International Waste Sector
Volume III: Benchmarking Review

NSW Environment Protection Authority
April 2019
This Benchmarking review has been prepared at the request of the NSW Environment Protection Authority (EPA) for further consideration by the NSW Government. The Benchmarking review comprises Volume III of three reports produced for the EPA (collectively the Report).

The Report has been prepared by PricewaterhouseCoopers and Sphere Infrastructure Partners (together, the Advisers) on the basis set out in Section 1 of the Report. It contains opinions, advice and recommendations for consideration by the NSW Government in the development of a 20-year Waste Strategy for NSW.

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1 Introduction

1.1 Background

The Environment Protection Authority (EPA) is the primary environmental regulator for New South Wales. It partners with business, government and the community to reduce pollution and waste, protect human health, and prevent degradation of the environment.

The EPA is working with Infrastructure NSW to outline a scope and concept for the development of a 20-Year Waste Strategy for NSW. The purpose of the Strategy will be to set a 20-year vision and direction to reduce waste to landfill, driving sustainable recycling markets and identifying and improving the state and regional waste infrastructure network.

As part of this work, the EPA engaged PricewaterhouseCoopers (PwC) and Sphere Infrastructure Partners (Sphere) to prepare a situational analysis and demand projects for the NSW waste sector and to benchmark the NSW waste sector against international or domestic best practice to identify innovation and areas for improvement.

This report reviews the waste management of select international jurisdictions (that may have aspects relevant to NSW) and benchmarks NSW performance against that of other cities, states and countries. The Report also identifies areas of innovation and improvement to inform NSW’s strategic directions for the future.

1.2 Approach and Methodology

The Report has been prepared in accordance with the following methodology:

- analysis of country, province or city specific data;
- analysis of independent research;
- consultation with international waste experts, including officials from the identified jurisdictions;
- analysis of waste policies and practices implemented by the NSW and other Governments internationally.

In undertaking the benchmarking analysis, the following criteria have been used to draw comparisons between the relevant waste management systems and the effectiveness of those systems in terms of reducing waste generated, increasing waste recycled or re-used and diverting waste from landfill:

- strategies for waste management;
- policy levers (identified through sources reviewed) for waste management;
- strategies for prevention and reduction of waste;
- methods for managing and treating waste;
- development of long-term and interim targets to support broader government strategy; and
- performance against articulated targets.
Where reliable data could be identified, the NSW waste market was benchmarked to the selected jurisdictions in terms of:

- volume of waste generated;
- volume of waste sorted at source;
- volume of waste disposed through landfill;
- volume of waste disposed through incineration;
- volume of waste recovered for energy; and
- volume of waste recycled.

1.3 Scope of works

The focus of this report is benchmarking the performance of the solid waste sector (excluding liquid or gaseous wastes) of NSW against international jurisdictions across the following waste streams, noting that terminology used is not always consistent across jurisdictions:

- Commercial & industrial (C&I) - waste from commercial and industrial businesses;
- Construction & demolition (C&D) - waste from construction and demolition activities;
- Municipal Solid Waste (MSW) - municipal solid waste, from households and public places.

Waste from additional waste streams such as mining, forestry and agriculture are not specifically considered within this report.

In certain jurisdictions, the report also briefly considers hazardous waste, e-waste and liquid trade waste as significant and particularly challenging components of the three core waste streams.

The scope of work comprised:

Situational analysis (Volume II) and demand projections

a) review available material (provided by the NSW EPA) and undertake any further research (of publicly available information) to analyse the waste sector in NSW covering:

- generation, sorting, distribution, storage, recovery, resource recovery destinations/markets, and disposal located domestically and internationally disaggregated by:
  - Construction and Demolition waste, Commercial and Industrial waste and Municipal solid waste
  - waste types, including e-Waste
  - waste recovered, and waste disposed
- rates of waste generation, distribution, recovery, storage and disposal
- synopsis of waste market and participants in the waste market
- macro and micro factors that positively and negatively affect the waste market including (but not limited to):
  - household attitudes and behaviour, and consumer demand
  - the role of government, markets (including product and waste markets)
  - regulatory, policy and contractual frameworks
  - the extent, nature and hierarchy of the waste infrastructure network and industry structure
  - spatial issues and implications (for the State and interstate and international supply chains as well as within and between metropolitan and regional areas)
  - innovation
  - initiatives or arrangements to avoid or minimise waste generation
International benchmarking (Volume III)

Based on jurisdictions agreed with NSW EPA and subject to availability of information:

b) review available material, undertaking any further research and taking necessary soundings to analyse the current NSW waste sector. This includes understanding the factors that affect the generation and management of waste, the avoidance, of waste, use of recovered materials and the role of the waste industry

c) undertake research of best practice domestic and global leaders (as agree with the NSW EPA) in the waste sector in an agreed number of jurisdictions, which includes (but is not limited to) investigating:
   o household attitudes and behaviour, and consumer demand
   o the role of government
   o markets (including product and waste markets)
   o regulatory, policy and contractual frameworks
   o the extent, nature and hierarchy of the waste infrastructure network and industry structure
   o spatial issues and implications (for the State and interstate and international supply chains as well as within and between metropolitan and regional areas)
   o innovation frameworks
   o initiatives or arrangements to avoid or minimise waste generation
   o lessons learnt from policy failures and market impediments

d) incorporate the latest thinking, research and evidence from policy and civil society institutions or from the academic community.

e) develop outcomes-focused objectives and criteria to support benchmarking analysis

f) benchmark NSW with best practice jurisdictions

g) develop draft and final reports to report on findings of benchmarking exercise and proposed areas of innovation and for improvement. These areas must explore:
   o the conditions for waste market investment attraction and retention
   o the competitiveness of the waste market
   o consumer behaviour change
   o waste system regulation, policy, monitoring and reporting
   o the choices available to use a range of government levers
   o the conditions for when and how government levers are exercised

h) develop a set of overarching directions and complementary recommendations in relation to these findings for inclusion in the draft and final reports. These recommendations must consider levers available to the State Government and could include levers beyond State-based environment protection legislation. The Service Provider may also make observations about the use of Commonwealth and local government levers too.

The nature and extent of the procedures undertaken by the Advisers in respect of the scope of works were subject to the availability of information and any revisions to the Adviser’s approach and analysis, agreed with NSW EPA during the course of the engagement.
1.4 **Data**

The data presented in this report has been collected from national or state governments of the reference markets. OECD and European Commission data has also been used to provide a comparison of performance across the benchmarking group.

There are significant limitations in terms of the comparability and consistency of reported data drawn from different cities, state and national governments. Data has been primarily drawn from publicly available sources within each of the relevant jurisdictions. Terminology, composition and measure rules may not be consistent across jurisdictions. Where differences exist and have been identified, this has been disclosed in the Report.

Where available, the sections on each jurisdiction contain a discussion about the role that waste data collection and tracking has had in driving delivery of waste strategies.

1.5 **Structure of the Report**

The Report comprises three volumes:

- **Volume I: Key Findings** is intended to provide a summary of the key findings, observations and recommendations arising from the Situational Analysis and the Benchmarking Review;
- **Volume II: Situational Analysis**;
- **Volume III: International Benchmarking Report**.

1.6 **Sources of information**

The information, statements, statistics and commentary contained in the Key Findings Report (Volume I), the Situational Analysis (Volume II) and the Benchmarking Review (Volume III) have been prepared by the Advisers based on material provided by the NSW EPA, consultation with overseas stakeholders and from other public data sources external to the Advisers and the NSW EPA. The content reflects a synthesis of the Advisers’ analysis and the views and facts provided by the underlying sources, but the Advisers are not responsible for any errors arising from the underlying sources and the Advisers’ use of those sources.

Where the report summarises overseas policy and regulation or findings from other adviser reports, reasonable efforts have been made to attribute the content to the relevant source at the commencement of the relevant section.

1.7 **Timing of Work**

PwC was engaged in January 2019. Our work was completed during the period January 2019 to March 2019, with the Report finalised in April 2019.

The Report has not been updated for any information or market developments that occurred post March 2019.

The Report is based on data available at that time (included data provided by the NSW EPA) and has not been updated for any new data which may now be available or for amendments to data previously provided.
Executive Summary

This benchmarking report provides a review of waste management policies across seven jurisdictions. The report highlights considerations for NSW in regard to the major strategic decisions, policy directions and delivery capability of waste management service providers.

The report analyses the performance of each of the seven jurisdictions on a number of different measures. These measures include: current policy settings; policy levers in use to deliver effective waste management services, waste generation, waste treatment, waste prevention, roles and responsibilities of the waste management sector and data.

The report has identified a number of considerations for NSW. These considerations are made from identification of best practice and lessons learnt from the benchmarked jurisdictions.

Strategy Considerations

The analysis has identified a global trend towards adopting a zero waste goal by 2050. This is supported by the transition to a ‘Circular Economy’ approach to waste management. Jurisdictions have articulated this economy differently, to suit their context and demographic profile. The main elements of the Circular Economy remain the same, including a prevention of waste and reduction in the use of raw materials, a shift in product design to ensure product re-use and recycling and a closed-loop cycle that retains the value of a product from design to re-use. Specific strategies that NSW should consider include The Netherlands Circular Economy Strategy, Ontario’s Circular Economy Strategy and Scotland’s transition to a Circular Economy.

Each strategy includes targets and interim actions and targets to achieve zero waste. These targets involve a reduction in waste generated, an increase in recycling and recovery of materials, a reduction in the use of raw materials and a total diversion of all waste from landfill.

Policy Lever Considerations

A range of policy levers are employed by jurisdictions to support strategic directions of waste management. These policy levers primarily involve legislation that mandates source separation of waste across all three waste streams, bans certain materials from landfill, mandates recycling and recovery and bans single use plastic and certain other soft plastics. In addition to this, a range of financial incentives are employed to encourage recycling and recovery such as landfill and packaging taxes.

In addition to strong legislative frameworks, and a robust financial incentivisation scheme, all but one of the jurisdictions considered in this report have some form of extended producer responsibility or product stewardship. The extended producer responsibility schemes of the Netherlands and Ontario require that manufacturers finance the cost of waste management for certain products, meaning financing the transportation, recovery and disposal costs of specified products that are sold on the market. In the case of the Netherlands, the cost of disposal is collected from producers and sent to municipalities to subsidise the cost of waste management services.

Waste Generation, Separation, Collection and Treatment Considerations

Source separation of waste results in a higher rate of recycling and a reduction in waste to landfill. Source separating at least three types of waste including recyclables, food and organic waste, mixed or other waste and paper or bulky waste has a significant impact on reducing contamination and facilitating recycling and recovery for each waste stream. Jurisdictions that have a high rate of recycling or diversion from landfill such as San Francisco, Slovenia, Scotland and the Netherlands all source separate at least four types of waste. This is also accompanied by a pay-as-you-throw system, where consumers are incentivised to separate waste better (including organic waste) and recycle more. In addition to this, jurisdictions such
as Scotland, Slovenia and the Netherlands also regulate and inspect the rate of contamination from households in MSW and in some instances penalise residents for incorrectly sorting their waste.

Jurisdictions vary in their collection methods, whether it is publicly delivered or a private contract, whether collection is weekly or twice a week or in the case of Singapore more frequent than that.

Treatment methods for waste are numerous and depend on overall strategic direction, the waste management services provider market, the market for recyclables, legislation and regulation, and financial and non-financial incentives. Jurisdictions such as the Netherlands, Singapore and Denmark rely on incineration as a primary treatment method. A lack of space, a need for reliable heat and energy sources and a strong industry for incineration infrastructure has resulted in a stable waste to energy market. Whilst this is not completely at odds with the Circular Economy, it is somewhat in conflict with the zero waste approach which seeks to reduce the amount of waste for final disposal, prevent waste from being generated and encourage the recycling and re-use of all materials. A more fulsome discussion on this and the relevant implications for NSW can be found in Chapter 12 of this report.

Other jurisdictions such as San Francisco have partnered with a major waste management service provider with significant recycling and composting capability to ensure that the majority of waste collected is recycled or treated with anaerobic digestion or incineration.

**Market Dynamics for Waste Management Services**

Market dynamics across the benchmarking group are experiencing some level of disruption in the wake of China’s national sword policy. A number of jurisdictions have taken the approach of finding other importers in South East Asia, scaling up incineration of waste and in some cases, landfilling more waste.

San Francisco, with its unique partnership with waste management provider Recology has managed to maintain diversion from landfill and invest in infrastructure to improve the quality of recyclates to attract a local market of manufacturers who use the recyclates for production.

The UK’s market dynamics are somewhat similar to Australia’s. The market is mostly serviced by five large companies. These companies are fiercely competitive. As a result of this, it is challenging for other companies, specifically small and medium sized local businesses to enter the market. The recyclates market is small and not expecting much growth. Jurisdictions such as Ontario and Denmark are working to stimulate these markets by leveraging ‘green’ public procurement and addressing quality standards and the cost of recyclate products compared to virgin materials.

**Infrastructure**

Waste to energy has a role in treating residual waste, even within a circular economy. Across the benchmarking group it is possible to observe a trend whereby incineration capacity is on a trajectory to be downsized, after the market stabilises post China’s National Sword policy. Low temperature treatment infrastructure such as anaerobic digestion and composting is being scaled up where an end-market is available.

**Delivery of Waste Management Services**

It has been difficult to accurately assess the various ways that each jurisdictions arranged the delivery of waste management services. The large majority of jurisdictions had some sort of strategy or policy statement that was set at a national level and supported by national or state implemented policy levers. The actual implementation of policy, strategy and delivery of waste management services was generally the responsibility of local authorities, municipalities and councils. On the whole, these services are delivered by private companies via a Public Private Partnership (PPP), contract or permit system with a provider. In specific circumstances, such is the case in Toronto, Canada, the local authority provides the waste management services
from collection to processing. Given the unique market environment of each of the jurisdictions, it is challenging to draw any clear recommendations on the delivery of waste management services. It is obvious that PPPs and delivery by private companies is the most popular and potentially cost-efficient option. However, in circumstances where there is a limited provider market, this would be different (as is the case in the non-levy areas of NSW).

**Waste Management Data Collection**

Across the benchmarking group there is a clear indication of the importance of transparent and accurate data. Various jurisdictions such as Slovenia, Scotland, the Netherlands and Denmark annually publish their waste data on a public website. The data presents, to various degrees of granularity, the volume of waste generated by stream, volume of waste treated by different methods and where the waste originated from. Scotland is leading the benchmarking group in best practice regarding data management. With a Data Strategy for Waste Management, Scotland is utilising its data to demonstrate the importance of source separation, the requirement to improve recycling rates and the necessity of appropriate management for food and organic waste. In addition to this, the data is utilised by the regulator, the Scottish Environmental Protection Agency, to regulate the waste management sector. NSW should consider Scotland’s approach to collecting and utilising data to support a zero waste goal.
### 3 Benchmarking jurisdictions

#### 3.1 Overview

In preparing this report, we researched a number of international jurisdictions which faced similar challenges to the NSW waste market. The following sections provide a high level overview of the jurisdictions chosen to benchmark NSW and the reasons for their selection.

**Figure 1: Benchmarking jurisdictions**

#### 3.2 The Netherlands

The Netherlands is a country in Northern Europe with a population of 17.2 million. The Netherlands has a significantly higher population than NSW and a significantly smaller land size, meaning a significantly higher population density. The Netherlands is a country which spear headed the shift to a circular economy and is regularly held up as an example of best practice.

#### 3.3 San Francisco

San Francisco is a major city on the west coast of the United States with a population of approximately 884,363. San Francisco was selected as a jurisdiction for review due to its significant progress and success in moving towards zero waste in the timeframe of 15 years. Reaching a 75% diversion rate from landfill by 2010, San Francisco has a unique public private partnership with its delivery partner, strong performance in separation at source, a pay-as-you-throw principle applying to waste collection, and a successful education campaign.
3.4 Scotland

Scotland is a country in the north of the United Kingdom with a population of 5.4 million. Scotland’s population is largely urban-based, with approximately 83 per cent of the population living in non-rural areas. Scotland provides an example of a strong regulatory approach to the waste sector, with a zero waste strategy, a series of targets and a transparent approach to data.

3.5 Slovenia

Slovenia is a country in Central Europe with a population of 2.1 million. Slovenia was selected as a jurisdiction because of its journey from a country that predominantly landfilled all its waste to one with advanced waste separation, sorting and treatment processes resulting in high waste diversion rates.

3.6 Ontario

Ontario is a province in the south east of Canada, with a population of 14.4 million. Ontario’s population is largely urban-based, with nearly half the province’s population (6.9 million) living in the Greater Toronto area. Ontario was selected as a jurisdiction for its similarities to NSW, including in terms of urban density and income per capita as well as being a state within a Federal system. It has had a heavy reliance on landfill for waste treatment and recently introduced a circular economy strategy to reduce waste generation.

3.7 Singapore

Singapore is a city state in Southeast Asia with a population of 5.64 million. Singapore’s climate and population density were significant factors in its selection as a part of the benchmarking group. Due to Sydney’s growing population, and the move towards higher density housing, it was important to review practice of a jurisdiction that faces similar challenges in managing waste collected from multi-unit dwellings.

3.8 Denmark

Denmark is a country in Northern Europe with a population of 5.8 million. Denmark’s population is largely urban-based, with approximately 88 per cent of the population living in urban areas. Denmark was selected as a jurisdiction for international benchmarking due to its waste generation profile. Historically a jurisdiction with high rates of waste generation and waste incineration, Denmark is representative of the broader shift towards zero waste that is occurring across the EU, including a move away from incineration.
4 Global trends

4.1 Introduction

Across the benchmarking group, waste management involves complex and multiple layers of governance.

Internationally, there are a number of different strategic directions for waste management. These approaches differ in terms of their relative focuses on the waste hierarchy; the three ‘R’s (reduce, reuse, recycle); Zero Waste programs and Circular Economy principles as well as policies targeting country or waste specific issues.

Plans and strategies are often set at the national level and are responding to either regional guidance such as the European Commission’s Circular Economy directive or commitments from the United Nations such as the Sustainable Development Goals.

Waste management policy frameworks or strategies set at a national or state level, often have the equivalent of local councils operating the day-to-day collection, sorting, processing and disposal of waste. Local councils or municipalities are responsible for meeting the obligations and broad objectives of the waste management strategy set by the state or national government. Certain countries in the benchmarking group demonstrate a coordinated and collaborative relationship between various layers of government. Other countries operate waste management in a highly regulated environment, creating little autonomy for local government.

Examples from the benchmarking group where this intergovernmental coordination appears to drive successful waste outcomes is where the local authority has more control over waste policy (e.g. San Francisco); when there is a simplified structure e.g. two levels of government in operation (e.g. Denmark and the Netherlands), or when there is a clear separation of roles and responsibilities set out in a robust legislative framework for waste management (the Netherlands and Slovenia).

In 2015, the United Nations General Assembly passed resolution 70/1, ‘Transforming our World: the 2030 Agenda for Sustainable Development.’ The sustainable development goals (SDGs) are a blueprint of actions and targets to achieve by 2030 with the intention of creating a more sustainable future for all.

The SDGs address 17 global challenges, including those related to poverty, climate change, inequality, environmental degradation, prosperity, peace and justice. The SDGs that are relevant for jurisdictions to consider in relation to waste management include:

- Goal 2 – Zero Hunger: avoiding food wastage
- Goal 9 – Industry, Innovation and Infrastructure: repurposing and reusing materials
- Goal 12 – Responsible Production and Consumption: recycling paper, glass, plastics and aluminium.
- Goal 14 – Life Below Water: Avoiding soft plastics and keeping our oceans clean.

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Certain jurisdictions utilise the Sustainable Development Goals as a platform for transformation of their waste management sector and to communicate the necessity of change to the public. As a UN resolution, the SDGs must be adopted by a UN member state and then ratified domestically.

4.2 European Union’s 2018 Circular Economy Package

The European Union’s 2018 Circular Economy Package and the 2015 EU Action Plan for a Circular Economy, introduced measures to move Europe to a circular economy. The Action Plan establishes a concrete and ambitious plan of action, with measures that cover the whole cycle from production and consumption to waste management. The included actions seek to close the loop on waste product lifecycles. EU member states are subject to the European Commission’s Circular Economy Package.

