs that arise from fire or another catastrophe. Actuarial pricing of these risk will create incentives for these businesses to modify their strategy (to reduce risk premiums) and reduces exposure of the public to clean-up costs. This mechanism needs further investigation particularly with respect to moral hazard problems. The cost and availability of such insurance may be influenced by the uncertain economic and political environment that currently exists in the waste sector, and by the discretionary nature of such insurance.[57]

5.6 OPPORTUNITIES TO IMPROVE THE MECHANISM TO ADDRESS ILLEGAL ACTIVITIES

Transaction complexities:

Information asymmetry hidden action – Illegal activities cannot be readily observed, and this allows individuals and firms to avoid costs associated with legal waste management pathways.

Strategy-proof institutions – Where institutions are not well-designed, they are susceptible to strategic behaviour that leads to unwanted outcomes.

The current economic environment in the waste sector creates a range of opportunities for strategic behaviour that is either legal but unwanted or illegal. An example of legal gaming is interstate trade in landfill and an example of illegal gaming is the disposal of waste to non-approved sites. The landfill levy

55 See https://laib.com.au/waste-management-business-insurance/ for an example of waste-risk insurance.

56 Waste risk insurance is insurable according to Berliner's (1982) insurability criteria. The cost and availability of such insurance may be influenced by the current waste environment and by the discretionary requirement to purchase such insurance.

57 Where waste risk insurance is not compulsory, the insurance pool may be reduced limiting the risk pooling potential for such insurance.

and differentials between levy rates between jurisdictions is partly responsible for these and other gaming opportunities. Legal and illegal gaming is an important consideration in the waste sector. It imposes costs on the environment, human health and amenity, and it creates an uneven playing field that weakens incentives for legitimate waste operators to invest in waste infrastructure. There are two opportunities identified by the CMD to address gaming problems in the waste sector.

5.6.1 Reduce opportunities for gaming

The first is to reduce the opportunity for illegal activities by designing mechanisms that are strategy-proof. The landfill levy, for example, creates incentives for legal and illegal gaming. Differentials in landfill levies between states also creates incentives for interstate trade in waste that is not welfare improving.

5.6.2 Optimal monitoring and enforcement strategies

The second more immediate opportunity is to apply well-understood economic concepts, referred to as "the inspection game", to all aspects of the waste economy where there are incentives for illegal behaviour. This offers a relatively simple and intuitive theoretical framework in which enforcement agencies, such as the EPA, consider the strength of incentives to break the law, the probability and cost of detection, and formulate an optimal inspection and punishment strategy.

5.7 OPPORTUNITY TO ADDRESS ISSUES WITH THE LANDFILL LEVY

As discussed above, the primarily policy lever used by the Victorian Government at present is the landfill levy. The Government's stated objective in introducing the MILL is to:

- act as an incentive to minimise waste, encourage greater re-use and recycling of resources, and promoting investment in alternatives to waste disposal to landfill; and

- provide funds for waste management infrastructure, support programs for industry, education programs and the resourcing of the bodies responsible for waste planning and management in Victoria.

The landfill levy is, in effect, a tax imposed on landfill, which creates an incentive to reduce disposal of waste to landfill. The landfill levy, as it is currently designed, has two problems.

- First, it does not fulfil a number of the Victorian Government's stated objectives. For example, the landfill levy does not act as an incentive to minimise waste (as it does not create incentivise for manufacturers to optimise their level and type of packaging, or their product redundancy strategies).

- Second, it creates incentives for illegal and legal gaming. An example of illegal gaming is the disposal of waste to non-approved sites. An example of legal, but unintended behaviour can be observed where wastes are stockpiled legally but this activity increases fire and other risks (which, in-turn, can lead to a breach of legal requirements related to safety and environmental protection). These strategic behaviours aim to avoid the landfill levy. These activities impose environmental, safety and amenity costs but also create commercial risks for legitimate investments in waste infrastructure.