In 2018, a revised legislative framework of the circular economy came into force. This involved a series of targets for all EU member-states including:

- 65% recycling of MSW by 2035;
- 70% recycling of packaging waste by 2030;
- 85% recycling rate of paper and cardboard;
- 80% recycling of ferrous metals;
- 60% recycling of aluminium;
- 75% recycling of glass;
- 55% recycling of plastic;
- 30% recycling of wood; and
- a binding landfill target that reduces landfill to a maximum of 10% of municipal waste by 2035.

The EU also introduced separate collection obligations, requiring separate collections of specific waste streams with the purpose of boosting the quality of secondary raw materials. These rules require separate collections for MSW and hazardous household waste by 2022, bio-waste by the end of 2023 and textiles by 2025.

The EU has also proposed to introduce a directive to reduce the impact of plastic products on the environment. An EU Strategy for Plastics in the Circular Economy, released in 2018 as a part of the EU’s broader Circular Economy packages seeks to transform production of plastics and packaging to ensure that all are recyclable by 2030. Further detail on this is provided in Volume II – Situational Analysis at Section 8.4.

4.3 Circular Economy – EU Implementation Approach

In 2015, the European Commission adopted an ambitious Circular Economy strategy, which included measures to transition Europe to a circular economy model. As part of the implementation process, the EU established an Action Plan for the Circular Economy.

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5 The information contained in this section of the report has been drawn from the key documents for the EU Final Circular Economy Package. Sourced from: https://ec.europa.eu/environment/circular-economy/
The Action Plan documented a programme of actions to be completed before 2020, covering the whole waste cycle: from production and consumption through to waste management and the market for secondary materials. The Action Plan outlined the required waste legislative requirements.

A revised legislative framework on waste came into force in July 2018. It sets clear targets for the reduction of waste and establishes a long-term path for waste management and recycling.

Key implementation measures were set out across the following areas:

**Production**
- Emphasis on circular economy aspects in future product requirements under the Ecodesign directive;
- Moves to develop standards on material efficiency for setting future Ecodesign requirements on durability, reparability and recyclability of products;
- Examining options and actions for a more coherent policy framework of the different strands of work of EU product policy in their contribution to the circular economy;
- Transitioning guidance on circular economy into Best Available Techniques reference documents (BREFs) for several industrial sectors;
- Establishing an open, pan-European network of technological infrastructure for SMEs to integrate advanced manufacturing technologies into their production processes;
- Developing an improved knowledge base and support to SMEs for the substitution of hazardous substances of very high concern.

**Consumption**
- Better enforcement of product guarantees;
- Action on false green claims, including updated guidance on unfair commercial practices;
- Analysis of the possibility to propose horizontal requirements on repair information provision in the context of Ecodesign;
- Adjustments to the Ecolabel, to be followed by actions to enhance its effectiveness;
- Assessment of the possibility of an independent testing programme on planned obsolescence;
- Examination of possible uses of the Product Environmental Footprint to measure and communicate environmental information; and
- Green Public Procurement: enhanced integration of circular economy requirements, to support higher uptake including through training schemes; support of recycled materials through government procurement policies; and stimulating the economy for recyclates as a material for wide scale use in production.

**Waste management**
- Improved cooperation with Member States for better implementation of EU waste legislation, and combat illicit shipment of end of life vehicles (or other problem wastes);
- Stepping up enforcement of revised Waste Shipment regulation;
- Promotion of industry-led voluntary certification of treatment facilities for key waste/recyclate streams; and
• Dissemination of good practice information in waste collection systems.

Market for secondary raw materials

• Development of quality standards for secondary raw materials (in particular for plastics);
• Proposal for a revised fertilisers regulation;
• Analysis and policy options to address the interface between chemicals, products and waste legislation, including how to reduce the presence and improve the tracking of chemicals of concern in products;
• Measures to facilitate waste shipment across the EU, including electronic data exchange (and possibly other measures); and
• Further development of the EU raw materials information system.

Sector Actions:

• Plastics:
  - Develop a strategy on plastics in the circular economy (2017); and
  - Specific action to reduce marine litter, implementing the 2030 Sustainable Development Goals (2015).

• Food waste:
  - Development of a common methodology and indicators to measure food waste;
  - Stakeholders platform to examine how to achieve sustainable development goals (SDG) on food waste, share best practice and evaluate progress;
  - Clarify relevant EU legislation related to waste, food and feed in order to facilitate food donation and utilisation of former foodstuffs for animal feed; and
  - Explore options for more effective use and understanding of date marking on food.

• Critical raw materials:
  - Report on critical raw materials and the circular economy;
  - Improve exchange of information between manufacturers and recyclers on electronic products;
  - European standards for material-efficient recycling of electronic waste, waste batteries and other relevant complex end-of-life products; and
  - Sharing of best practice for the recovery of critical raw materials.

• Construction and demolition:
  - Pre-demolition assessment guidelines for the construction sector;
  - Voluntary industry-wide recycling protocol for construction and demolition waste;
  - Core indicators for the assessment of the lifecycle environmental performance of a building and incentives for their use.

• Biomass and bio-based materials:
  - Guidance and dissemination of best practice on the cascading use of biomass and support to innovation through Horizon 2020;
  - Ensuring coherence and synergies with the circular economy when examining the sustainability of bioenergy under the Energy Union;
- Assessment of the contribution of the 2012 Bioeconomy Strategy to the circular economy and possible review.

**Innovation and investments:**

- Pilot project for "innovation deals" to address possible regulatory obstacles for innovators;
- Targeted outreach to encourage applications for funding under the European Fund for Strategic Investment and support the development of projects and investment platforms relevant to the circular economy;
- Support to Member States and regions to strengthen innovation for the circular economy through smart specialisation;
- Assessment of the possibility of launching a platform together with the European Investment Bank and national banks to support the financing of the circular economy;
- Engagement with stakeholders in the implementation of this action plan;
- Support to a range of stakeholders through actions on public-private partnerships, cooperation platforms, support to voluntary business approaches, and exchanges of best practices.

**b) Key Targets**

Key targets under the EU’s circular economy proposal included:

- A common EU target for recycling 65% of municipal waste by 2035;
- A common EU target for recycling 70% of packaging waste by 2030;
- Recycling targets for the following specific packaging materials:
  - Paper and cardboard: 85%
  - Ferrous metals: 80%
  - Aluminium: 60%
  - Glass: 75%
  - Plastic: 55%
  - Wood: 30%
- A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2035;
- Separate collection obligations are strengthened and extended to hazardous household waste (by end 2022), bio-waste (by end 2023), and textiles (by end 2025);
- Minimum requirements are established for extended producer responsibility schemes to improve their governance and cost efficiency;
- Prevention objectives are significantly reinforced, in particular, requiring Member States to take specific measures to tackle food waste and marine litter as a contribution to achieve EU commitments to the UN Sustainable Development Goals.

**c) Stakeholder Engagement**

As part of the implementation program, the EU established the European Circular Economy Stakeholder Platform, a virtual open space which aimed at promoting Europe’s transition to a circular economy by facilitating policy dialogue among stakeholders and by disseminating activities, information and good practices on the circular economy.
4.4 Trends in waste management and strategic directions

Over the last decade, there has been a global movement towards recognising the value of waste and capturing this value across a product’s life cycle. The move away from relying on raw materials and instead designing and transitioning to a more sustainable system of production is supported by the concept of a ‘Circular Economy’.

A circular economy approach (transitioning the waste management system from a linear model to one that is circular, redefining product design and focusing on positive society-wide benefits) has begun to form the basis of many waste strategies around the world. The model designs out waste and pollution, keeps products and materials in use and regenerates natural systems.

In this vein, there has been an increased focus on recycling and recovery solutions targeting specific waste streams, with a move away from landfill, in particular, as a disposal method. While the waste hierarchy remains a relevant foundation, upon which many national and provincial/state strategies are based on, it is somewhat fundamentally at odds with the concept of a circular economy. The waste hierarchy, whilst prioritising reduction and recycling and re-use, retains three concepts clearly; the continued use of raw materials, the continued use and dependence on energy for waste facilities as a disposal option and also the continued use of landfill (although at a last resource) as a residual waste disposal option. In a pure circular economy which is working to design out the use of raw materials as much as possible, and close the loop on a product’s life cycle, incineration and landfill are not options (albeit that many jurisdictions acknowledge that a staged approach to adoption of a circular economy, which incorporates residual waste, is necessary). This is important to keep in mind when considering the various zero waste programs and waste management strategies of the jurisdictions.

4.5 Strategies for waste management – overview of benchmarked jurisdictions

All jurisdictions reviewed have a waste management strategy in place that has evolved over time, some taking into account international and circular economy developments and others focusing on jurisdiction-specific issues. Current strategies on the whole follow the waste hierarchy or have adopted a circular economy approach. Most strategies also are seeking ‘zero waste’ by 2050 or before. The table below gives an indication of approaches taken by each jurisdiction.
Table 1: Comparison of strategies for waste management

<table>
<thead>
<tr>
<th></th>
<th>San Francisco</th>
<th>Ontario</th>
<th>Singapore</th>
<th>Scotland</th>
<th>Denmark</th>
<th>Slovenia</th>
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<tr>
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</table>

What is clear from the benchmarking review, is that strategies that have achieved a significant reduction of waste and diversion from landfill are supported by strong legislative and regulatory policy levers, as well as financial disincentives for non-compliant behaviours.

The following sections detail the history, policies and approach of the benchmarked countries. Sections 12 then examines and compares their results.
5 The Netherlands

5.1 History and background

In the 1980s and into the 1990s the Netherlands suffered from a lack of landfill capacity and insufficient thermal treatment capacity, due in part to public resistance to the construction of new landfill or incineration plants. Planning and construction of processing plants was managed at regional or provincial levels, but lacked coordination and harmonisation across all levels of government. Waste management activities were considered to lack scale and provided inadequate environmental protection.

The emerging waste problems provided a platform for a series of new waste programs and activities. A new waste policy framework was implemented, that was built around:

- implementing a waste hierarchy for waste management to limit the supply of waste via waste prevention; preparing for reuse; recycling; other recovery e.g. energy recovery; and disposal;
- promoting the reuse and recycling of waste;
- stringent waste treatment standards: reducing the unwanted environmental impact of waste management;
- developing planning at a national level and promoting cooperation between the relevant authorities.

Key initiatives included:

- extended producer responsibility schemes - through a combination of voluntary and binding agreements on a waste management fee (to contribute to the cost of material recovery, processing and reuse);
- a ban on landfill for specified waste streams (which in effect banned all wastes that were suitable for recovery or incineration from going to landfill);
- implementation of landfill levies;
- use of various instruments to stimulate prevention and recycling, including:
  - a landfill tax and volume-based waste fees to influence behaviours and support the shift towards recovery and recycling;
  - expansion of waste collection and processing options for households and business (expanded waste collection services for recyclable materials and creation of collection centres for other problem wastes); and
  - raising public and community awareness.

Accompanying these actions were strict waste treatment standards governing the treatment system, including:

- standards for soil protection from landfilling;

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6 The information contained in this section of the report has been primarily drawn from: Rijkswaterstaat Environment, the executive of policies and regulations of the Ministry of Infrastructure and Water Management. Sourced from: [https://rwsenvironment.eu/](https://rwsenvironment.eu/)


7 The landfill tax has subsequently been revoked as the volume of waste going to land fill is now under 3%
• standards for the quality of secondary materials derived from waste;
• air-quality standards for emissions from incineration processes; and
• quality standards for organic fertilisers from bio-waste.

A waste management council was initially established via a voluntary agreement covering the national, provincial and local governments to deliver a joint and coherent approach to waste management.8

Between 2000-2014 the waste treatment approach shifted from relying on disposal via landfill to recycling via incineration9. This revised approach meant that non-combustible waste streams such as soil, asbestos and some residual household waste continued to be sent to landfill and the remainder was recycled. From 200-2014 the ‘recycling’ rate has remained stable between 79.5-83%. The large share of this being construction and demolition waste, glass and paper10.

5.2 Current Policy Settings and Levers11

Regional influence from the European Commission has a significant impact on the waste management policy developed by member states. A consequence of this, there is a consistency of policy settings and levers across the benchmarking group with responsibility for the delivery of waste management services often sitting with local municipalities. Municipalities are not only responsible for implementing national policy, but also complying with directives set by the EU. To meet the requirements of the EU and national policy, municipalities have increasingly established municipally-run facilities to collect different valuable waste streams. The Netherlands has a mandated system of separate collection of recoverable materials and a strict landfill ban for certain products. In response to this, many municipalities have introduced kerbside collection and unit-based pricing to encourage recycling. Paper, cardboard and glass are the most common recyclables. These are separately collected, as are textiles and clothing. Food and organics can also be taken to collections points.

5.2.1 National Waste Management Plan12

In 2002 the Environmental Management Act came into force in the Netherlands, which implemented a centralised approach to waste management. Under the Act, the relevant Minister must prepare a National Waste Management Plan every four years. The plan must set out the policy for the management of all waste covered by the Environment Management Act, covering a 10 year horizon.

The Netherlands’ National Waste Management Plan sets out a comprehensive policy framework for waste management across the country and is updated every four years.

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8 The council was disbanded in 2006, however, cooperation still exists across the different tiers of government for defining policies, implementation and enforcement.
10 Ibid
11 Information in this section is largely drawn from: Rijkswaterstaat Environment (2019).Sourced from: https://rwsenvironment.eu/
The objectives of the 2009-21 plan were:\(^{13}\):

- to encourage waste prevention and to reinforce the decoupling of GDP from total waste supply achieved in the period 1985-2000. This primarily involved stepping-up prevention by consumers and the trade, services and government sector;
- to encourage waste recovery, through waste separation at source and the post-collection separation of waste streams;
- to optimise the use of the energy content of non-reusable waste;
- to limit the quantity of waste to be disposed of in 2012 to a maximum (rounded) of:
  - 9.5Mt (2Mt of non-combustible waste, excluding non-cleanable soil);
  - 5.1 Mt of non-hazardous waste that is incinerated as a method of disposal in waste incineration plants;
  - 0.1 Mt of hazardous waste that is incinerated in rotary furnaces and waste incineration plants; and
  - 2.3 Mt of sewage sludge. Landfilling of the surplus combustible waste, as currently happens, must be ended within five years.
- to achieve a level playing field in Europe, promoting the operation of market forces and encouraging innovation in prevention and waste management.

The National Waste Management Plan (NWMP) 2017-23 comprises two parts:

- policy framework: which sets out the key points of the waste policy, including national objectives; and the general principles for the use of instruments (such as licensing and enforcement);
- sector plans: that flesh out the policy framework for specific categories of waste. The NWMP contains 85 sector plans.

### 5.2.2 Circular Economy

The Netherlands recently released a strategy to move towards a circular economy, citing the dependency on other countries for raw materials, CO\(^2\) emissions and climate change as key motivations for the change in approach.\(^{14}\)

With a vision to achieve a circular economy by 2050, the Dutch government outlined an intention to reduce the use of raw materials by 2050. The strategy outlines a three phase transition towards this circular economy, as seen in Figure 2 below.

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\(^{13}\) Objectives from the 2009-2021 Plan (predecessor to the 2017-2023 plan) have been included as they reflect the initial transition towards a circular economy, sourced from: [https://rwsenvironment.eu/subjects/from-waste-resources/national-activities/national-waste/](https://rwsenvironment.eu/subjects/from-waste-resources/national-activities/national-waste/)

The current state of a ‘linear’ economy is characterised by raw materials being extracted from the earth and a linear process of these raw materials to disposal via landfill.

The second state is titled the ‘reuse’ economy where raw materials are predominantly recycled or reused and the demand for virgin raw materials decreases as more recycled products enter the economy.

The third state of the ‘circular economy’ sees a circular closed loop model with minimal or zero draw on raw materials and an entirely new approach to product design. The strategy articulates four strategic priorities including biomass and food, manufacturing industry, plastics, construction sector and consumer goods:

- 50% reduction in the use of primary raw materials by 2030;
- 52% recycling rate of plastics and packaging by 2017;
- 100% renewable (recycling and biobased) plastics by 2050.

Notably, the Dutch circular economy strategy retains the input of raw materials over the three phase transition. It is anticipated that the reliance on incineration generally will pose significant barriers to achieving a circular economy, as will also be discussed in the case of Denmark.

5.2.3 Policy levers

The Netherlands employs a number of different levers and instruments to promote waste prevention and recycling. These levers include enforcement of legislation, financial incentives, mandatory separate collection, effective communication and an extended producer responsibility scheme. The following analysis identified levers that were in place to support the NWMP 2009-21 plan.

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17 Ibid
18 Ibid
19 Ibid
5.2.4 Source separation

The Dutch government mandates separate collection of unsorted household waste and compostable waste across the Netherlands, though how this waste is collected is a decision of local government.

Targets have been set for the recovery of individual waste items through source separation under the National Waste Management Plan (see Section 5.2.1).

Every municipality has a public amenity centre where people can dispose of their waste. Public collection is also offered for organic waste, paper and cardboard and plastic and glass.

5.2.5 Financial instruments

Instruments include:

- Environmental tax on landfilling;
- Producer responsibility programs: producers share the responsibility for the management of their products at the end-of-life stage. This may result in some of the waste management costs being internalised into the product price.
  
  Where the cost of scrapping products at life end poses a risk of the products being disposed of in an illegal manner, the internalisation of recovery and processing is an important deterrent.
  
  For hazardous materials such as tyres, the producer responsibility is extended to include an obligation to collect discarded vehicle tyres ‘free of charge’.

- Rate differentiation in the collection of household waste: households pay in proportion to the quantity of their residual waste. Payment may be determined, by reference to the volume of waste presented for collection (e.g. large volume general waste bins attracted a higher charge) or on the basis of the number of times a household presents waste.

Recycled materials do not attract a waste charge, providing households with a financial incentive to reduce the amount of residual waste presented for collection. This provides an incentive for the prevention or better separation of the waste.

Several Dutch municipalities have introduced unit-based pricing of unsorted and compostable waste as a measure to simulate separate collection and disincentivise waste generation. In 2012, 36% of municipalities had implemented a unit-based fee system. This system is shown to have some benefit, though perhaps not as significant as the pay-as-you-throw scheme implemented in San Francisco.

Financial incentives are also used to contribute to achieving the objectives of the National Waste Management Plan. Examples have included:

- government grant schemes to support innovative collection techniques and for reuse and recycling;
- grants supporting the development of markets for secondary plastics, financed by the business community and government;
- grants to support innovation in the processing and reuse of recovered materials (including the development of new end markets for recycled waste).

Incentives are also used to stimulate activities that result in structural improvements in the management of waste.
5.2.6 Contracting and Innovative Tenders

In 2015, municipal government companies Midwaste and Cirrulus-Berkel adopted an innovative tender process to challenge sorting companies to raise the percentage of plastics sorted from 50% to 90%.\textsuperscript{21}

The Dutch Cabinet is encouraging municipalities and waste collectors to make use of all contracting mechanisms available to them to reduce the volume of residual waste all the way along the value chain.\textsuperscript{22}

5.2.7 Extended Producer Responsibility

In the Netherlands, producers or importers under producer responsibility schemes are responsible, or share responsibility, for the management of the products that they have or will be put on the market when the products are discarded.\textsuperscript{23} This responsibility can be agreed upon voluntarily or through legislation. An example of this is the plastic packaging scheme.

Plastic Packaging Scheme

The Netherlands has an ambitious target to increase the recycling rate of plastic packaging to 52% by 2022. In the Netherlands all costs for collection, separation, sorting and recycling packaging waste are fully reimbursed by the packaging industry.\textsuperscript{24}

Each producer has to declare the volume of packaging waste it produces, with some products attracting a fixed fee scheme.

Afvalfonds has been granted a license to manage the flow of household plastics. Afvalfonds coordinates and collects fees from the packaging industry depending on the size of production and size of the company. Afvalfonds then compensates municipalities for collecting plastic packaging waste for producers.\textsuperscript{25} In 2015, municipalities received a financial contribution of EUR 677 per tonne for separated plastic.\textsuperscript{26}

5.2.8 Packaging Covenant

The Netherlands has introduced a ‘Packaging Decree’ which seeks to meet the requirements of the European Commission’s Directive on Plastic Packaging.

The decree incorporates the essential requirements to improve the sustainability of plastic packaging, including a minimum percentage (90% by 2022)\textsuperscript{27} for the recycling of packaging materials in the Netherlands. This percentage is higher than the percentage stipulated in the EC directive.

The Dutch Packaging Decree is supported by a Framework Agreement for packaging, which essentially sees the national government, the packaging industry and the Association of Dutch


\textsuperscript{22} Ibid


\textsuperscript{25} Ibid

\textsuperscript{26} Ibid

Municipalities make agreements about the implementation of the decree. As executing this decree and the agreements are costly, the packaging industry has developed a Packaging Waste Fund which provides compensation to municipalities for all the costs they incur in executing the Framework Agreement of Packaging.\textsuperscript{28}

5.3 Waste Generation

Whilst policy in the Netherlands presents a strong focus on reducing the volume of waste going to landfill, the figure below indicates there has not been any significant reduction in the total volume of waste being generated. Current policy settings, however, have an objective of decoupling the rate of growth in total waste volumes and GDP, something that had been achieved previously (see Section 5.2.1).

Figure 3: Waste Generation in the Netherlands


The figure below illustrates trends in waste treatment methods in the Netherlands from 2000 to 2014. Recycling rates have remained relatively stable throughout this period at over 80%. It is important to note, however, that the Netherlands Government calculates energy recovery as a form of recycling, which partly explains this high recycling rate. Incineration refers to waste that is incinerated for disposal, as opposed to energy recovery, here articulated as recycling.

5.4 Waste Prevention

The Dutch government has developed strategies that target:

- materials that comprise the largest share of waste disposed via incineration (household residual waste; and residual waste from the trade, services and government sector); and

- wastes where there is already considerable potential for prevention (e.g. building and renovation sectors).

For household waste, prevention programs focus on:

- factors that motivate positive behaviours;
- developing alternate ways of behaving;
- stressing the role of the householder as a player in the waste chain.

For the commercial sector, the focus of the Netherlands has been on developing policies targeted at businesses offering the greatest potential for reductions in waste going to incineration (retail trade chains; larger offices; health care institutions). Policies have included:

- financial incentives for larger waste generators to take preventive measures;
- information campaigns to highlight the image of companies;
- targeting of smaller businesses through trade associations; shopping centre managers and waste collection companies.

For industrial waste streams, policies have focussed on larger companies and industry chains including:

- focus on improving information transfer on prevention, the granting of licenses and enforcement;
- use of levies to stimulate the efficient use of raw materials.
For the building and renovation sector, the environment has been included under the building decree. The ‘Sustainable Building Program’ also promotes sustainable chain management.

5.5 Waste Separation

Implicit in the National Waste Management Plan is the assumption that in order to achieve the greatest possible reuse and recycling it is necessary to keep the waste separate immediately after it is created. This is believed to produces the purest waste and is therefore the easiest to reuse or recycle.

Reusable and recyclable components can be acquired through post-separation of integrated residual waste streams. However, these represent only a limited number of substances, for instance construction and demolition waste.

The policy with respect to waste separation at the source will continue unabated in the 2017-23 plan and will be intensified for two specific target groups, consumers and the trade, services and the government sector.

Households

The government has mandated the wastes that have to be separated by householders:

- organic household waste;
- paper and board;
- glass;
- textiles;
- white and brown goods;
- minor chemical waste; and
- components from bulky household waste (such as bulky garden waste and household construction and demolition waste, including impregnated wood).

Waste collection targets include:

- household organic waste: 55%
- paper and board: 75%
- glass returnable: 90%
- textiles: 50%
- white and brown goods: 90%
- minor chemical waste: 90%

To support householder separation, the Dutch government has established the Incentive Programme for Waste Separation and Prevention of Household Waste (STAP).³¹

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²⁹ Local authorities are also responsible for the collection of bulky household waste. In this context, among other things they must ensure that there is at least one place within the municipality, or within the municipalities with which it cooperates, where individuals can bring items of bulky waste.


³¹ Ibid
The programme encompasses a large number of projects designed to stimulate waste separation and prevention. It is updated annually. Priority areas included in the program include:

- Facilitation: The exchange of knowledge, but also financial support to assist local authorities in improving waste collection (subsidy scheme for reducing environmental pressure);
- Monitoring and benchmarking: providing information about local results and costs;
- Communication: Waste separation and prevention depend on public support. Increased and more effective communication will be used to stimulate waste separation and prevention both locally and nationally.

The national framework of programs and targets allows flexibility for provinces and local authorities to take their own initiatives with respect to waste separation at the source. Local authorities have the authority to exempt parts of their territory from the requirement to separately collect specific waste streams where local conditions inhibit the realisation of the targets.

**Waste separation by companies**

Companies are obliged to separate all waste, to keep it separated and to dispose of it separately unless that is an unreasonable demand.

Obligations and guidelines have been established for waste separation by companies. The guidelines establish the minimum volume of waste (by material type) where source separation must be undertaken.

Obligations have also been established for business-specific waste, such as waste products (bread industry, fishing industry), construction and demolition waste, process waste in industrial sectors, incontinence materials in hospitals etc. These individual waste streams are relatively homogeneous and, at source, are clean types of waste that can be released in larger quantities and in concentrated forms. Implementing waste separation strategies at source should deliver improved waste outcomes.

Hazardous wastes, paper and board and white and brown goods must always be separated, kept separate and disposed of separately.

**5.6 Waste Recovery**

The National Waste Management Plan aims to utilise as much as possible of the energy stored in waste that is not or cannot be recycled or reused. The strategy follows a waste hierarchy approach, with the first preference to avoid creating waste as much as possible, then recover usable and valuable raw materials and generate energy by incinerating residual waste, before landfilling. Thermal energy from waste therefore continues to be a key recovery policy for residual waste in the Netherlands.32

**5.6.1 Plastics and packaging waste**

Packaging waste is commonly collected by municipalities by door-to-door or kerbside collection. Throughout Amsterdam, residents are able to recycle plastic packaging by depositing it for collection in specialised containers.

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In 2014, 50% of packaging plastics was recycled. A challenge for both the Dutch and Danish waste industries is that the incineration of plastic waste produces up to three times more energy than any other materials. Improvements in recycling decreases the volume of plastic waste from and lowers the energy output, increasing incineration costs and reducing the effectiveness of the return.

This creates a disincentive to recycle plastics for the waste to energy plants that are commonly owned by municipal authorities.

5.7 Roles and responsibilities

5.7.1 Powers and duties of local authorities
The powers and duties of local authorities include:

• collection, separation or otherwise, of household waste;
• taking steps to optimise the prevention and separation of household waste;
• granting exemptions for the incineration of waste outside establishments;
• ensuring that the regulations governing waste prevention and waste separation (licensing and enforcement) are at a sufficient level in establishments for which local authorities are the competent authority;
• undertaking incentive activities to give sufficient substance to the regulatory framework.

5.7.2 Responsibilities of the business community

Businesses are responsible for preventing the generation of waste and for its proper management. These obligations are derived from provisions relevant to businesses under the Environmental Management Act, including the duty of care, specific regulations and licences. Statutory regulations and regulations based on licences impose positive obligations on business with respect to their waste management practices. Businesses are also expected to utilise the potential for shaping waste prevention and waste management as effectively as possible.

Producers have a role in the management of their products at the waste stage via regulations or producer responsibility agreements.

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35 Approximately 75% of establishments in the Netherlands are covered by rules (Orders in Council under Section 8.40 of the Environmental Management Act) where the local government authorities are generally the competent authority.
5.7.3 Responsibilities of private citizens

Citizens also have a duty of care arising from the Environmental Management Act. As consumers, citizens are responsible for preventing the generation of waste and facilitating sound waste management:

- Citizens need to be aware of the environmental consequences of their conduct and to endeavour to conduct themselves in a manner that results in the least possible waste.
- Citizens are required to keep waste separate and present it for collection in the manner required by their local authority.

5.8 Data

The Central Bureau of Statistics, Netherlands (CBS) provides high level data on waste management at a national level. This data is collected on an annual basis. The Dutch Government has a CBS data portal, which provides information on all available data sets. Datasets are also available on the Dutch National Data Portal. The method for collection of data presented on the CBS portal is not disclosed.

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6 San Francisco

6.1 History and background

In the 1980s, the San Francisco Recycling Program (SFRP) was implemented throughout the city. Buy-back centres and kerbside recycling programs were initially implemented. In 1986, California’s Bottle Bill (AB2020) was implemented and community recycling centers began offering monetary compensation for recovered materials, similar to a container deposit scheme. The City formed an advisory council to help design additional residential kerbside programs, bar and restaurant glass collection programs and city government office paper recycling.39

In 1988, San Francisco’s Solid Waste Management Program set a diversion goal of a 32% reduction in the City’s waste stream by 1992 and 43% by 2002. In 1989, the Integrated Waste Management Act (AB 939), preempted San Francisco’s goals by setting waste reduction goals of 25% by 1995 and 50% by 2000. The Integrated Waste Management Act required cities and counties to reduce, reuse, and recycle solid waste generated in the state to the maximum extent feasible before incineration or landfill disposal.

By 1989, kerbside pilot programs were collecting mixed paper and containers (glass, aluminum and plastic).40 This program was fully operational by 1991, delivering a 27% diversion rate by 1990.41 Whilst significant improvements had been achieved, studies indicated that a significant portion of unrecovered recyclables remained in the waste stream. San Francisco developed new kerbside recycling pilots that included the collection of food residuals.42

In 1999, a color-coded collection system was implemented for business and households. The program included financial incentives, with savings realised if their residual waste volumes decreased. The new program helped achieve a 50% diversion rate.43 44

Based on the success achieved, the City elected to pursue higher diversion rates than those required by the state. The 1997 Sustainability Plan included a long-term goal “to maximize sustainable uses of natural resources and to eliminate solid waste generation in the City and County of San Francisco.”45

Alameda County set a goal of achieving a 75% waste diversion rate by 2010. As a condition of the Waste Disposal Agreement for disposing San Francisco waste in the Altamont Landfill in Alameda County, the City was required to recycle or divert waste at the same or greater level than that of Alameda County.46 As a result, a Zero Waste Goal was implemented in 2002,
requiring San Francisco to divert 75% of its waste by 2010 and to achieve zero waste by 2020.\textsuperscript{47}

\section*{6.2 Current Policy Settings and Levers\textsuperscript{48}}

San Francisco’s waste programs and strategies are localised,\textsuperscript{49} tailored to the population and consumer behaviour and designed around waste service provider Recology. In the absence of a formalised ‘strategy’, San Francisco Environment have released zero waste commitments, a declaration and goals.

San Francisco Environment (SF Environment) is the city department responsible for regulating waste management. SF Environment is driving an ambitious environmental policy to achieve 100% diversion of waste from landfill by 2020. The ‘zero waste’ target is the most ambitious in the benchmarking group.

SF Environment states that ‘zero waste means that we send zero discards to the landfill or high temperature destruction’, effectively eliminating incineration as a treatment option\textsuperscript{50}. In addition to this target, there are a number of ordinances that mandate audits of large refuse generators, as well as mandating citizens to separate recyclables, compostable and landfill bound waste.\textsuperscript{51}

San Francisco’s Zero Waste Program is entirely funded by revenue generated from refuse rates charged to customers. This revenue sustains collections, processing, disposal, hazardous waste collections, all outreach and marketing materials as well as other programs.\textsuperscript{52}

Focusing on the zero waste goal, San Francisco works with major waste provider Recology to ensure that waste generation is reduced, products are recycled or reused and that waste is diverted from landfill.

San Francisco’s waste targets have been in place since 2004. The initial target of 75% diversion from landfill was achieved by 2010.

\section*{6.3 Policy Levers}

San Francisco has a robust legislative framework and a series of financial incentives to encourage citizens to recycle responsibly and reduce waste creation. Critical to San Francisco’s success in turning around its waste management system, was a coordinated approach across government that prioritised waste prevention, recycling and reuse. Zero waste objectives were supported by public policy that saw a shift from landfill and incineration to an increase in landfill levies, a ‘pay as you throw’ (PAYT) scheme and a strong anti-incineration mentality. Policies have also enforced a culture of waste separation.

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\textsuperscript{48} Information in this section is largely drawn from the SF Environment website. SF Environment (2019). Sourced from: https://sfenvironment.org/

\textsuperscript{49} Subject to complying with legislation from the national and Californian state government.


\textsuperscript{51} ibid

\end{flushleft}
6.3.1 Mandatory (Universal) Recycling Ordinance

In 2009, the city passed the ‘Mandatory Recycling Ordinance’, requiring all of San Francisco to separate recyclable materials, compostable materials and landfilled trash. This Ordinance covers both municipal waste and commercial/industrial waste.

6.3.2 PAYT Scheme

San Francisco has introduced a PAYT scheme. This scheme incentivises residents and businesses to recycle and compost more. Refuse rates are higher for landfill waste and lower for recycling and composting. Bins offered to residents are a 32 gallon (121 kg) composting bin, 64 gallon (242 kg) recycling bin and a 16 gallon (61 kg) landfill bin. Residents are able to customise their service levels (frequency of collection) and container sizes (small residual waste bins attract lower fees). Rates differ for single unit dwellings, multi-unit dwellings and commercial businesses.

If a household switches from a 32-gallon trash bin to a smaller one, the monthly rate decreases, providing an incentive to recycle and compost more. However, if the 32-gallon bin is too small and some waste is left beside the bin, the household will receive a fine. This also applies to contamination in the recycling bins because it prevents users from throwing every type of trash into the recycling bin. Apartment buildings that sort materials correctly into recycling, composting and landfill bins qualify for a diversion discount.

The discount is determined by the service frequency and volume with the potential to receive a 75% discount off the monthly bill. Commercial rates are based on service configurations, frequency of collection and site-specific diversion rates.

6.3.3 Single Use Plastic Bag Ban

The 2007 Plastic Bag Reduction Ordinance banned the thinnest type of plastic shopping bags and required the use of compostable plastic, recyclable paper and/or reusable checkout bags by supermarkets and drugstores.

The 2007 ordinance specified two different classes of materials for reusable bags. The first class of materials was “cloth or machine washable material.” The second class of material was “durable plastic that is at least 2.25 mils thick.”

In 2012 San Francisco expanded the bag ordinance to further reduce waste, litter and other bag impacts. Key policy levers implemented included:

- a ten cent fee on carry out bags;
- expansion of stores covered by the ban and fee to include all retail establishments in the city;
- extension of the law to apply to food establishments, including fast food, however, certain exemptions remained in place (e.g. bags intended prescription drugs);
- amending the definition of a reusable bag, specifying that a bag must be made for at least 125 uses, carrying 22 pounds over a distance of 175 feet. It also made bags subject to provisions in the California Toxics in Packaging Prevention Act.

The ban is expected to reduce overall bag use in San Francisco by 70% to 90%.

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6.3.4 Food Service Waste Reduction Ordinance

Implemented in 2006, the ordinance requires all food vendors and restaurants in San Francisco to use compostable or recyclable takeaway containers. Food vendors are prohibited from using polystyrene foam containers. Compostable products include paper or plant fibre and PLA\(^55\) plastics\(^56\).

6.3.5 Zero Waste Textile Initiative

The Zero Waste Textile Initiative aims to provide a means to recycle unwanted textiles rather than sending to landfill. Textile waste comprised 3.4% of the city's total waste stream—making it one of the top 10 landfilled materials. Clothes, linens and rags are accepted recycling in the blue kerbside recycling bin. Clothing that is in good condition, as well as shoes and bags are taken to local reuse and recycling sites. \(^57\)

The San Francisco model has been adopted by other pilot programs. \(^58\) In one program the scheme organiser and its retail partners set up collection bins at retail stores, apartment complexes, schools and public buildings around the city and began awareness campaigns to encourage residents to recycle their clothes and footwear. The scheme worked with third party sorters and graders to break them into 400 different categories to allocate as second-hand clothing, reuse as cloths, recycled into fibres and paddings, or upcycled into a product of equal or higher quality.

Whilst textile fibres can be recycled, they shorten and degrade when they are recycled. Recycled fibres therefore have to be combined with virgin materials.

6.3.6 Construction and Demolition Debris Recovery Ordinance

The Construction and Demolition Ordinance took effect in July 2006. This Ordinance requires that all C&D material removed from a project must be recycled or reused. No C&D debris can be taken to landfill or put in the garbage. The ordinance applies to all C&D work that occurs in San Francisco. There are significant penalties if parties do not comply with ordinance, including civil and or criminal penalties, fines and suspension of registration. \(^59\)

All debris is to be sorted at the job site for reuse or recycling (metal, wood, drywall, cardboard, concrete etc.) and must be taken to a facility that reuses or recycles the materials. All mixed debris must be transported off-site by a Registered Transporter and taken to a Registered Facility that processes all loads containing mixed debris.

The full demolition of an existing structure requires a Demolition Debris Recovery Plan that is submitted to the Department of Environment before a permit is issued and the work can be undertaken\(^60\).

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\(^{55}\) Polylactic acid or polylactide (PLA) is a biodegradable and bioactive thermoplastic aliphatic polyester derived from renewable resources, such as corn starch, cassava roots, or sugarcane.


\(^{57}\) SF Environment (2019). Recycle Your Clothes, Linens, and Rags (Textiles). Sourced from: https://sfenvironment.org/textiles


6.3.7 Event recycling and Composting Requirement
Every event held in San Francisco is required to offer the three bin kerbside options – landfill, compost and recycling bins. Special events must include a recycling plan in permit applications. Zero Waste Training is offered by the Department of Environment to ensure that all information is available to adhere to policy requirements.

6.3.8 Cigarette Litter Abatement Ordinance
A charge of 20 cents per pack of cigarettes sold in San Francisco has been imposed to recover the cost of abating cigarette litter from streets, sidewalks and other public property. Failure to comply with this ordinance can result in the suspension of a tobacco sales permit and imposition of a fine.

6.4 Waste Generation
Waste generation is remarkably difficult to quantify in San Francisco. As will be explained further below, very little data is published regarding how much waste is generated, how it is treated and the quantity of waste that is recycled, recovered for energy and landfilled. Sources such as news reports indicate that San Francisco produces around 476,424 tonnes of waste for disposal.

6.5 Waste Prevention
San Francisco’s approach to managing waste is still somewhat immature in the development of strategies through all levels of the waste hierarchy. Existing policy settings focus heavily on the end of the waste cycle and the disposal or recycling of waste as opposed to the beginning on waste reduction or prevention including through product design.

Research indicates that strong industry lobbying has hindered San Francisco’s ability to regulate more tightly the product design and prevention of waste element of the circular economy. Industry pressure was evident at the time of the Single Use Plastic Bag ban, with a legal action brought against the City.

6.6 Waste Treatment
San Francisco is an example of significant and rapid change in waste management system and performance. From 2004 to 2010, San Francisco achieved an 80% diversion of waste from landfill. The strong regulatory framework and unique partnership with a single waste management provider Recology, in addition to frequent and well-tailored education campaigns had delivered significant progress for the city.

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The city’s success in diverting waste, is potentially debatable with diversion calculations often obscuring the amount of waste generated. San Francisco is quite unique in the benchmarking group for the arrangement it has with private company, Recology, to manage the city’s waste. Instead of a contract, Recology and San Francisco are subject to a long term ordinance where the City sets and approves the fees payable. This model of service delivery will be further discussed in chapter 12 and warrants careful and cautious consideration at the State and Local Government level in NSW.

San Francisco’s 1932 Refuse Ordinance regulates collectors of discarded materials through 97 exclusive permits. Over time, Recology has bought all permits resulting in the company becoming the exclusive collector of discarded material within the city.

Municipal solid waste

The three bin kerbside collection program is supported by Recology. Whilst successful for single unit dwellings, this collection program has proved a challenge for apartment blocks in the city with a single waste disposal chute. The city has recently passed legislation to ensure that all new builds have a three chute system.

Recology recovers over 272 million kilograms of recyclables each year. Recently, Recology has focused on improving the recycling of ‘film’ plastics, developing technology to process and treat soft plastic waste.

In 1996 Recology designed and built the first large scale composting facility in California. The compost created via anaerobic digestion is distributed to local agricultural industries, such as the wine region of Napa Valley. 65

Recology utilises optical sorting to sort like plastics which are then sold to processors of recyclables in America.

Commercial & Industrial

Food and organic waste is a significant component of all C&I waste produced. Recology has a number of programs to support businesses to reduce their food waste and remain compliant with the city’s regulations. An example of this is the Recology Grocery Division. The Division provides large and small grocers throughout California with an organics collection, hauling, staff training and consulting services to ensure that they are compliant.