As an alternative mechanism, there is a case to investigate a levy on waste creation, where the rate of the levy is determined by the volume and type of waste created (different levies for different types of packaging, for example). There is also scope to redistribute the revenue collected from a waste creation levy to: increase the use of recycled materials (if needed); invest in beneficial research; and fund infrastructure capacity gaps where there is a clear and material market failure.[58] Alternative mechanisms to incentivise waste minimisation (which is a stated objective of the Victorian government) include extended producer responsibility (EPR) policies and product stewardship schemes. Further research is needed to identify the "best" mechanism for introducing these incentives into the economy. On first principles, these styles of mechanism appear to display superior economic efficiency properties compared with a tax on disposal (because they directly address the cause of market inefficiency), and would appear to be less susceptible to legal and illegal gaming strategies.

In practice, the successful implementation of such a mechanism would require support from the Commonwealth government, and co-ordination between states (to prevent gaming opportunities arising from differential landfill levies between states)

5.8 IMPLICATIONS FOR WASTE INFRASTRUCTURE

The private sector makes significant investments in infrastructure which has few alternative uses, is long-lasting and involves commercial and political risks. Private businesses base their investment decisions on the expected returns from the services that will be provided from infrastructure. These investment decisions can only be efficient when they are informed by efficient price signals for the services produced. In this report we have identified many instances where the current institutions:

- do not reveal the information needed to make decisions;
- do not align outcomes with policy intentions;
- do not address important transaction complexities; and
- are not strategy-proof.

The CMD has identified opportunities to improve price revelation through mechanisms such as:

- incentives to avoid waste production;
- menus of incentive compatible contracts;
- improved incentive structures that provide rewards for beneficial behavioral change;
- improved coordination and information opportunities;
- improved procurement of waste collection services;
- auctions to increase the level of waste processing and recycling;
- compulsory insurance on waste-created risks; and
- improved specifications for international trade in waste materials.

[58] The hypothecation problem with landfill levy funds is noted in Section 5.8.

In addition to the price revelation advantages of these mechanisms, they also allow individuals with different values and preferences with respect to waste, to translate their attitudes, preferences and ambitions into actions.

The CMD has also argued that there is a strong case to investigate mechanisms that incentivise waste minimisation (which is a stated objective of the Victorian government), including a tax on waste creation, extended producer responsibility (EPR) policies and product stewardship schemes.

The final observation made by the CMD is that ambitious waste objectives can impose welfare costs on the economy. Waste programs need to be both efficient and transparent. To promote these objectives, it will be important to establish aspirational economic efficiency objectives in future waste legislation to complement the aspirational waste reduction objectives defined in current legislation. It will also be important to ensure that public funds allocated to waste programs are competitive with other public policy objectives including alternative environmental, human health, welfare and domestic violence programs – these services are also important to Victorians. To this end, it is widely accepted that hypothecation of public funds should be avoided in favour of a competitive allocation process.

Table 4: OPPORTUNITIES TO IMPROVE PRICE REVELATION AND ECONOMIC EFFICIENCY IN THE PROVISION OF WASTE SERVICES

Transaction	Transaction complexity	Opportunity to improve efficiency and effectiveness
Production of goods and services	**Externalities** – Producers do not face all the costs and benefits of alternative waste strategies **Information asymmetry** – Information about the type of waste generated from packaging and residual waste not revealed at transaction	Tax on type and level of packaging material Tax on type and level of residual material
Sorting	**Information asymmetry** – Information about the type of materials that make up waste is not immediately obvious **Contamination externalities** – Incorrect sorting of wastes can cause contamination of recyclable material reducing the value of batches of these materials **Collection and transport cost externalities** – The distribution of sorting effort has an important impact on the collection/transport costs of wastes	Menu of incentive compatible contracts: • Expand technical pathways particularly for organic material o Private sector able to offer additional pathways on the menu • Include all costs and benefits for each pathway including impact on collection costs and benefits • Private sector to post price for additional pathways matching of type to optimal contract
Sorting organics	As for sorting *Note: The menu of contracts creates options to remove organics from the general waste stream. Removal close to source is of interest because: the value of processed organic products is low; their value can be quickly eroded by transport costs; organic wastes create negative externalities (methane gas and odour) where they decompose anaerobically; and they make up a significant proportion of landfill.*	Expanded menu of contracts • Create a complete set of organic pathways to facilitate: o remote processing – additional organics bin, InSinkErator with remote removal of organics o source processing – compost, worm farms + neighbourhood markets o local processing – allow private sector to add pathways
Plastics Paper and Cardboard	As for sorting *Note: The fraction of recyclable material processed by Materials Recovery Facilities (MRF) is determined by market prices.*	Expanded menu of contracts to guarantee that what is placed in the recycle bin is recycled. • Create a menu contract that guarantees to recycle and reuse plastics, paper and cardboard