All of San Francisco’s organic waste is transported by road to Jepson Prairie Organics (JPO), in Vacaville California. This company, owned by Recology, is one of the largest food scrap composting operations in the United States. JPO processes approximately 100, 000 tonnes of organic material from San Francisco and surrounding communities annually.66 Five different products are produced, a premium compost which is used by organic farmers and vineyards in the area, a super organic compost which is favoured by nurseries, JPO topsoil, Ultra Potting Mix and customised blends for growers.67


6.7 Data

San Francisco presents data on waste management in diversion rates. San Francisco Environment do not publish any information on the various treatment streams of waste, nor Recology the private partner. It is therefore challenging to find accurate data on waste generated, recycled and recovered (by waste stream and by material type) in San Francisco.

San Francisco reports its ‘diversion rate’ being the ‘the percentage of total waste that is diverted from disposal at permitted landfills and transformation facilities (such as incineration) and instead is directed to reduction, re-use, recycling and composting’. 68

Whilst diversion rates are effective in determining the amount of waste that is recycled or recovered and not sent to landfill, diversion rates fail to focus on the front-end or beginning of the waste cycle, such as measuring the impact of preventative measures, recycling initiatives and behavioural change. Therefore, in terms of a zero waste measurement, diversion rates fail to measure the full picture of activity that is achieving the zero waste goal. 69

Information that has been provided is from CalRecycle, California’s data warehouse waste manager. Certain sets of data are estimates. 70

Figure 5: San Francisco Waste disposal volumes

Source: CalRecycle. (2019). Multi-year Countywide Destination Summary. 71

The data in Figure 5 provides an estimate of the amount of material in San Francisco’s waste stream.

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68 Zaman et al have presented a Zero Waste Index that not only measures the diversion of waste from landfill and incineration, but also measures the potential use and sustainability of raw materials within the waste cycle. Zaman, A. (2013). The Zero Waste Index: a performance measurement tool for waste management systems in a ‘zero waste city’. Journal of Cleaner Production (50), 123-132.

69 Zaman et al have presented a Zero Waste Index that not only measures the diversion of waste from landfill and incineration, but also measures the potential use and sustainability of raw materials within the waste cycle. Zaman, A. (2013). The Zero Waste Index: a performance measurement tool for waste management systems in a ‘zero waste city’. Journal of Cleaner Production (50), 123-132.


71 https://www2.calrecycle.ca.gov/LGCentral/DisposalReporting/Destination/CountywideSummary (disposal refers to all waste generated in the San Francisco jurisdiction which is disposed at an approved CalRecycle landfill)
San Francisco claims an 80% diversion rate, superior to comparable cities worldwide. However, debate exists as to how this figure is calculated\(^{72}\). San Francisco takes into account glass, paper, plastic, metal, organic material and heavy construction material recycling. In terms of tonnage, construction material diversion represents a large part of the total amount of waste diverted. Factoring it into the diversion rate calculation does not necessarily give a fair assessment of the effectiveness of policy efforts across households and business. Diversion rates also fail to capture whether the total amount of waste being produced is reducing, and therefore whether efforts to ‘prevent’ waste have been successful.

7 Scotland

7.1 History and background

Scotland and the UK more broadly has relied on landfill as the primary disposal method for waste. Landfilling was the most cost-effective option. As the negative consequences of landfill such as significant CO2 emissions, a soaring population growth and an unavailability of land became more prominent, the Government turned to financial instruments to de-incentivise landfill. The introduction of a landfill tax in 1996 by the UK Government (addressed under current policy settings in Section 7.3.6) and current policy settings act as a deterrent to landfilling.

The introduction of the European Union Landfill Directive in 1999 set targets for all member states to reduce the amount of biodegradable municipal waste disposed to landfill. This resulted in changes in waste management in the UK and increases in the recycling of waste. Scotland’s response to the Landfill Directive was set out in the 1999 National Waste Strategy. The strategy focussed on:

- Sustainability – meeting the needs of the present without compromising the ability of future generations;
- Self-sufficiency and the proximity principle – waste should be managed and disposed of as close as practicable to where it is generated;
- The waste hierarchy – to move as close as possible to the top of the hierarchy by minimising the waste generated, reusing waste materials, recycling, and where this is not possible, disposing of waste in ways that unlock or recover energy;
- Best Practicable Environmental Option – a method of option appraisal used to examine the best way of dealing with various types of waste in the light of social, environmental, economic, practicality and other policy issues.

Since 1999, various developments have been taken forward in the National Waste Strategy:

- 2003: following an extensive consultation process, the National Waste Plan was issued. The plan established the direction of the Executive’s policies for sustainable waste management to 2020, built around a major funding commitment to transform Scotland’s record on waste reduction, recycling, composting and recovery;
- 2003: Separate Waste Collection Systems – Best Practice Review. The findings from this study provide best practice guidance for the development of separate waste collection systems in Scotland;
- 2004: new recycling targets were established for councils. Targets for recycling/composting municipal waste were extended to 30% by 2008;
- 2006: Publication of Strategic Outline Cases for the treatment of residual waste in six areas of Scotland.
- 2007: Way forward for recycling – provided funding for residual waste treatment;

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With this background Scotland has also implemented a range of other policy settings to encourage resource recovery, outlined below.

7.2 Current Policy Settings and Levers

7.2.1 Waste (Scotland) Regulations 2012

In 2012, Scotland implemented a revised set of waste regulations. The main policy drivers for the revised regulations were:

• Waste Framework Directive (2008/98/EC); and

• Scotland’s Zero Waste Plan.

The regulations are intended to:

• maximise the quantity and quality of materials available for recycling and minimise the need for residual waste treatment capacity;

• move residual waste management up the waste hierarchy (away from landfill) so as to extract resource value (energy and heat) from those materials that can’t be recycled;

• drive operational and cultural shifts in how waste is managed, including improved services to households and businesses; and

• create the market certainty needed to support investment by businesses in the recycling, materials reprocessing and waste management sector.

Specific measures introduced by the Regulations include:

• a requirement to remove key recyclables (plastics and metals) from mixed waste prior to incineration (from 1 July 2012);

• a requirement for businesses to present dry recyclables (metals, plastics, paper, card and glass) and food waste of more than 50 kg/week for collection from end of 2013, with those producing less than 50kg/week exempt until end 2015;

• businesses involved in food manufacture, preparation or retail are required to separate food waste for recycling if they produce more than 5 kg of food waste a week;

• a requirement on local authorities to provide householders with a collection service for dry recyclables (end 2013) and food waste and organics (end 2015);

• from January 2021, a ban on waste management providers landfilling or incinerating recyclable materials which have been separated at source; and

• a ban on materials collected separately for recycling going to landfill or incineration (end 2013);

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75 The Waste Framework Directive is a European Union Directive of 17 June 2008. The aim of the WFD was to establish the basis to turn the EU into a recycling society.

• a requirement for operators of incineration facilities to remove key recyclables from waste prior to incineration (metal, plastic, glass, paper, card and food);
• a ban on biodegradable municipal waste going to landfill, thus helping to substantially reduce harmful emissions of methane (from 2021); and
• a minimum 60% household recycling rate by 2020.

The regulations recognised the unique challenges for collecting and managing waste in areas challenged by significant distances and travel times with consequential increases in the financial costs of waste collection and recycling and the carbon costs from vehicle emissions. As a result the regulations included certain exemptions in “rural areas”, including an exemption for businesses presenting food waste for collection.

**Phased implementation**

A phased approach was taken to implementing the key measures in the regulations. The implementation strategy:

• ensured that there was sufficient time for businesses, particularly small businesses, to adopt new recycling services;
• there was sufficient time for engagement with the public and business prior to the roll out of new recycling services;
• allowed improved levels of recycling to be stimulated prior to banning material from landfill and to help ensure that the need for residual waste treatment infrastructure capacity in Scotland was kept to a minimum.

**Domestic recycling**

The regulations included measures to require those producing or managing waste to take steps to promote higher quality recyclable materials. This requirement recognised an increased likelihood that materials would be recycled in Scotland, supporting the local economy and insulating industry from global fluctuations and unpredictable future quality demands.

Similarities exist between the needs of the Scottish recycling sector and issues currently faced by recyclers in NSW.

### 7.2.2 Zero Waste Plan and Making Things Last: a Circular Economy for Scotland

In 2010, Scotland released a Zero Waste Plan which set out a vision for a Scotland where resource use is minimised, valuable resources are not disposed of in landfills, most waste is sorted into separate streams for reprocessing, leaving only limited amounts of waste to go to residual waste treatment, including energy from waste facilities.
The regulations discussed in Section 7.2.1 set in place statutory measures to support delivery of the Zero Waste Plan.

Key actions under the Zero Waste Plan include:

- improving resource efficiency through actions such as discouraging use of single-use materials;
- taking action to reduce and recycle food waste;
- introducing a deposit return scheme for drinks containers;
- implement progressive bans on the types of waste that can be disposed of in landfill;
- introducing a carbon metric for waste;
- implement sector-specific programs of work;
- supporting delivery partners to tackle litter and flytipping (illegal dumping);
- taking advice from the Expert Panel on Environmental Charging and other measures;
- funding Zero Waste Scotland to deliver waste-reducing initiatives;
- funding SEPA to regulate on the treatment and disposal of waste; and
- delivering the New Plastics Economy global commitment.

An economic assessment of the plan found that delivering the proposed regulations would benefit the Scottish economy by £178 million by 2025, and deliver annual greenhouse gas savings equivalent to taking nearly 800,000 cars of the road.\textsuperscript{81}

In 2018, Scotland released ‘Making Things Last: a Circular Economy for Scotland’\textsuperscript{82}. In Scotland’s terms, a circular economy means minimising the population’s demand on primary resources or raw materials, and maximising the reuse, recycling and recovery of resources, rather than treating them as waste\textsuperscript{83}. The Strategy articulates the following targets to be achieved by 2025, including:

- Reduce total waste arising in Scotland by 15\% against 2011 levels
- Reduce food waste by 33\% against 2013 levels
- Recycle/compost 70\% of waste, preparing for re-use
- Send no more than 5\% of remaining waste to landfill.\textsuperscript{84}

The Ellen McArthur Foundation prepared a report for the Scottish Government to support the development of the Strategy. The Foundation outlined the importance of recognising current treatment methods and indicating whether these methods would remain relevant in the


\textsuperscript{84} Ibid
context of a circular economy. The figure below represents the transition to a circular economy.\textsuperscript{85}

\textbf{Figure 6: Circular Economy Approach}\textsuperscript{86}

In this Strategy, the Scottish Government committed to the following actions to aid the transition to a Circular Economy:

- A statutory ban on biodegradable municipal waste going to landfill;
- Regulating the waste-to-energy sector to ensure that the infrastructure is effective in managing the ‘leak’ from a more circular approach;
- Convene an international group of experts on producer responsibility to develop a formalised framework for implementation across Scotland;

Scotland has introduced a Household Recycling Charter and Code of Practice for MRFs to improve the rate of contamination of recyclables and improve the quality of recyclates.\textsuperscript{87}

Scotland’s strategy proposes that Scottish products be designed with their full life-cycle in mind, for long lifetimes, ready to be disassembled and repaired, and eventually recycled. The strategy seeks companies to redesign their business approaches to find ways to keep hold of valuable products and components.\textsuperscript{88}


\textsuperscript{86} Ibid


\textsuperscript{88} Ibid
7.3 Policy Levers

7.3.1 Resource Efficient Scotland

Resource Efficient Scotland, was launched in 2013. The programme offers free advice and technical support as well as the sharing of best practices and new technologies. Programs include:

- tools for business to assist with measuring and tracking waste;
- guidance on how to reduce waste bills and boost your business profile at the same time.
- support with developing waste prevention plans;
- programs targeting the prevention of waste in construction: tools, guides and support to the construction industry to help reduce the amount of construction waste sent to landfill;
- reducing food waste in the food and drink industry;
- improving waste management: guide to help businesses identify and implement collaborative waste management improvement opportunities.

7.3.2 Single-use materials

Research indicates that single use materials are an inefficient use of resources. The Scottish Government’s approach is to shift behaviour in Scotland away from single-use materials completely, rather than displace activity into alternative single-use materials. The Scottish Government has banned single-use hot drinks cups in all Scottish Government buildings (preventing 450,000 cups being thrown away per year). Furthermore, in 2018, the Government of Scotland announced a sale and manufacturing ban of single-use plastic cotton buds.

7.3.3 Biodegradable Municipal Landfill Ban and Organic Waste

Scotland has a target to reduce all food waste arising in Scotland by 33% by 2025. Policy actions primarily focus on prevention and does not include food waste recycling. Actions are grouped under four themes:

- business and organisations showing leadership;
- empowering people to make better choices;
- areas where product standards and regulations may be applicable; and
- technology and innovation to avoid or add value to wastes.

The Scottish Government announced in April 2018 a ban on all biodegradable food waste going to landfill from 2021. This was a significant policy announcement and lever, differing to other parts of the UK. The announcement has seen a small increase in waste to energy infrastructure to manage the biodegradable waste. However, most Local Authorities have not

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yet acted upon this and are likely to be non-compliant in 2021. The Scottish Government is currently investigating how to work with Local Authorities to ensure compliance and develop necessary infrastructure to manage biodegradable waste. Guidance from SEPA states that biodegradable waste will be accepted into landfills after it has been treated by incineration and MBT.

Industry food waste

SEPA has established regulations to ensure that the biggest food businesses recycle their food waste. The Waste (Scotland) Regulations 2012 initially required all food businesses generating more than 50 kilograms in non-rural areas to recycle their food waste. In 2016 this requirement was extended to those generating more than 5 kilograms.

7.3.4 Container deposit return scheme

Scotland is in the process of implementing a container deposit scheme with the objectives of:

- increasing the quantity of target materials captured for recycling;
- improving the quality of material captured, to allow for high-value recycling;
- encouraging wider behaviour changes in the uses of materials; and
- delivering the maximum economic and social benefit for Scotland.

The consultation process on the scheme design and feedback is being analysed.

7.3.5 Carbon Metric

Scotland has made a move away from utilising weight-based recycling targets. Whilst these targets have been useful in driving performance to date, weighing in tonnage fails to measure the particular materials that have the greatest environmental value.

Scotland has developed a ‘carbon metric’ to measure whole-life carbon impacts of Scotland’s waste from resource extraction, manufacturing through to end-of-life management. The carbon metric involves using the tonnage diversion levels, and then weighting them by applying a carbon factors to the materials collected. This carbon factor takes into account the environmental benefits of recycling over landfill.

The metric has led to policy decisions such as Scotland’s 33% per capita food waste reduction target.

7.3.6 Scottish Landfill Tax

This is a tax on the disposal of waste to landfill. The tax is charged by weight and is based on two rates, a standard rate for active materials and a lower rate for less polluting materials (inert). Operators of landfill sites are liable for the tax and this cost is passed on to the local authorities and businesses who dispose of waste at the landfill sites. Revenue Scotland administers the tax alongside SEPA. As of April 1 2018, the standard rate is £88.95 per tonne.

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and a lower rate of £2.80 per tonne. This tax provides revenue of around £100 million per year, however this is declining.

7.3.7 Single use carrier bags

In 2014, the Single Use Carrier Bag Regulation was introduced and introduced a minimum charge of 5 pence for each new single-use carrier bag. The charge applies to all single-use bags including those made of paper, plastic and some plant-based materials.

The regulation has been estimated to have reduced carrier bag use by 80% in its first year of operation.

7.4 Waste Generation

Scotland’s total waste generation declined by 11% between 2011 and 2016. As shown in the figure below, waste generation rates in Scotland have declined by 4% between 2011 and 2016 in the household and construction and demolition waste streams. Commercial and Industrial waste generation declined by 23% over the same period. As in NSW, the largest source of waste is the construction and demolition stream.

Figure 7: Waste generation by stream – Scotland

Recycling and recovery rates have been increasing in recent years, particularly in the Construction and Demolition and Commercial and Industrial waste streams. This reflects efforts from the UK and Scottish governments to improve resource sustainability and recovery of material for recycling, as discussed above.

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96 Ibid

Table 2: Waste Generation by Treatment Stream – Scotland

<table>
<thead>
<tr>
<th>Scotland – Treatment (‘000 tonnes)</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Waste Generated</td>
<td>11,317</td>
<td>10,785</td>
</tr>
<tr>
<td>Disposed</td>
<td>4,360</td>
<td>3,867</td>
</tr>
<tr>
<td>Disposed (%)</td>
<td>39%</td>
<td>36%</td>
</tr>
<tr>
<td>Recovered</td>
<td>647</td>
<td>770</td>
</tr>
<tr>
<td>Recovered (%)</td>
<td>6%</td>
<td>7%</td>
</tr>
<tr>
<td>Recycled</td>
<td>6,474</td>
<td>7,155</td>
</tr>
<tr>
<td>Recycled (%)</td>
<td>57%</td>
<td>66%</td>
</tr>
</tbody>
</table>

Note: waste generated will not add up to 100%. Local authorities often store waste in the interim prior to final recycling, disposal or recovery. This data does not include amount of waste that is in interim storage. Source: Scotland’s Environment. (2019). Scotland’s Environment Waste Discover Data Tool. Sourced from: https://www.environment.gov.scot/data/data-analysis/waste-from-all-sources/

7.5 Waste Prevention

Scotland’s waste prevention target, articulated in the Strategy for a Circular Economy is a significant step forward and commitment to reduce waste. Although the target only suggests a 15% reduction, this will require a significant change in consumer behaviour to achieve. Scotland is working with Zero Waste Scotland to address this target. As noted previously, two key initiatives of the Scottish Government to prevent waste are the implementation of a producer responsibility scheme and the consideration of a deposit return scheme (Section 7.3.4).

7.5.1 Producer Responsibility

Producer responsibility schemes have been introduced in the UK without extending financial responsibility, in full, to producers. Scotland is subject to UK-wide producer responsibility schemes.

- Waste Electrical and Electronic Equipment (WEEE)
- End of life vehicles

Producers’ Responsibility Obligations (Packaging Waste) Regulations

In 2007, Scotland introduced the Producers’ Responsibility Obligations (Packaging Waste) Regulations which provide a statutory framework by which the UK meets the minimum recovery and recycling targets on the European Commission’s Directive on Packaging and Packaging Waste.

The obligations place legal obligations on most companies who have a turnover exceeding two million pounds and handle more than 50 tonnes of packaging and packaging materials each year. Producers are required to register and submit data to SEPA (Scottish Environment Protect Authority) every year and have specific recycling and recovery obligations.

The UK also operates a unique market-based Extended Producer Responsibility scheme for packaging. All members of the packaging chain, including manufacturers, converters, packers and sellers, must register if they handle over 50 tonnes of packaging annually.

Producers must purchase a set number of Packaging Waste Recovery Notes (PRNs) from re-processors, which serves as evidence that their packaging has been recycled. The proportion of material required to be recycled is linked to the performance and weight of the packaging material.

The packaging charge income funds the Environment Agency’s compliance work with producers, reprocessors and exporters. It also funds their work to identify packaging producers.
who are non-compliant. The Environment Agency monitors producers to assess their compliance and takes enforcement action if necessary.

Several deficiencies have been identified in respect to the responsibility program, including whether waste materials are actually being recycled, rather than being exported and stockpiled overseas.

7.6 Waste Separation

Household waste collection in Scotland is the responsibility of local councils, many of which are taking efforts to improve the sorting of waste at source. Edinburgh Council, for example, provides several different kerbside bins for residents to dispose of their waste. There is a mixed waste bin, a food and organics waste bin, a paper waste bin and recycling bin (packaging, glass and textiles). It is also possible to request bins for electrical and hazardous waste. Citizens may also request a ‘bulky’ uplift from the Council. For cities such as Glasgow and Edinburgh, the main challenge for kerbside collection is with tenement flats. To address the lack of easy waste disposal solutions for tenement flats, Edinburgh and Glasgow councils provide large bins for each waste stream which stay on the streets. Over time the frequency of collection for the general waste bin has been reduced to encourage consumers to extract as much recycling and food waste from their bins as possible. Overall, consumers have demonstrated successful waste separation habits despite the challenges associated with tenement flats.

Aberdeen Council provides a refuse (landfill) waste bin, a recycling bin, an outdoor food bin and an indoor food caddy and a small bag for battery disposal. Both councils are seeking to reach the national government’s target of 60% of household waste being recycled by 2020.

Recycling centres are also accessible to the public for extra recycling or bulky items. Most councils, such as Aberdeen do not provide a kerbside collection service for glass. Residents are encouraged to drop their glass at a Recycling Point throughout their local council area.

As in NSW, material recovery facilities in Scotland play a key role in sorting mixed recyclables for processing. Usually recyclables will be separated from residual waste which is then either sent to landfill or for thermal treatment (energy from waste).

In the C&I sector, food wastage is a significant issue for Scotland. A Zero Waste Report found that 1.35 million tonnes of food was waste in Scotland in 2013. Of this, 740 000 tonnes were from the C&I sector. The Scottish government has committed to reducing the 2013 baseline figure by 33% by 2025. The Waste Scotland Regulations (2012) identify producers of food as having a ‘duty of care’, and that waste is to be separately collected where possible. As noted above, businesses that produce over 5kg of food waste a week must segregate the food waste from general waste and present it for collection.

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Stakeholder consultations have informed on the success of various kerbside collection schemes. Scottish consumers lobbied their local authorities for separate collection for recycling, paper and food and organic waste, in the wake of Europe’s recycling success. The success of consumers in source separating and recycling waste has led to an increase in recycling rates, and increase in recovery of waste and also a decline in overall MSW generated. In fact, consumer behaviour in source separation has been so successful that much of Scotland’s MRF technology has been made somewhat redundant. Local authorities now face the challenge of maintaining expensive technology that is being underutilised.

7.7 Waste Treatment

Most food waste in Scotland is treated by anaerobic digestion and made into compost. The compost is then returned to the agricultural industry in the local area. SEPA has published guidelines on the disposal of food waste, which include a food waste hierarchy. Prevention is the preferred approach, followed by re-use (redistribution to people and animal feed), then recycled into compost, followed by incinerated for energy recovery and lastly landfilled.

Scotland also employs Mechanical Biological Treatment facilities and thermal energy from waste facilities to treat and process both recyclable materials and mixed waste.

Thermal energy from waste is considered a key treatment method through which Scotland is making progress towards its waste targets. SEPA lists 17 energy from waste plants currently operating across Scotland. Six of these process municipal waste. Five process biomass, with the balance processing clinical (4 plants), cement, and tannery waste. Energy from waste facilities in Scotland are regulated under the Pollution Prevention and Control (Scotland) (PPC) Regulations 2012, which includes the controls required under the European Waste Incineration Directive.

SEPA annually tests the qualities of recyclates that are produced by different facilities. A ‘recylcates quality’ tool has been developed to determine contamination. SEPA reported in Q2 of 2016, the contamination rate for recylcates was at around 11.2%, which is lower than England’s 14%.

The Glasgow Recycling and Renewable Energy Centre, owned by Viridor, recycles household recycling waste in the Smart Recycling Facility. The Centre also treats organic and food waste, removing it from the waste stream for conversion into ‘green energy’ via anaerobic digestion. The centre incinerates the residual waste producing a synthetic gas which is controlled and converted to heat and power for around 22,000 homes in Glasgow.

The Advisers conducted stakeholder consultation with professionals in the Scottish waste sector. These consultations provided insight into the waste to energy infrastructure market in Scotland and the implementation of waste management policy.

After the landfill ban and the development of the zero waste policy, the Scottish Government determined that the optimal solution was to hold funds for waste to energy infrastructure at

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105 Ibid
107 Ibid
the centre of government and encourage local authorities to collaborate to procure infrastructure. The ideal situation for this would have resulted in 4 to 5 plants that the Scottish Government would have released funding to the local authorities to pay for. This policy idea was not realised as local authorities were unable to reach agreement on a joint approach. To resolve this quickly and meet the landfill ban and diversion targets the Scottish government distributed funding across the local authorities. A view was expressed that funds were distributed too thinly, resulting in subscale projects.

Scotland now has up to twenty small scale (100,000 - 150,000 tonnes) energy from waste facilities, that are commercially viable because the landfill levy is so high. This contrasts significantly to England’s approach. Waste management policy in England has historically been set by the economics of various options. Over time, debt and equity investors have gained confidence in the waste from energy sector and are now funding projects wholly on a merchant basis, therefore not requiring public funding. In the past, in both Scotland and England, investors have suffered significant losses on waste infrastructure investments involving gasification and advanced conversion technologies such as MBT. This is partially due to the scale of contracts and type of waste that was used with these technologies. It will be important for NSW to consider this when investing in conversion technologies and particularly the market dynamics that would support the bi-products from these technologies.

The Scottish Government, in partnership Zero Waste Scotland has pursued a bold waste management policy. However, as informed by stakeholder consultation, the implementation of this policy has been impacted by the level of collaboration and coordination between local authorities, SEPA and the Government. Concerns were also expressed that the actual impact of the policy on the waste management market and sector may not have aligned with intentions.

7.8 Roles and responsibilities

7.8.1 Scottish Environmental Protection Agency

The Scottish Environmental Protection Agency (SEPA) regulates the waste management sector closely, collecting data and ensuring that all regulations are followed. This agency licenses and monitors waste management facilities such as landfill and incinerators. The agency also administers producer compliance schemes for particular waste streams, regulates the trans-frontier shipment of wastes and responds to pollution incidents and illegal dumping.

In 2018, SEPA fined two major waste providers for inappropriately landfilling waste. Fines totalled closed to £50,000.110 All businesses have a legislated duty of care to manage their waste appropriate and maximum statutory fines for non-compliance are up to £10,000 pounds.111 SEPA regularly inspects waste providers and local authorities to ensure that all participants in the waste management system are complying with the Waste (Scotland) Regulations 2012.

The Scottish Government, in partnership with Zero Waste Scotland and SEPA sets the waste management policy for Scotland. Zero Waste Scotland is an independent body that is at arm’s length to the government and essentially lobbies the government on waste management policy. Zero Waste Scotland is funded by the Scottish Government.

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Industry Stakeholders expressed the view that the commercial implications of the regulatory approach taken by the Scottish Government were not fully considered prior to the implementation of the approach. Some views were expressed that the approach prioritised environmental outcomes. Such an approach needed to ensure the commercial feasibility and risks that would have to be mitigated by Industry and local authorities were comprehensively assessed.

Certain elements of Scotland’s waste management are very similar to England’s as some policies have been set by Westminster. One example of a variation that exists is the landfill tax. Despite being the same rate in both England and Scotland, this is a devolved matter so the Scottish Government could vary the rate if it wanted to.

7.8.2 Local Authorities

As in NSW, legal responsibility for waste management services in Scotland lies with local councils or the Local Authority. Each Local Authority has a slightly different approach to collection, sorting and treatment.

There are 32 local authorities across Scotland. The scale of the challenge of waste management service delivery is too large for smaller local authorities. Research indicated that local authorities may have challenges in collaborating and this may have resulted in a number of small scale (100 000 tonnes per annum) and potentially costly energy from waste projects being developed.

The main challenge facing local authorities in Scotland is being compliant with the upcoming 2021 landfill ban for all biodegradable waste.

The Local Authority Code of Practice for Waste Collection, signed by the Scottish Government and the collective body for local authorities, is a joint agreement to standardise the collection regimes across Scotland. The result of this so far has been a consistent approach to kerbside recycling.

7.9 Data

Scotland maintains one of the most transparent waste datasets across the benchmarking group. With significant functionality, Scotland’s dataset allows citizens to filter various waste streams for particular items and the way that they have been treated. The Waste Discover Data tool presents waste from all sources, including households, construction and demolition sector and commercial and industrial sectors. The tool shows a breakdown of waste types from 2011-2016. It also demonstrates the trend for Scottish waste landfilled since 2005. The Household Waste Discover Data tool shows waste from household sources only. The tool shows how much waste has been generated, recycled and managed since 2005.

With the introduction of the European union Waste Statistics Regulations (EC 2150/ 2002) all Member States were required to provide data to the European commissioning every two years on the generation and treatment of waste, as well as the number and capacities of waste management facilities. These facilities include incineration, recovery and disposal. SEPA has taken an active approach to prepare data for Scotland and send it to the Department for Environment, Food and Rural Affairs who then compile it into a UK dataset for submission to EuroStat.

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Commercial and industrial waste data is derived from licensed and permitted site returns. All Scottish local authorities (councils) are required to submit data on generation and treatment of waste to the web-based reporting tool WasteDataFlow. SEPA, Zero Waste Scotland and the Scottish Government have partnered to publish a waste data strategy and action plan. With Scotland’s transition to a more circular economy, the data strategy outlines priority actions to be taken to improve understanding of how products and materials flow through the economy. The strategy has a number of aims to meet the data needs of Scotland into the future. These aims include to:

- Collect and report waste data that is reliable and relevant, sharing it on a timely basis in an integrated, coherent and open format;
- Explore new approaches to collect and report data, embracing digital solutions and innovative ways of working;
- Further develop the use of non-weight based measures, for example carbon assessment, to increase understanding of the economic, environmental and social impacts of waste;
- Identify what waste materials need to be tracked and the methods required to measure and monitor the movement of waste flows.

In addition to these aims, the Strategy also outlines 5 priority actions that were identified through stakeholder consultation, to improve transparency of the waste section. The actions to be progressed over the next decade include:

1. Reviewing the waste data needs, considering gaps, overlaps, inconsistencies and future requirements for capture
2. Identify opportunities to improve systems and processes, working with stakeholder to implement necessary changes. Develop guidance and training materials to support users to access the data.
3. Collect and manage waste data using best practice principles, building trust and clarity across the data chain.
4. Review and progress tools and levers required to support and monitor Scotland’s transition to a more circular economy.

Share and publish waste data in an efficient and timely manner, in ways that makes it easier to communicate the impact and value of waste. Central to Scotland’s approach to data collection and management is a partnership model of operating, which recognises that people are vital to ensuring reliable data. SEPA is taking an active approach to engaging key stakeholders such as local authorities and waste management providers to ensure best practice and consistency across the data chain. In addition to this, the Scottish government is investing in improving systems to ensure that the most relevant data is collected and presented in a user-friendly.

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8 Slovenia

8.1 History and background\textsuperscript{115}

Slovenia’s entry into the EU in 2004 instigated significant change to waste management across the country, with a shift away from waste being landfilled to meeting targets in the EU’s 2030 Circular Economy Package.\textsuperscript{116} As part of the accession process to the European Union, Slovenia had to implement the European Commission’s policy on waste management. This primarily meant the implementation of the then-applicable Framework Waste Directive (75/442/EEC). EU legislation has significantly shaped Slovenia’s legislative framework for waste management. All targets within Slovenian waste legislation are directly related to those found in the EU directives.

Prior to this, the Slovenian Rules on Waste Management adopted in 1998 provided the framework for waste management. The Rules set out the tasks and obligations of waste management participants and certain waste producers. The rules were subsequently updated to address identified deficiencies and align with the approach of the broader European Union, firstly by the Decree on waste management in 2008 and subsequently by the Decree on waste in 2011 and 2015, implementing the European Parliament and Council Directive 2008/98/EC on waste.

The Decree of 2015 prescribed the obligation of the Ministry of the Environment and Spatial Planning to analyse data on waste management and report to the European Commission on the implementation of Directive 2008/98/EC. The Waste Framework Directive sets the basic concepts and definitions related to waste. The Directive introduces the concept of extended producer responsibility and requires each member state to have a waste management plan and a waste prevention plan. Member states have to report against these and progress on EU targets to Eurostat annually or bi-annually. These requirements have resulted into a sophisticated approach to capturing and publishing data on waste management.

Historically, Slovenia has operated a decentralised waste management system, which was operationalised and managed at the municipal level. Municipal waste remains responsibility of local municipalities. There are 212 municipalities in Slovenia administering waste management services to a population of just two million. Municipal authorities were empowered to issue special regulations regarding waste management in their area and often have unique approaches to increasing recycling rates and reducing waste prevention. As will be discussed, Slovenia’s recycling success is largely attributed to the separate collection of waste that is provided by municipalities.

8.2 ‘Roadmap towards the Circular Economy in Slovenia’

On joining the EU, Slovenia’s waste management plan included separate collection, regional biological treatment plans and two large-scale incineration plants. Whilst Slovenia utilises a number of policy levers, the real success of their progression is the source separate collection of waste. Sorting up to seven different types of waste, Slovenia reached a recycling rate for MSW of 60.6% in 2014 (with EU target being 50% by 2020).

\textsuperscript{115} The information contained in this section of the report has been drawn from https://www.senica.si/prispevki/how-slovenia-implemented-eu-standards-on-waste-management/

The most important change was adopting a structured approach, acknowledging that waste management is futile without the prevention of waste production. In dealing with waste, Slovenia’s primary objective is the preparation of waste for its subsequent reuse, followed by recycling and other forms of processing. Disposal by landfill is a last resort.

Slovenia’s waste management strategy champions the benefits of separate collection and sophisticated waste processing systems. Citizens and businesses sort up to seven different types of waste which are treated and processed at sophisticated processing plants.

In 2018, Slovenia released its ‘Roadmap towards the Circular Economy in Slovenia’ (the Roadmap). This Roadmap, broader in scope than other jurisdictions in the benchmarking group, speaks to the need for circularity in the broader socio-technical system. The Roadmap also sits side by side with the Development Strategy. Supporting the Roadmap is the Strategic Research and Innovation Partnership for a Circular Economy Action Plan.117

The Roadmap contains a number of recommendations, including:

- green public procurement;
- ecological design of products;
- incentivising industry to engage in circular transformation
- integration of the circular economy with the bio-economy.118

### 8.3 Current Policy Settings and Levers119

The Ministry of Environment and Spatial Planning regulates the waste management sector. The Environment Protection Act (2004) provides the regulatory framework and ‘Rules on Waste Management’. These rules are supplemented by subsidiary groups of regulations, including:

- Regulations governing individual types of waste (management of waste oils, individual types of waste and packaging and packaging waste);
- Regulations governing facilities and equipment for waste management (disposal and incineration of waste);
- Regulations governing transboundary shipments of waste.

The Rules on Waste Management provide for the obligations of particular waste management participants, classifications of all types of waste, waste management obligations generally, prohibitions on mixing waste, waste treatment and reporting.121 In addition to the Environmental Protection Act, the Decree on Landfilling of Waste and the Decree on Waste are the most relevant pieces of legislation for Slovenia.

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8.3.1 Landfill Tax

In 2001, Slovenia introduced a landfill tax. All operators of landfill sites are obliged to pay a tax for the disposal of waste. Since 2010, the money collected from the tax is paid to municipalities with the intention that this is used to support the delivery waste management services to the public (though this is not regulated).

8.3.2 Organic Waste Policy

Slovenia has implemented policies to reduce the quantities of biodegradable waste, as well as limiting the volume of biodegradable waste that is generated. Various decrees such as the, Decree on the management of organic kitchen waste and garden waste (Official Gazette, No. 39/10), Decree on the treatment of biodegradable waste (Official Gazette, No. 62/08) and Decree on the management of waste edible oils and fats (Official Gazette, No. 70/08) . These decrees have mandates separate collection and treatment of biodegradable waste and conditions for use.

Almost half (43%) of food waste generated in Slovenia in 2013-2015 was recovered anaerobically in biogas plants. A quarter was recovered anaerobically in composting systems. In 2015, 48% of people in Slovenia had a home composting system, in addition to the food and organic waste collection service that is provided to households by municipalities.

8.3.3 Producer Responsibilities

Despite having a highly regulated and heavily legislated environment for waste management, Slovenia does not present a strong producer responsibility scheme. The implementation of extended producer responsibility schemes is hindered as producers are refusing to pay 100% of the collection and end-disposal of the waste they put in the market. The scheme is structured, similar to Ontario’s previous EPR scheme with two entities providing services to the producer. The Waste Management Organisation is responsible for the collection of waste from producers. The Packaging Recovery Organisations (PRO) are then responsible for the final disposal or recycling of that material. The PROs also set the pricing in a competitive market.

In Slovenia, the threshold for exemption from any extended producer responsibilities obligations is 15,000 kg per annum. Costs are administered per tonnes according to the material and additional specifications for reuse. There are no financial incentives for improved design for re-use, recycling or recovery. Final costs for packaging waste collection and treatment are determined by the Packaging Recovery Organisation. There is competition between PRO’s hence prices are not fixed, and like the UK impacted by market dynamics.

Similar to Ontario’s former EPR scheme, which will be discussed below, there is limited public governance of oversight of these schemes and therefore limited accountability and incentives for producers to move towards a producing more sustainable products.


126 Ibid
Slovenia is planning a registration procedure for packaging, where obligated companies are obliged, regardless of packaging quantities placed on the market to register themselves as producers.127

Environmental taxes have been introduced for the:
- use of lubricating oils;
- generation of end-of-life motor vehicles;
- generation of waste electrical and electronic equipment (in the context of this also the generation of waste batteries and accumulators);
- generation of packaging waste (in the context of this also the generation of graveside candle waste);
- generation of end-of-life tyres and by waste disposal; and
- waste electrical and electronic equipment.

8.3.4 Packaging Waste Scheme

In 2004, Slovenia implemented a scheme for the separate collection of packaging waste.128 By 2007 Slovenia was recovering 53% of the total mass of packaging waste, however, this remained below the 2012 target of at least 60% of packaging waste. The target for 2012 envisages 55-80% recycling for certain materials including plastic, paper, cardboard and wood.129

Management of packaging waste is subject to the Decree on Packaging and Packaging Waste Handling. The objective of the decree is to ensure high levels of environmental protection and performance by setting rules for the management, collection, reuse, recovery and disposal of packaging waste. As well as to prevent the restraining of competition.130

The management of household packaging waste in Slovenia is based on a shared responsibility between local management companies and packaging recovery organisations. The collection of source separated packaging waste is financed by local waste management companies. The Packaging Recovery Organisations then receive this packaging from the waste management companies. The collection, sorting and recycling is the responsibility of the packaging Recovery Organisations. Certain companies are obliged to enter a Packaging Recovery Organisation scheme or to meet their packaging obligations individually.

8.3.5 End-of-life-vehicles and used tyres

Slovenia implemented a system for breaking down end-of-life vehicles. The scheme targets an 80% level of reuse and recycling of vehicles and 85% reuse and recovery of tyres was met in 2006 and 2007 respectively. The system was supported by the introduction of a certification system. Slightly fewer than 7000 cars were dismantled in 2008 at no cost to the final owner.

129 Ibid
The quantity of collected and recovery-destined used tyres increased significantly when the program became an extended producer responsibility scheme in 2006. Before then, a total of 2.5 kg per person of used tyres were collected annually, while in 2008 a total of 19,000 tonnes were collected – 8.4 kg per person.

Tyres are subjected either to material or energy recovery, while smaller quantities are destined for reuse or renewal. In 2008 a total of 47% of used tyres were destined for material recovery, and 50% for energy recovery.

8.4 Waste Separation

Slovenia is one of the highest performing EU countries on waste separation. Households are obliged to separate into:

- paper and cardboard
- glass
- plastic and light packaging
- biologically degradable waste (which is the largest percentage of produced waste)
- residual waste.

Since 2012, the rate of separately collected municipal waste generated rose 18.5 percentage points from 51.5% to 70%.  

8.4.1 Ljubljana Case Study

Ljubljana, the capital of Slovenia, has one of the highest rates for the separate collection and recycling of waste in Europe – over 60 per cent. The city has chosen to maximise recycling and reduction ahead of incineration to control landfill.

A key step has been to collect separated waste directly from people’s homes. Biodegradable and recyclable waste is collected more frequently, encouraging people to separate diligently to prevent it from piling up (and beginning to smell).

Snaga, the company managing the city’s waste, has run information campaigns to promote reduction, re-use and responsible consumption to curb the amount of waste that is being disposed of. Reducing food waste is a particular target of information campaigns. Snaga also operates collection centres for waste items including hazardous or bulky waste and electrical appliances.

The city began with separate collections of paper, cardboard, glass and other packaging. The remaining mixed waste (residual) went to landfill. In 2006, Snaga began a door-to-door collection of biodegradable waste in addition to recycling. In 2012, Snaga also began collection recyclates door-to-door. This proved to be highly effective. Within months packaging recycling increased more than three times in one area of the city and residuals fell 29%.

After introducing the door-to-door collection, Snaga lowered the frequency of collection for residual waste, whilst keeping the collection of recyclables and compostables just as frequent.