Table 4.cont.: OPPORTUNITIES TO IMPROVE PRICE REVELATION AND ECONOMIC EFFICIENCY IN THE PROVISION OF WASTE SERVICES

Transaction	Transaction complexity	Opportunity to improve efficiency and effectiveness
Collection (household)	**Information complexity** – Networks function efficiently when information that defines the type, location, timing etc, of services is revealed **Site synergies** – The costs of supplying a service can be reduced if the service is supplied to adjacent sites as a package **Coordination complexity** – Networks require consumers to coordinate activities **Network externality** – The cost of utilising network services for one user depends on the number of other users **Optimisation complexity** – Network efficiency can only be achieved by optimising value creation across all nodes.	Allocate collection contracts with combinatorial auction of collection routes • Collect on demand – introduce mobile phone App to allow nodes to coordinate and reveal information o Only require collection when needed. o Develop optimisation algorithm to reduce collection costs • Pay per lift – introduce charges per lift • Increase coordination options between households
Processing and recycling	**Information asymmetry (hidden information)** – Markets for waste materials rely on defining the quantity and quality attributes that determine value **Information asymmetry (hidden action)** - These markets rely on mechanisms to enforce transactions to ensure buyers receive what was described **Thin markets in waste processing** – Thin market problems can create market power and exposure problems if one player exits the industry	Introduce accurate and enforceable metrics for export trade Compulsory purchase of waste handling risk insurance Intervention beyond market outcomes based on market failure. Avoid interventions that pick winning technologies, locations and firms. Where government aims to increase recycling and reuse beyond the market, an auction of waste processing contracts will be the best mechanism.
Disposal	**Information complexities:** • Hidden information – information about type of waste needs to be revealed • Hidden action – it is not possible to observe all disposal activities **Environmental externalities –** Markets for emissions from landfill sites and other waste disposal facilities are missing	No change to the institutions currently used to determine gate fees. Many environmental externalities are priced in gate fees. Some residual emissions are not priced, and some risk not priced in gate fees. Investigate a tax on waste packaging (where the rate of tax is determined by the volume and type of packaging) and a tax on the volume and type of residual waste.

Table 4 cont.: OPPORTUNITIES TO IMPROVE PRICE REVELATION AND ECONOMIC EFFICIENCY IN THE PROVISION OF WASTE SERVICES

Transaction	Transaction complexities	Opportunity to improve efficiency and effectiveness
Waste risk	**Risk externality** - Waste-created risk appears to be an insurable risk. Market failure caused because the risk-creator does not have an incentive to take measures to mitigate this risk.	Compulsory waste risk insurance to cover public liability, environmental, safety, human health costs

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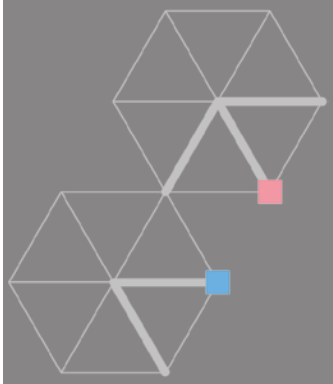

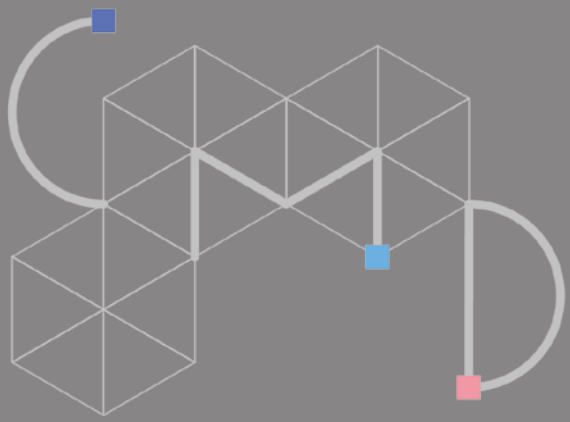

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