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134 Ibid

135 Ibid
For low-density population areas collection reduced to one collection every three weeks. In densely population areas, mostly multi-unit dwellings residuals were collected weekly. The reasoning behind this method of collection being that if residuals are collected less frequently than recyclables or compostables, citizens will be encouraged to separate their waste rather than leave it in their homes.

To assist with the change in waste management, Snaga adopted a new communication campaign in 2013. Moving away from awareness raising, Snaga began encouraging citizens to reduce the amount of waste they produce, promoting reduction and re-use instead. The ‘get used to reusing’ campaign, became a national campaign in partnership with the chamber of commerce.

These programs have seen the amount sent to landfills decrease by 59 per cent, with total waste dropping by 15 per cent. The average monthly waste management cost is less than 8 euros per household in 2014 – the lowest in the country.

Ljubljan and dozens of other municipalities are part of the Zero Waste Europe network, which encourages the idea of a circular economy in which products and services are designed to maximize resource efficiency and minimize waste and energy consumption. Zero Waste Europe is a partner of UN Environment’s Sustainable Consumption and Production 10-Year Framework of Programmes.\footnote{136}

In 2015, the collection system included eight collection centres where citizens could take their waste if it was not collected at their door. At these centres, people are able to sort waste into hazardous items, metals, plastic electronic waste and electric equipment, garden waste, construction waste, car tyres, wood and wood products, bulky waste, clothes and textiles.\footnote{137}

### 8.5 Waste Generation\footnote{138}

While Slovenia has demonstrated significant improvement adhering to the waste hierarchy and reducing the amount of waste that is landfilled or incinerated, the country has steadily increased the amount of waste generated in recent years. In 2004, when Slovenia began changing the waste management framework 417kg of municipal waste was generated per capita.\footnote{139} In 2017, 478 kg of municipal waste was produced per capita.\footnote{140} As can be seen in the figure below, total waste generated has increased by 38% between 2012 and 2017.


\footnotesize{138 Data on waste generation in this section was sourced from Republic of Slovenia, Statistical Office (2019), sourced from: https://pxweb.stat.si/SiStat

\footnotesize{139 Ibid

\footnotesize{140 Ibid}
In 2017, 70% of all waste municipal waste was separately collected. In the same year, 57.8% of municipal waste was recycled and 52% of all waste streams generated was recycled. In 2017, only 6% of all waste streams generated (excluding major mineral waste) was disposed.\textsuperscript{141}

As discussed below, Slovenia has put particular focus on food waste. The graph below indicates the method of treatment of food waste in the country from 2013 – 2017. As evident, the primary treatment methods include composting and recovery in biogas plants.

\textsuperscript{141} Republic of Slovenia, Statistical Office (2019), sourced from: https://pxweb.stat.si/
8.6 Waste Treatment

In 2016, Slovenia operated 386 facilities for waste recycling, 180 facilities for waste recovery with backfilling, 10 facilities for waste incineration for the purpose of energy recovery and 3 facilities for waste incineration for the purpose of waste disposal.\textsuperscript{142} In 2016, there were 17 operating landfill sites, of which two were for inert waste and one for hazardous waste.

One of the facilities that processes a significant quantity of Slovenia’s waste is Ljubljana Regional waste management Centre (RCERO), operated by Snaga. This centre includes an expanded landfill, leachate treatment plant and waste recovery facilities. The waste recovery facility is an MBT with capability to process two types of waste, separately collected bio-waste and residual mixed municipal waste.\textsuperscript{143} Mixed residual waste is shredded and sieved.

Separators sort different types of plastic, paper and other useable materials. Metals are collected by a magnet. Un-recyclable materials are processed into fuel. Bio-waste is also sieved, with smaller parts of the waste travelling to a bioreactor (fermentation), bigger pieces of bio-waste are shredded and sieved. Any solid particles or metal is removed. Biogas is collected from the anaerobic digestion and is used to generate electricity and heat which powers the facility. The anaerobic digestion process also produces biomass. Once delivered from the bioreactor, this is squeezed, aired and left to mature to create compost.\textsuperscript{144}

Energy from waste in Slovenia, is produced as combined heat and power, electricity production from landfill gas and in regional waste management centres. Slovenia’s operational program for waste management allows energy to be recovered from municipal waste if the MSW recycling goals are fulfilled (i.e. 50% by 2020 and 65% by 2030).\textsuperscript{145}


\textsuperscript{144} Ibid

8.7 Roles and Responsibilities

Similar to Scotland, in Slovenia, policy and regulation is managed at the national level and implementation and operation is the legal responsibilities of local municipalities. Both household and commercial waste is collected by local municipalities, and as noted above is required to be source separated.

8.8 Data

The Republic of Slovenia’s Statistical Office (SOURS) obtains data from the Slovenian Environment Agency (the Agency) and prepares for reporting to Eurostat, as with Scotland and the Netherlands\textsuperscript{146}. Under legislation, persons liable for waste management must report annually on waste management for the previous calendar year. Forms for reporting information are available on the Agency’s website. The Agency then publishes data collected on the basis of the reports received. Data is collected from municipalities and waste management service providers on how much waste is produced, and how this waste is treated. Data is also collected on the amount of waste imported and exported for processing. In addition to this, the Agency also manages various Registers to regulate waste management across the country. Different registers are maintained, including registers of persons providing recovery, disposal providers, waste collectors, transport operators, dealers and brokers in the sector. These registers are updated monthly on the website and are published annually in the official Journal of the Republic of Slovenia.

9 Ontario

9.1 History and background

Ontario’s policy setting for waste has transformed significantly over the past two decades. In the early 2000s, Ontario’s recycling initiative, the Blue Box program, was at risk of being abandoned due to a lack of funding from municipalities. The Blue Box program provided residents in Ontario with a separate collection for recyclables. To address the lack of funding at the municipal level, the provincial government passed the Waste Diversion Act 2002, which transferred the responsibility for funding to producers of products and packaging, and the administration for this to Industry Funding Organisations. This established a producer responsibility scheme.

Along with the Blue Box Program, three more programs were also funded by producers including:

- the municipal hazard or special waste program;
- the waste electrical and electronic equipment program; and
- a used tyres program.

When the Waste Diversion Act (2002) came into force and established the modern framework for waste management in Ontario, it also sought to change the approach of consumers and producers by:

- further encouraging the reduction, reuse and recycling of wastes;
- facilitating the development and implementation of Waste Diversion Program; and
- establishing Waste Diversion Ontario, to regulate the Waste Management Sector.

Waste Diversion Ontario had oversight of waste diversion programs operated by industry funding organisations and monitored producer responsibility scheme more broadly. The Government’s decision to establish a statutory body to oversee operation of the programs and overall producer responsibility scheme was controversial at the time. To stimulate producer responsibility within the marketplace, the Provincial Government distanced itself from managing the relationship with municipalities and instead transferred responsibility to an industry run organisation and board with little interest in genuine product stewardship. Producers or ‘product stewards’ made an effort to minimise cost to business rather than genuinely reduce or recycle waste. The establishment of Waste Diversion Ontario meant that the Government was unable to be held to account for their involvement in waste management across the Province.

In 2002, Ontario was producing 797.6 kg per capita of undiverted waste. Over time this has decreased to 673.4 kg in 2012. In 2012, Ontario was diverting 23.86% of waste from landfill.

150 Ibid
which was slightly below Canada’s average of 25.25%. Data is not available on the recycling and waste to energy rates for this time period. The criticism faced by the Government for the arm’s length producer responsibility schemes, and the lack of genuine stewardship resulted in a total overhaul of policy settings in 2016.

9.2 Current Policy Settings and Levers

In 2016, Ontario passed the Waste-Free Ontario Act which enacted two further acts, the Resource Recovery and Circular Economy Act (2016) and the Waste Diversion Transition Act (2016).

Waste Diversion Ontario was overhauled, along with programs established under the 2002 Waste Diversion Act. In place of Waste Diversion Ontario, a new authority was established with greater oversight called the Resource Productivity and Recovery Authority (the Authority).

The Authority regulates waste management in Ontario and manages Individual Producer Responsibility (IPR) requirements. IPR requires producers of products and packaging to meet mandatory and enforceable targets for the collection and recycling of their products and packaging. Producers are required to register with the Authority and report on progress. Producers are able to collect the end of life products themselves or contract with Producer Responsibility Organisations to meet the legislative requirements.

The Waste-Free Ontario Act encourages producers and consumers to turn more of their waste into new products and reduce greenhouse gas emissions by reusing, recycling or composting materials that would otherwise go to landfill. Together with an underlying strategy, the Act:

- encourages businesses to be innovative with design of products to use recyclates and make easily reusable or recyclable products;
- eliminates industry funding organisations, which were setting fees that were passed onto consumers;
- encourages companies to look for ways to make their recycling processes more economical whilst staying competitive;
- boosts recycling in the business and institutional sector;
- shift the costs from the Blue Box (Ontario’s product stewardship scheme for plastics and packaging) from the taxpayer to producers, whilst continuing to provide collection services for Ontarians; and
- reduces the amount of food and organic waste going to landfill.

The Waste Diversion Transition Act (2016) was established to transition waste management programs under the previous legislative framework (Waste Diversion Act 2002) to the new. These programs included:

- the Blue Box, operated by Stewardship Ontario;
- Municipal Hazardous Waste, operated by Stewardship Ontario;

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\(^{152}\) Information in this section is largely drawn from the Ontario Government Website. Sourced from: https://www.ontario.ca/page/waste-management


• Waste Electrical and Electronic, operated by Electronic Stewardship; and
• Used Tyres operated by Ontario Tyre Stewardships.

The Act also provides the Authority with the ability to close down Industry Funding Organisations, completely changing the model of the producer responsibility scheme. With the Authority now in place, and the new IPR scheme established, products under the four previous Programs are slowly being transitioned over to the new scheme. The Ontario Government, in establishing this Authority reclaimed responsibility and oversight for product stewardship and also established a far more serious scheme for producer responsibility.

Ontario has approximately 850 landfills that are operating and 1,525 that have been closed.\textsuperscript{155} Projected population growth is indicating that if the Province does not reduce waste generated it will need to build another 16 new sites by 2050.\textsuperscript{156} Ontario also operates three approved waste-to-energy facilities. Algonquin Power in the Peel region is the largest facilities and processes up to 180,000 tonnes of MSW and C&I waste annually.

\subsection*{9.2.1 Strategy for a Waste-free Ontario: Building the Circular Economy\textsuperscript{157}}

Ontario is shifting to circular economy approach to waste management. Ontario’s strategy is closely aligned to its Climate Change Action Plan, with an articulated objective to reduce greenhouse gas emissions. Ontario’s Circular Economy strategy seeks to minimise the use of raw materials and energy through a ‘restorative’ system.

Ontario has set a number of goals, including:

\begin{itemize}
  \item 50% diversion of waste from landfill by 2030; and
  \item 80% diversion before 2050 with the ultimate goal of zero waste.
\end{itemize}

While this may seem an unambitious goal in comparison to San Francisco’s target of zero waste by 2020, it is important to note that Ontario’s methods of waste management focus on prevention and recycling with minimal waste being incinerated as a form of recovery.

Importantly, the strategy also puts in a full producer responsibility scheme. The scheme applies to particular products. When identifying potential candidate materials for full producer responsibility, the province considers those products and packaging whose recovery helps fulfil one or more of the following three broad results:

\begin{itemize}
  \item recovering high-volume resource streams to increase diversion;
  \item keeping hazardous materials out of landfills to protect the environment; and
  \item reducing domestic and global greenhouse gas emissions to fight climate change.
\end{itemize}

The strategy sets out a long term timeframe for implementation, which is important in staging implementation of the producer responsibility scheme to ensure businesses have time to adapt.


The strategy outlines four objectives:\(^{159}\):

1. **Enhance provincial direction and oversight.**
   
   Key actions include:
   
   - Empower the Resource and Productivity and Recovery Authority to oversee producer’s performance under the new producer responsibility regime, and the operation of existing waste programs;
   
   - Operating a public-facing registry – a data clearinghouse – with information and data related to resource recovery and waste reduction, as well as conducting compliance and enforcement activities.

2. **Enable efficient and effective recovery systems.**
   
   - Amend regulations to increase resource recovery across all sectors and ensure that any existing landfills are well planned and managed to reduce greenhouse gas emissions;
   
   - Establish service provider requirements to protect the environment while promoting resource recovery;
   
   - Winding up existing waste diversion programs and replacing them with regulations to make producers fully responsible for the materials under the existing programs (without any disruption of services); and
   
   - Establish promotion and education requirements to support public participation in resource recovery.

3. **Increase waste reduction and resource activity.**

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\(^{159}\) Ibid
Ontario’s industrial, commercial and institutional (IC&I) sectors, including construction and demolition, divert just over 13 per cent of their waste. Under previous arrangements large IC&I establishments (e.g., hospitals, restaurants, and offices) were required to identify the amount and types of waste they generate, develop waste reduction work plans, separate certain wastes at source and make reasonable effort to ensure that separated wastes are sent for reuse or recycling. Manufacturers, packagers and importers were required to audit their packaging practices and develop packaging reduction plans and multi-residential dwellings (six or more units) were required to source separate recyclable wastes.

These policies were more than 20 years old, and no longer adequately drove waste diversion. The policies were limited to large establishments and only select waste materials and required only “reasonable efforts” to send source-separated wastes for recycling or reuse.

Key actions to improve outcomes under objective 3 include:

- designate new materials to ensure producers are fully responsible for recovering more materials from products and packaging;
- implement an action plan to reduce the volume of food and organic wastes going to landfill;
- implement an Excess Soil Management Policy Framework to increase the reuse of excess soil, while protecting human health and the environment;
- adopt and implement modern regulatory approaches to build on and promote innovative best practices;
- the role of promotion and education in improving IC&I diversion rates;
- performance measures that could be used to increase diversion; and
- exploration of complementary tools, such as producer responsibility and disposal bans, to recover resources and reduce waste.

4. Create conditions to support sustainable end markets

To promote the recovery, recycling and re-use of waste, the cost to recycle must be more viable than sending waste to landfill. Stimulating end markets will assist with increasing recovery and recycling rates, as more and more waste is retained within the economy and resource loop. Actions to achieve this include:

- Improve and establish environmental standards to provide a level playing field and a strong foundation for markets;
- Use green procurement practices to build market demand for recovered materials;
- Implement disposal bans to direct materials to end-markets.

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9.3 Waste Generation

In 2016 Ontario disposed approximately 9.5Mt of total waste. 3.7Mt of this total came from residential sources \(^{161}\) and 5.8Mt came from non-residential sources. \(^{162}\) Waste generation rates from 2010 to 2016 are shown in the graph below. Rates have remained relatively stable over this period.

*Figure 12: Waste Generation by Type—Ontario*

3.3Mt tonnes of waste from all waste sources was diverted from landfill in 2016. This included a diversion of 1.3Mt of organic waste in the same year. In 2017, the City of Toronto, the major municipality of Ontario, reported that 53% of MSW was diverted from landfill.\(^{163}\)

9.4 Waste Prevention

Ontario’s waste prevention initiatives are focused particularly on food and organic waste. Food and organic waste makes up approximately one third of total waste generated in Ontario. To address this, the government has released a Food and Organic Waste Framework that provides an action plan to reduce food waste.

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\(^{161}\) Residential non-hazardous recyclable materials include solid non-hazardous materials produced in all residences and include non-hazardous materials that are picked up by the municipality (either using its own staff or through contracting firms) and non-hazardous materials from residential sources that are self-hauled to depots, transfer stations and disposal facilities.

\(^{162}\) Non-residential waste means Non-residential sources include solid non-hazardous recyclable material from the Industrial, Commercial, and Institutional (IC and I) sector as well as the Construction, Renovation and Demolition sector (CRD). Materials are those generated by all IC and I and CRD sources in a municipality, and are excluded from the residential waste stream.

\(^{163}\) City of Toronto. (2019). Diversion Rates and Reports. Sourced from: https://www.toronto.ca/services-payments/recycling-organics-garbage/solid-waste-reports/
The Framework provides a number of initiatives that support food redistribution. One such initiative is the Ontario Community Food Program Donation Tax Credit for Farmers. This provides tax credits to people that donate agricultural products to appropriate programs.

The Local Food Act 2013 has also been amended, with certain specific limitations, to protect food donors from liability as a result of injury caused by the consumption of donated food.166 The province is investing in research into food waste prevention and reduction, as well as collecting better data to measure progress.

9.5 Waste Separation

Encouraging the source separation of recyclates is a focus for local governments in Ontario. As in NSW, local governments have the primary responsibility for residential waste collection.

The City of Toronto practices a separate collection of 3 types of waste. A blue bin is provided for recycling, a green bin for food and organics and a black bin for other waste.

The City conducts inspections upon collection of recycling bins to encourage source separation. Bins that have the wrong or contaminated waste are tagged and not collected.

Homeowners with tagged bins are provided with a Recycling Notice and guide. The City is considering introducing a cost recovery system, whereby residents are charged for contaminated waste to offset the cost of treatment.167 The province is also reviewing the Building Code Act to address the lack of food recovery from multi-unit dwellings and ensure that there are options to easily recover food and organic waste in new builds.168

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9.6 Resource Recovery

Ontario has four diversion programs to reuse, recycle or safely dispose of waste. They operate on the producer responsibility principle, where producers are responsible for managing their products and packaging at end-of-life.

The existing programs are the:

- Blue Box Program: recycles printed paper and packaging (plastics, paper, glass, aluminium, steel);
- Municipal Hazardous or Special Waste Program: recycles or properly disposes of paint, antifreeze, batteries, fertilizers and other hazardous or special materials;
- Waste Electrical and Electronic Equipment Program: reuses or recycles electronic equipment like computers, televisions and stereos; and
- Used Tyres Program: recycles used tyres from passenger, truck and off-road vehicles.

The province also operates four Industry Stewardship Plans:

- Used paints and coatings;
- Pesticides, solvents and fertilizers;
- Automotive materials; and
- Soda stream.

The existing programs and plans will be transitioned to full producer responsibility regimes with:

- the government to lead the transition process;
- each waste diversion program will be directed by the Minister;
- Ontarians’ access to existing services will not be negatively impacted, such as kerbside collection of Blue Box materials;
- transition will promote competition and a level playing field in the marketplace.

New programs will remain subject to infrastructure considerations; cost-benefit analysis; industry participation.

The first set of materials will include, but is not limited to:

- small appliances;
- electrical tools;
- batteries;
- fluorescent bulbs and tubes;
- mattresses;
- carpets;
- clothing and other textiles; and
- furniture and other bulky items.
The province also has the Ontario Deposit Return Program for beverage and alcohol containers.169 Ontario is also in the process of developing a food and organic waste landfill ban, and aims to implement programs to support the recovery of food and organic waste.170 Many business in the IC&I sectors are already subject to end-of-life management of paper and packaging under the Environmental Protection Act. Diversion rates for paper and packaging in the IC&I sectors remain low at 26%.

Municipal governments are also taking their own actions to improve resource recovery rates. In the City of Toronto, for example, residential food and organic waste is treated via anaerobic digestion and converted to compost and biogas. In 2019, in partnership with Enbridge Gas Distribution Inc, Toronto will begin installing a new solid waste management facility which will convert biogas into a form of renewable natural gas that will be used to fuel the city’s waste collection trucks.171

9.7 Roles and responsibilities
9.7.1 Government

In Ontario (as in NSW), while the provincial government sets the overarching policy and legislative framework, the delivery of waste management services is the responsibility of each municipality. Services are often delivered directly by local councils.

In the City of Toronto, for example, the City provides waste management services. The responsible division of council is Solid Waste Management Services. This division is responsible for collecting, transporting, processing, composting and disposing of all three waste stream. They manage 13 maintenance and operating yards, two single stream recycling facilities, one organics processing facility, seven transfer stations and household hazardous waste depots and the Green Lane Landfill.172

9.7.2 Extended Producer Responsibility Scheme

Under recent legislative changes, Ontario has established a producer responsibility scheme, which gives producers a key role in waste management efforts. Producers involved in this scheme include brand holders and/or others with a commercial connection to designated products and packaging in Ontario, such as first importers, wholesalers, retailers and e-tailers.173

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To enhance oversight within the new producer responsibility system, the province overhauled Waste Diversion Ontario into the Resource Productivity and Recovery Authority (the Authority), a non-Crown, not-for-profit organization. The Authority oversees producers’ performance under the new producer responsibility regime and the operation of existing waste diversion programs until they are transitioned to the new producer responsibility regime.174

9.8 Data

The Canadian Government provides high level data on waste, which is accessible via the Statistics Canada website. This data is collected by two surveys, the Waste Management Industry Survey which is distributed to the Government and Business Sectors. The survey gathers information on collection, disposal and recycling quantities reported by municipalities and other public bodies that provide waste management services. Waste and recycling quantity data are combined across the Government and Business sector surveys. Surveys are collected in Spring and Summer following the reference year. The survey is a census with a cross sectional design and data is collected for all units of the target population. Responding to the survey is mandatory. Data quality is evaluated against any reporting that individual provinces such as Ontario undertake.

Ontario, whilst lacking large scale data infrastructure, does fund a program called Datacall. Managed by the Resource Productivity and Recovery Authority, Datacall is the reporting function for Ontario collecting information on:

- residential waste diversion rates;
- organic collection and processing;
- municipal hazardous or special waste collection;
- Electrical and electronic equipment collection; and
- Garbage collection and or disposal.

The Municipal Datacall requires municipalities, recycling associations and First Nations to report on the amount of waste that is generated and treated. This also includes tonnage and financial information for related programs such as the Blue Box program.


10 Singapore

10.1 History and background

Singapore is a city-state with a fully urbanised population. Rapid population growth in Singapore has contributed to a sixfold increase in the amount of solid waste that is disposed of, from 1,260 tonnes a day in 1970 to 8,443 tonnes a day in 2017.

Due to Singapore’s geographical location in the tropics, organic waste can cause significant public health issues if left exposed in the humid climate. Daily collection of waste is required to mitigate this problem.

In addition to the climate and the growing population, Singapore’s urban profile of mostly high density buildings also creates issues for municipal solid waste management, as most high density buildings do not have facilities for separate collection of recycling, food and organic waste and mixed waste.

As land is scarce, waste-to-energy and incineration plants offer the best solution for disposal of mixed waste, although this does not align with Singapore’s waste strategy. To address these problems, Singapore has adopted a series of strategies to develop a more sustainable waste management system.

The National Environment Agency (NEA) plans and administers Singapore’s solid waste management systems. This includes licensing and regulating the waste management sector. The NEA has developed an integrated waste management system centred on two key elements, waste minimisation and recycling.

10.2 Current Policy Settings and Levers

The legislative framework for waste management in Singapore is governed by the Environmental Public Health Act, the Environmental Public Health (General Waste Collection) Regulations, the Environmental Public Health (Public Cleansing) Regulations, Environmental Public Health (General Waste Disposal Facilities regulations) and Environmental Public health (Toxic Industrial Waste) Regulations. Under the General Waste Collection and Public Cleansing regulations, all generated solid waste has to be collected. Singapore has articulated four key strategies for solid waste management.

Key policy levers for Singapore in relation to waste prevention align with those of Ontario, the Netherlands and San Francisco. A pricing mechanism is used to incentivise greater recycling. This is considered to have the most effect on changing consumer behaviour. Other articulated strategies are to ‘promote’ efficient use of resources and the 3Rs (Reduce, Reuse and Recycle). Incineration remains a primary solution to waste management. The NEA states that ‘Incineration reduces waste volume by up to 90% saving landfill space’. The heat from

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incineration is recovered to generate electricity, providing up to 3% of the country’s electricity needs.\textsuperscript{181}

10.2.1 National Recycling Programme (NRP)

The NRP was launched in April 2001 and requires all public waste collectors licensed by the NEA to provide public recycling bins and collection services to all properties in the public waste collection scheme.\textsuperscript{182} Mixed recyclables are collected three times a week by trucks and sent to a Materials Recovery Facilities for sorting. After sorting these recyclables are sent onto recycling facilities for further processing.\textsuperscript{183} Since 2014, a two chute system has been required for all new high density buildings. One chute for recycling and the other for general waste. From 2018, all new private residential developments taller than four storeys will be required to install two chutes.

10.2.2 Towards Zero Waste

The Sustainable Singapore Blueprint articulates Singapore’s commitment to becoming a zero waste nation\textsuperscript{184}. The Blueprint articulates a target to increase the domestic recycling rate to 70% by 2030 with the 2016 recycling rate at 61%.\textsuperscript{185} In addition to this, Singapore has committed to:

- implement better recycling infrastructure and mandate centralised recycling chutes for all high density buildings;
- establish Pneumatic Waste Conveyance Systems in high density building towns to support convenient and hygienic waste disposal;
- build an Integrated Waste Management Facility which will have the capacity to separate recyclables from general waste; and
- introduce initiatives to reduce food waste in the C&I sector and also improve recycling of electrical and electronic waste.\textsuperscript{186}

The Ministry of the Environment and Water Resources and the National Environment Agency (NEA) will be publishing a Zero Waste Masterplan in the second half of 2019. The Masterplan will chart the adoption of a circular economy approach to sustainable waste and resource management. It will detail the key policies and strategies that the Government will be implementing in the next few years, supported by industry transformation and research and development. Policies will include the introduction of the Extended Producer Responsibility approach to managing e-waste by 2021.

A #RecycleRight movement will be launched to encourage Singaporeans to recycle the right way. The public will be educated on the items that can go into the blue recycling bin and the importance of ensuring items are clean and free of food/liquid waste. To support relevant ground-up projects, a ‘Towards Zero Waste Grant’ program will also be established.


\textsuperscript{182} Ibid

\textsuperscript{183} Ibid


The Towards Zero Waste Grant will be used to support ground-up initiatives that drive waste reduction and recycling in any of the three key waste streams – packaging waste, food waste and electrical and electronic waste (e-waste) – or encourage households to recycle more and/or recycle right.

In addition to the 3Rs, Singapore has a number of programs and agreements that support the management of particular waste streams:

- education programs and strategies will focus on:
  - Food waste: buy, order and cook only what you can finish; turn leftovers into new meals; and to donate your excess food;
  - e-waste: buy only what is needed; repair instead of replace; donate reusable items; and recycle e-waste at designated collection points;
- packaging materials: avoid single-use disposables where possible; use reusable bags, containers and utensils; choose products with less/green packaging;
- recycle more: Deposit recyclable waste at designated collection points, e.g. blue bins; and
- recycle right: Do not contaminate recyclables with food or liquid waste.

S$45 million has been invested in harvesting smart technology, as well as research and development.

Bans on plastic bottles within Government are being encouraged.

Options are being examined to extract potentially toxic metals from incineration waste, so that it may be used to mix with construction materials to be used in road construction.

10.3 Waste Generation

As shown in the figure below, total waste quantities generated per capita in Singapore have been trending downwards since 2000.

![Figure 14: Waste Generation](https://data.gov.sg/dataset/solid-waste-management-total-domestic-waste-disposed-per-capita?view_id=e7298947-e719-4904-96a5-81dcb2a61f5d&resource_id=21727bdf-bc4f-4992-9354-8375e9286644)

7.7Mt of waste was generated in 2017 including:

- 60,000 tonnes of e-waste (60% of people do not know how to recycle their e-waste);
• 0.81Mt of food waste was generated in 2017, with 50% generated by households; Of the 1.6 million tonnes of domestic waste disposed in 2017, one third consisted of packaging waste (includes plastics). 40% of materials deposited into recycling bins are not considered suitable for recycling. These include items with food and liquid waste, which contaminate other recyclables. Food waste is one of the biggest waste streams in Singapore and it has grown by 40% over the last 10 years.

Singapore’s waste management statistics for 2017 indicate that approximately 61% of waste generated was recycled during the period.\(^\text{187}\)

**Table 3: Waste Management and Recycling Statistics for 2017**

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Waste Generated (Tonnes)</th>
<th>Waste Recycled (Tonnes)</th>
<th>Waste Disposed (Tonnes)</th>
<th>Waste Recycled %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction debris</td>
<td>1,609,300</td>
<td>1,599,900</td>
<td>9,400</td>
<td>99%</td>
</tr>
<tr>
<td>Ferrous metal</td>
<td>1,578,800</td>
<td>1,571,000</td>
<td>7,800</td>
<td>99%</td>
</tr>
<tr>
<td>Used slag</td>
<td>272,500</td>
<td>269,400</td>
<td>3,100</td>
<td>99%</td>
</tr>
<tr>
<td>Non-ferrous metals</td>
<td>93,700</td>
<td>92,200</td>
<td>1,500</td>
<td>98%</td>
</tr>
<tr>
<td>Scrap tyres</td>
<td>35,900</td>
<td>33,000</td>
<td>2,900</td>
<td>92%</td>
</tr>
<tr>
<td>Wood</td>
<td>424,100</td>
<td>326,800</td>
<td>97,300</td>
<td>77%</td>
</tr>
<tr>
<td>Horticultural waste</td>
<td>328,300</td>
<td>220,700</td>
<td>107,600</td>
<td>67%</td>
</tr>
<tr>
<td>Paper/Cardboard</td>
<td>1,144,800</td>
<td>568,800</td>
<td>576,000</td>
<td>50%</td>
</tr>
<tr>
<td>Glass</td>
<td>71,300</td>
<td>12,400</td>
<td>58,900</td>
<td>17%</td>
</tr>
<tr>
<td>Food</td>
<td>809,800</td>
<td>133,000</td>
<td>676,800</td>
<td>16%</td>
</tr>
<tr>
<td>Ash and sludge</td>
<td>243,400</td>
<td>28,600</td>
<td>214,800</td>
<td>12%</td>
</tr>
<tr>
<td>Plastic</td>
<td>815,200</td>
<td>51,800</td>
<td>763,400</td>
<td>6%</td>
</tr>
<tr>
<td>Textile/Leather</td>
<td>150,800</td>
<td>9,600</td>
<td>141,200</td>
<td>6%</td>
</tr>
<tr>
<td>Other (stones, ceramic, rubber, etc.)</td>
<td>326,400</td>
<td>7,100</td>
<td>319,300</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,704,300</strong></td>
<td><strong>4,724,300</strong></td>
<td><strong>2,980,000</strong></td>
<td><strong>61%</strong></td>
</tr>
</tbody>
</table>


Singapore’s household recycling rate is only 21%, much lower when compared with other developed countries.

As noted in Section 10.6, NEA has setup several recycling facilities that converts C&D waste into secondary aggregates for further processing and reuse, leading to a 99% recovery rate.

Blue recycling bins are being placed at Housing and Development Board flats to improve recycling rates, however, about 40 per cent of the materials in the bins is contamination, demonstrating a lack of understanding of what can be recycled.

Singapore’s efforts towards a zero waste society are hindered by two key factors; the high levels of waste that consumers continue to generate and the difficulties associated with high density buildings. Critical to achieving a zero waste society is the prevention of waste generation and redesigning products so that they can be easily reused and recycled. Singapore’s blueprint is working to educate the public on the importance of waste reduction in addition to improving the rate of recycling.\(^{188}\)

### 10.4 Waste Separation

Solid waste in Singapore is broadly classified into three main categories:

- Domestic refuse is waste generated by households, markets, food centres and commercial premises such as hotels, restaurants and shops;
- Industrial refuse does not include hazardous or toxic waste; and
- Institutional refuse is waste from Government and Statutory Board installations, hospitals, schools, recreational facilities and public development projects.\(^{189}\)

Singapore operates a fairly simple waste management system of waste sorted at source, with recyclables being processed and remaining waste sent to waste-to-energy plants for incineration. The incineration ash and other wastes that are not appropriate for incineration are then transported to the Tuas Marine Transfer Station where they are barged to Semakau Landfill for final disposal.

Singapore operates two collection methods for waste. Direct collection from individual households, private residential estates and shops. Indirect collection is also practiced, as is used for high density buildings where waste is stored in large containers at the base of the block. Indirect collection also includes the centralised refuse chute system that is more common in new builds. In this case, refuse is discharged through common hoppers located in individual flats to a central container. From there the waste is transferred to a collection truck mechanically. This system has improved the efficiency of collection processes.\(^{190}\)

Under the National Recycling Programme, mixed recycling is collected at the kerbside before being sent to a MRF. At this stage recyclables are sorted into different waste streams and sent to local or international recycling plants. Paper, plastic, glass and metal are all sorted for recycling. A significant barrier to Singapore’s progression towards a zero waste society is the lack of local recycling facilities. Sarimbun Recycling Park is a repurposing and landfill site that rents plots of land at a low rate to recycling facilities.\(^{191}\)

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10.5 Waste Recovery

As indicated above, the approximate recycling rate in Singapore in 2017 was 61 per cent. In the same period, 7.7 Mt of solid waste was generated, a decrease of 110,000 tonnes from 2016. The amount of waste recycled fell by 50,000 tonnes from 4.77 Mt in 2016 to 4.72 Mt in 2017. Overall, the recycling rate remained unchanged at 61 per cent from 2016. The recycling rate for construction debris, ferrous metal and used slag is particularly high in Singapore, all of which had recycling rates in 2017 of approximately 99 per cent. The result for construction debris is of particular note given that C&D waste is a major waste stream in Singapore. The NEA has setup several recycling facilities that converts C&D waste into secondary aggregates for further processing into non-structural concrete products for use in new builds or as materials for temporary road access at construction sites.

10.6 Waste Disposal

Singapore is home to four incinerators, Tuas which processes 2,000 tonnes per day, Ulu Padan processing 1,700 tonnes per day, Senoko processing 2,400 tonnes per day and the largest Tuas South processing 3,000 tonnes per day. Singapore remains reliant on incineration and landfill as a key component of its waste management strategy. Semakau Landfill is an offshore landfill that was created to meet Singapore’s disposal needs. The facility covers 350 hectares and has a landfill capacity of 63 million cubic metres. Located 25 km south of mainland Singapore, the landfill only accepts inorganic waste and ash.

Singapore is currently in the process of developing TuasNexus, an Integrated Waste Management Facility (IWMF) and the Tuas Water Reclamation Plan. The IWMF will process 5800 tonnes of waste per day, 250 tonnes of household recyclables collected under the NRP, 400 tonnes of source-segregated food waste per day and 800 tonnes of dewatered sludge.

10.7 Roles and responsibilities

The NEA appoints Public Waste Collectors (PWCs) through open tenders to serve domestic and trade premises in Singapore by various geographical sectors. The companies bidding for the tenders must meet certain criteria. Successful bidders are awarded licenses to provide waste and recyclable collection services. These licenses are for up to eight years.

Singapore also has a general waste collection system. The NEA licenses General Waste Collectors which primarily serve the C&I sector. The type of waste handled by collectors includes inorganic and recyclable waste, organic waste, used cooking oil, sludge from water treatment plants and sanitary waste from ships and aircraft.

196 Ibid
10.8 Data

Singapore publishes a significant amount of waste data, comparable to Scotland and Slovenia. The National Environment Agency is responsible for collecting and managing data on waste. Part of Singapore’s success in providing detailed and transparent provision of data to the public is due to the mandatory reporting of waste requirements for ‘workplaces’ in Singapore. The Environmental Public Health Act was amended in April 2014 to effect mandatory reporting of waste data, and submission of a waste reduction plan by any owner, occupier or lessee of a workplace. This reporting requirement aims to draw greater attention to the amount of waste produced by C&I and C&D sectors as well as how this waste is managed. According to waste legislation, a ‘workplace’ is defined as any premise or place used for industrial, trade, commercial or manufacturing purposes, including construction sites, worksites and farms. As of September 2019, businesses will also be required to submit in their waste reporting the daily recorded waste of their general waste. 197

11 Denmark

11.1 History and background

Denmark presents a somewhat complex policy picture in regard to waste management. The reliance on incineration as a form of waste disposal and public investment in incineration infrastructure makes the effort to reduce waste generation and recycle more, a conflicted one. As an EU member state, Denmark fully complies with directives of the European Commission in regard to waste management. However the small nation of approximately 5.7 million people is known to produce the most waste per capita in the OECD. Denmark has one of the highest waste generation levels per capita at 789kg per capita in 2015. This is approximately 11.3Mt of waste. The public-sector has the responsibility of ensuring that waste collection and treatment is handled properly – and that the rate of recycling is as high as possible, though recycling in Denmark also includes incineration as a form of energy recovery.

Denmark has a long tradition for incinerating waste, with the first plant established in 1903. With space for the landfilling of waste diminishing, numerous cities across Denmark adopted incineration for waste management and heating. This was further embraced during the 1973 Oil Crisis and the 1997 ban on landfilling of all waste which is suitable for recycling or incineration.

The Danish Environmental Protection Agency is the primary authority on waste matters. The administration of waste management and also the regulation of privately delivered waste management services is the responsibility of local and regional councils. Waste management is planned in detail by the local government. Local councils are under the obligation to survey waste amounts and to draw up waste management plans. It is the responsibility of local and regional councils that sufficient incineration and landfill capacity is available. The broad strategic direction of Denmark’s waste management has been focussed around the waste hierarchy. Recent strategies have articulated that prevention is the top priority, though few actions have been fully effective in supporting this goal. Denmark’s waste management is perhaps better described as a system that relies heavily on waste-to-energy as a method for treatment.

In 2011, the Danish Government released a national waste management strategy ‘Denmark Without Waste, Recycle More and Incinerate Less’. The strategy identified four priority areas:

- Reducing incineration rates and retaining value of resources;
- Reduce environmental impacts from waste;
- Improve recycling rates and qualities;
- Re-organisation of waste management to involve public-private partnerships.

Municipalities will have primary responsibility for waste schemes, especially household waste.

The strategy focused heavily on moving away from incineration as a primary treatment approach to improving the quality and volume of products that were recycled. In 2011,

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198 Sources: Waste and Resource Network Denmark https://dakofa.com/
approximately 9 million tonnes of waste was generated. Of this waste, 61% of was recycled (including recovery via incineration or thermal treatment), 29% was incinerated for final disposal and 6% was landfilled. For household recycled waste, (organic waste, paper, cardboard, glass, wood, plastic and metal waste) the incineration rate was approximately 75% in 2011. Decreasing quantities of incineration was seen as a key mechanism to achieve the strategy’s goal to double recycling rates of household waste.\footnote{The Danish Government. (2013). Denmark without waste: recycle more- incinerate less. Sourced from: https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Ressourcestrategi_UK_web.pdf}

In 2013, the Danish Government launched another waste management strategy entitled \textit{Denmark Without Waste}, which focused on improving the recycling of waste. The Strategy also addressed the consumption of raw materials in the production cycle. Despite this Strategy, Denmark Denmark’s historical reliance on incineration to divert a significant portion of waste from landfill remained. In addition to this, volume of waste generated continued to increase.


The legislative framework that provides governance of Denmark’s waste management includes one major piece of legislation and a series of Statutory Orders:

- the Danish Environmental Protection Act;
- the Statutory Order on Deposits and collection;
- the Statutory Order on Packaging;
- EU Reach Regulation.

In 2015, the Danish government released \textit{Denmark without Waste II} a second generation strategy to reduce waste generation and reform waste management in Denmark. The Danish government has set a goal that 50% of household waste will be recycled by 2022\footnote{Recycling rate is not inclusive of incineration. Ministry of Environment and Food of Denmark (2019) Denmark Without Waste II – A Waste Prevention Strategy. Sourced from: https://eng.mst.dk/air-noise-waste/waste/denmark-without-waste-ii/}. This sits slightly below the EU target of 55% MSW recycled by 2025. The waste prevention strategy seeks to reduce wastage of resources and prevent waste generation. Key areas of action outlined in the strategy include preventing food waste, reducing pollution from the textile sector, recycling and reuse of electrical and electronic equipment as well as the overall reduction of the packaging produced\footnote{Ibid}.

Key objectives outline in the strategy included:

- improve the resource efficiency of Danish enterprises;
- facilitate consumers to buy products and services that require fewer resources and fewer problematic substances and that generate less waste;
- reduce food waste at all stages of the value chain;
• enable the building and construction industry to act in a more resource efficient way and
shift to safe and environmentally sound substances, and improve knowledge sharing
across the sector;
• support textile companies to reduce environmental impacts in the production phase and
make it easier to reuse and recycle textiles, in part by reducing the use of hazardous
substances in textiles;
• simplify the reuse and recycling of electronics and electronic waste, so that the life of these
products is extended and they are better integrated into the circular economy; and
• reduce the environmental impact of packaging.

The commitments behind these objectives will be discussed in greater detail below.

No quantitative targets are mentioned in the strategy. Whilst the strategy adopts a circular
economy approach, in contrast to other jurisdictions such as Scotland and Ontario, the
strategy focusses predominantly on maximising the resource efficiency of products. The
strategy does not discuss the efficiency of waste collection, sorting, treatment and disposal.

With close to half of Denmark’s waste being recovered for energy or incinerated for disposal,
and most incineration plants being publicly owned, there is significant investment from a
range of participants that is likely to ensure that extracting waste from energy and specifically
incineration remains the dominant management method.205

11.3 Policy levers

Policy instruments

Historically Denmark has used a combination of administrative instruments (acts, orders,
circulars), and economic instruments covering taxes and charges as well as subsidy schemes:

• a general state tax is applied to waste. The tax is differentiated so that it is most expensive
to landfill waste, cheaper to incinerate it and tax exempt if waste is recycled;
• a landfill ban on combustible waste to incentivise energy recovery;
• a "green" tax is also applied to certain materials such as packaging, plastic bags,
disposable tableware and nickel-cadmium batteries;
• deposit and return systems were established for a number of packaging types;
• municipal councils were allowed to charge fees to finance their waste management
programs;
• for certain types of products such as tyres and lead accumulators special fees were levied
to finance their collection and recycling;
• subsidy schemes were established to fund projects targeting cleaner technology or solving
waste problems.

Agreements were also entered into with industry, councils and other organisations to meet
environmental targets in the waste area (e.g. treatment of building materials and CFC-
containing refrigerators).

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https://eng.mst.dk/air-noise-waste/waste/denmark-without-waste-ii/
Denmark Without Waste II contained 72 initiatives including:

**Transition in Danish businesses – efficient use of materials**

The Strategy includes a number of initiatives to transition Danish businesses to operating with a more efficient use of resources. These initiatives involve funding new programs through the Danish Green Investment Fund, funding small to medium sized business from the Pool for Green innovation and also supporting the development and implementation of green business models. Initiatives also include a taskforce to investigate regulatory reform to remove barriers to increasing resource efficiency and developing tools and guidance with the Ellen McArthur foundation. These approaches may seem high level, however, they establish a framework for the national strategy in the context of a country where waste management is directly regulated and managed by local and regional councils.

**Green consumption – intelligent procurement practices**

The strategy proposes initiatives to improve procurement practices so that they are more orientated towards a circular economy approach. This includes subsidising local projects that promote green transition and resource efficiency in procurement, expanding the ‘mind the trash’ education material across schools, establishing a green procurement taskforce to offer assistance to municipalities, regions and national government to develop a ‘green’ procurement approach. Denmark has already demonstrated success in Green Procurement (see Section 11.3.1).

**Less food waste**

The Strategy commits to a partnership for the reduction of avoidable food waste with businesses and organisations, establishing a team of ‘food waste hunters’ who will offer their assistance in the public and private food service sectors, and innovation consortiums on minimising food waste and also again working at a regulatory level to exempt more food products from the regulations on shelf-life labelling.

**The construction sector**

Initiatives in the construction sector include tightening requirements for building demolition and the qualifications for companies, considering the sustainable use of chemicals in products, analysing technologies for removal of hazardous substances from buildings, as well as establishing a taskforce on sustainable building materials.

**Clothing and textiles**

Initiatives behind the clothing and textiles objective includes a partnership to prolong the durability of clothes between businesses and organisations, subsidising businesses that want to ecolabel their textiles, adopting environmental targets for the public procurement of textiles and textile services and also reducing harmful chemicals in textiles.

**Electrical and electronic equipment – longer life span and fewer substances of concern**

Initiatives regarding electrical and electronic equipment include an analysis of barriers and opportunities to promote reuse and repair of electrical and electronic equipment, a survey of potential reuse and repair opportunities, development and continuous revision of the Nordic Ecolabel and the EU Ecolabel for electrical and electronic equipment, a voluntary agreement with industry to promote eco-design, ban on hazardous substances and a campaign about the content of mercury in energy saving bulbs and the benefits of LED alternatives.

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206 Ibid
Packaging – more than just pretty wrapping

Initiatives regarding packaging are not as fulsome as the others. There are a few reasons for this, Denmark already imposes a packaging tax (discussed at Section 11.6.1). Plastic packaging is also an energy rich source for incineration, and therefore incentivising genuine recycling and re-use may be contrary to the energy industry’s desires and position. Initiatives articulated in the strategy involve a partnership between businesses and organisation, and include inspection campaigns targeted at selected types of packaging and an information campaign and subsidies for the development of environmental technologies to increase the rate of recycling and establish more closed-loop value chains for packaging waste.

11.3.1 Public Procurement (Partnership for Green Public Procurement)

Transitioning to a zero waste society and adopting a circular economy approach significantly impacts public procurement. In Denmark, the public sector procures good services for approximately EUR 38 billion annually. To contribute to Denmark’s commitment to reduce waste, the government has reformed public procurement practices to support the market to transition to a closed-loop circular economy. The Partnership for Green Public Procurement (GPP) is a collaborative initiative between Danish regions, municipalities and the Ministry of Environment and Food. It is based on joint, mandatory procurement objectives. Obligations under the partnership include:

- to follow jointly specified green procurement objectives;
- to have a procurement policy in which environmental concerns play a significant part;
- to publish the procurement policy on the respective authority’s website.

14 partners are involved and have committed to integrating green goals into their procurement policies as well as using green products for 11 specific product groups. Criteria for green procurement includes the recyclability of a product, the chemical composition, the lifespan and total cost of ownership.

11.3.2 Financial levers

Denmark has a series of taxes in place to deter waste generation. These taxes target raw materials consumption, volumes of waste produced and landfilled and also promote green products. In addition to this, there are several State-owned funds, programmes and pools to support the transition for businesses to be more resource efficient. Examples of these funds include the ‘Green Development and Demonstration Program’ which typically funds projects with a budget between DKK 50 000 and DKK20 million.

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11.4 Waste Generation

Denmark has the highest rate of waste generation per capita in the EU and the OECD. In 2016, Denmark reported to generate 779.1kg/capita. Every Dane consumes 160kg of packaging a year. Around half of the total amount of packaging consumed ends at households before being thrown away. Eurostat reports in 2017, Denmark recycled approximately:

- 213kg per capita;
- 149kg per capita of organic waste; and
- 413kg per capita of waste was recovered or about 2.38Mt.\(^\text{214}\)

Denmark has the highest share of MSW in the EU, incinerating around 55% for energy recovery.\(^\text{215}\) Depending on the municipality, waste is either source separated for collection or is collected as mixed waste. Since the introduction of the first Denmark without Waste Strategy, total recycling rates have increased from 67% in 2013, to 68% in 2015.\(^\text{216}\)

Recovery of waste for energy remains a significant treatment stream for all waste in Denmark. The Scientific Foresight Unit prepared a report for the European Parliament in 2017 titled Towards a Circular Economy – Waste Management in the EU\(^\text{217}\). This report presented Denmark as a case study for review. It noted that Denmark has up to 27 dedicated waste to energy facilities distributed across the country. Despite the Denmark without Waste II strategy’s shift in focus to prevention and recycling, incineration remains the most popular way to treat waste. However, since the release of the 2013 Denmark Without Waste strategy, incineration rates for overall waste treatment have declined by 1% per annum.\(^\text{218}\)

Most incineration facilities are publicly owned and provide district energy and heating, creating a significant conflict with the Government’s move towards a waste free society. The Danish government’s efforts to reduce the volume of waste generated and increase the amount of waste recycled has impacted the waste-to-energy sector, such that Denmark imports waste for incineration to maintain incineration capacity and operating efficiencies. The import of waste for incineration increased from 5% to 11% in 2015.\(^\text{219}\)


Figure 15: Waste Generation by Treatment Type – Denmark

<table>
<thead>
<tr>
<th>Year</th>
<th>Recycling and other material recovery</th>
<th>Incineration for disposal</th>
<th>Landfilling and other disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>67%</td>
<td>29%</td>
<td>4%</td>
</tr>
<tr>
<td>2014</td>
<td>68%</td>
<td>28%</td>
<td>4%</td>
</tr>
<tr>
<td>2015</td>
<td>69%</td>
<td>27%</td>
<td>4%</td>
</tr>
</tbody>
</table>


11.5 Waste Separation

Source separation has been a key element of Danish waste management. For certain wastes (paper, cardboard and glass) collection systems with source separation have been implemented. These schemes enjoy widespread acceptance and are used extensively by citizens and enterprises.

The Order on Deposits and Collection mandates local authorities to introduce collection schemes for paper and cardboard, recyclable glass packaging waste and recyclable metal and plastic packaging waste. This Order does not require that the different products are source separated but they are treated separately. Demand is growing for a kerbside collection service or a door-to-door service. There is no legislated requirement for separate collection of bio-waste, however many municipalities have provided an option for garden waste. Plastic packaging is not separated from household waste in Denmark. The costs for its management are born by the local authorities, with the exception of glass.

With several municipalities in Denmark not separating waste at source, Copenhagen’s 2018 Waste Management Plan made a commitment to change consumer behaviour, requiring local authorities to facilitate source separation of household and business waste. Residents separate their waste into: bulky waste, cardboard, electronics, garden waste, glass, organic waste, plastic, hazardous waste, metal, paper and residual Waste (non-recyclable waste).

Copenhagen council provides waste bins and collects waste. If residents do not wish to have as many different bins on their property, they must take their recyclables to a collection centre. Businesses pay to subscribe to a recycling service. Previously, businesses had free access to a recycling centre if they paid their property tax. With the privatisation of the waste management sector, commercial businesses and industry are now responsible for arranging...
their own collection or separating their waste and transporting it to collection centres. This has resulted in higher rates of contamination of waste.

11.6 Waste Recovery

Since the introduction of the first *Denmark without Waste Strategy*, total recycling rates have increased from 67% in 2013, to 68% in 2015. As noted previously recovery of waste for energy is a significant treatment stream of all waste in Denmark.

Table 4: Industry and Household Waste Generation – Denmark

<table>
<thead>
<tr>
<th>Industry and Household - Denmark (1000 Tonnes)</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Waste Generated*</td>
<td>11,536</td>
<td>11,397</td>
</tr>
<tr>
<td>Recovery of Waste (including incineration)</td>
<td>7,784</td>
<td>7,711</td>
</tr>
<tr>
<td>Incineration of Waste</td>
<td>3,085</td>
<td>2,991</td>
</tr>
<tr>
<td>Disposal of Residual Waste (landfill)</td>
<td>471</td>
<td>418</td>
</tr>
<tr>
<td>Special Treatment of Waste</td>
<td>101</td>
<td>113</td>
</tr>
<tr>
<td>Temporary Storage of Waste</td>
<td>96</td>
<td>74</td>
</tr>
<tr>
<td>Incineration of Waste %</td>
<td>26.7</td>
<td>26.5</td>
</tr>
<tr>
<td>Disposal of Residual Waste (landfill)%</td>
<td>4.1</td>
<td>3.7</td>
</tr>
</tbody>
</table>

*Soil waste is not included in this table*

*Source: Statistics Denmark, 2018.*

11.6.1 Packaging Legislation in Denmark

Lifecycle assessments are performed on each packaging material to determine the rate of tax to be charged to households per unit weight. The aim of the packaging tax is to reduce waste and create incentives to use less packaging. The charge consists of four tax items:

- A volume-based tax designed as a unit duty on certain beverage containers;
- A weight-based tax on carrier bags of paper and plastic;
- A weight-based tax on disposable tableware; and
- A weight-based tax on PVC foils for food.

Tax Levy rules apply to parties including manufacturers, distributors, re-fillers of beverage containers, importers and distance sellers. Conclusions have been drawn that this system of taxation for packaging has incentivised high recycling rates of packaging, noting that most of the plastic is incinerated for energy and not recycled into recyclate material.

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223 Ibid
11.7 Roles and Responsibilities

Denmark’s legislative framework outlines the roles and responsibilities for waste management. Currently, there is no producer responsibility scheme in Denmark. When the European Commission introduced the Packaging Directive in 2001, Denmark had already exceeded the recycling targets outlined in the Directive. Denmark is therefore the only EU member state that employs an internal, government run system (tax) to bear the cost of processing transferring responsibility to Industry.\(^{227}\) Part of the motivation behind this is due to the value of packaging in terms of how much energy it produces when incinerated. Requiring producers to pay for the end-of-life disposal of packaging, when it is a commodity in Denmark is counter-productive. Instead, companies are taxed on packaging to encourage ‘recycling’ via a method other than energy recovery.

The organisation of waste management activities differs across municipalities. Large municipalities typically choose to manage waste themselves. Smaller municipalities cooperate in inter-municipal waste companies.

Private companies provide services in respect to the collection of household waste and industrial and commercial waste, as well as providing recycling services.

A network of inter-municipal transfer stations is in operation for the management of hazardous waste, servicing most municipalities in Denmark. A few municipalities handle hazardous waste internally.

11.8 Data

Denmark publishes an annual report that details waste statistics. The report provides detailed descriptions of the quantity of waste generated in Denmark, disaggregated by waste types and treatment options. The report is published by the Danish Environmental Protection Agency, and is based on data that is reported to the Waste Data System (Affaldsdatasystemet – ADS).\(^{228}\) This data is sometimes supplemented with data from external sources, particularly in relation to data on residual waste, from biomass firing.

The Danish EPA and municipalities are jointly responsible for the quality assurance of waste data reported to the ADS. Data is not presented in these reports at the municipal level as the data quality is not sufficient and may demonstrate incorrect trends. Raw data can be accessed by the public from both the Danish EPA and the ADS, though all data and information is in Danish.

Denmark’s reported data quality issues means that information available is limited. There is no articulated and published strategy to improve the data available to the public.

\(^{227}\) Pro Europe. (2019). Packaging waste legislation in Denmark. Sourced from: https://www.pro-e.org/Denmark

12 Jurisdiction comparison and considerations for NSW

12.1 Waste Statistics

The following section summarises the performance of the various jurisdictions considered in this report across a common set of measures. The data indicates that jurisdictions with a higher gross domestic product such as Denmark generate more waste per capita. This may be related to the consumer behaviours of these jurisdictions, and the propensity to buy more products and/or due to waste policy historically focussing on recycling and diversion rather than the volume of waste produced and reused.

Table 5: Jurisdiction comparison across key metrics

<table>
<thead>
<tr>
<th>Jurisdiction type</th>
<th>NSW</th>
<th>Netherlands</th>
<th>San Francisco</th>
<th>Scotland</th>
<th>Slovenia</th>
<th>Ontario</th>
<th>Singapore</th>
<th>Denmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (millions)</td>
<td>7.95</td>
<td>17.2</td>
<td>0.88</td>
<td>5.4</td>
<td>2.1</td>
<td>14.4</td>
<td>5.64</td>
<td>5.8</td>
</tr>
<tr>
<td>Total waste generated (MT)</td>
<td>21.4</td>
<td>59.86</td>
<td>2.9</td>
<td>10.79</td>
<td>6.17</td>
<td>9.48</td>
<td>7.7</td>
<td>11.3</td>
</tr>
<tr>
<td>MSW waste generated per capita (kg, 2015)</td>
<td>570</td>
<td>523</td>
<td>na</td>
<td>481^</td>
<td>446</td>
<td>na</td>
<td>313.9</td>
<td>788</td>
</tr>
<tr>
<td>Recycling rate (2015) %</td>
<td>65</td>
<td>81.9</td>
<td>76</td>
<td>56.4</td>
<td>57</td>
<td>65</td>
<td>61</td>
<td>69</td>
</tr>
<tr>
<td>(2017 waste diverted)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSW recycling rate %</td>
<td>42</td>
<td>24</td>
<td>na</td>
<td>44</td>
<td>58</td>
<td>57.7</td>
<td>na</td>
<td>46</td>
</tr>
<tr>
<td>(2017 waste diverted)</td>
<td>2017</td>
<td>(2014)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incineration for disposal rate %</td>
<td>na</td>
<td>15.4</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>27</td>
</tr>
</tbody>
</table>

*estimated based on waste generated per capita, 3.3 tonnes p/y (https://medium.com/sustainable-food-systems/san-franciscos-race-to-zero-waste-has-one-last-major-hurdle-6c76ca8f2f86)

^estimate for whole of UK

Source: Various – detailed by jurisdiction in this report.

Noting the data limitations in the information presented above, it is still possible to make a few observations regarding waste generation and management across the benchmarking group. For example, despite having a population of just under double NSW, Ontario produces only 9.48 Mt of waste compared to 21.4 Mt for NSW. As has been presented throughout the

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229 There is likely to be some difference in how waste generation is measured in the two jurisdictions.
report, Denmark has a significantly higher amount of waste generated annually than all of its European neighbours. The factors contributing to this have already been discussed, as has the reason for the high recycling rate (as it includes incineration as a method of recovery).

Performance in recycling is relatively stable across the benchmarking group. Recycling of waste from all sources is highest in the Netherlands, with a recycling rate of 81.9%. MSW recycling rates are significantly lower given the difficulties associated with consumer behaviour and source separation, and the treatment of food and organic waste. The highest rate of recycling for MSW is Slovenia at 58% which is 35 percentage points higher than the published MSW recycling rate for Slovenia in 2010. The remainder of the benchmarking group demonstrate consistent figures in the low 40s for MSW recycling rates.

Also worth noting is the inconsistency in reporting of incineration rates. Given that countries such as the Netherlands, Singapore and Denmark utilise incineration as a method of both energy recovery (and therefore label as recycling), as well as for final disposal, extracting clear and consistent incineration data is challenging. What is evident is that Denmark and the Netherlands succeed in extracting energy from a significant proportion of waste. In jurisdictions such as Ontario, Slovenia and Scotland, incineration is not significant enough a method for treating waste to report on.

What is missing from table 5 is comparable data on C&I and C&D waste streams. This is partly due to a consistent lack of data across the benchmarking group. For both these waste streams, it is more generally the responsibility of individual businesses to contract waste management service providers to deal with their waste. As a result of this, it is very difficult to obtain data on how much is being produced that is accurate enough to compare across jurisdictions. Where possible this data has been discussed in each chapter.

NSW must consider the relative volume of waste being produced in each stream and the rate at which it is being recycled or recovered. Benchmarking suggests that on a statistical basis, NSW is some way behind other jurisdictions in its ability to not only demonstrate performance against identified measures, but in terms of its recycling and energy recovery capability. There is significant benefit in tracking statistics relative to new policy measures and levers employed over the next five years to determine whether there is a significant decline in waste generation. This would provide the best indicator of success, as there is insufficient information to draw conclusions regarding NSW at this stage.

The figure below presents information on the treatment of waste across the benchmarking group. There are limitations with the data sources used to support this, as noted in Section 1.4. The reported data is also inconsistent across the benchmarking group, with certain jurisdictions not reporting at all for certain treatment categories and also defining what is included as ‘recovery’, ‘recycling’ and ‘disposal’ on a different basis.

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230 Including treating waste via thermal treatment or incineration for energy recovery
It is worth noting the amount of waste that is incinerated for recovery in Denmark, the United Kingdom and the Netherlands. The above analysis indicates that despite the shift in strategy towards the prevention of waste generation, the incineration of waste remains the most significant treatment stream in Denmark. The population’s dependence on waste-to-energy for energy price reliability, and strong industry investment remains the main barrier to Denmark’s waste prevention and recycling targets.

In contrast to this, the data above demonstrates that Slovenia’s largest waste treatment stream is the recycling stream with 199 kg of MSW recycled, followed by 73kg/capita of waste composted, compared to the 36kg/capita recovered for energy. The success of Slovenia’s material recycling and composting is due in part to the separation of waste at source, and a successful PPP that delivers effective waste sorting and treatment.

Table 6: Recycling Rates in 2015 for all waste streams

<table>
<thead>
<tr>
<th>Recycling Rates %</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Netherlands (recycling not including recovery)</td>
<td>51.8</td>
</tr>
<tr>
<td>San Francisco</td>
<td>76*</td>
</tr>
<tr>
<td>Scotland</td>
<td>56.4</td>
</tr>
<tr>
<td>Slovenia</td>
<td>57</td>
</tr>
<tr>
<td>Ontario</td>
<td>65</td>
</tr>
<tr>
<td>Singapore</td>
<td>61</td>
</tr>
<tr>
<td>Denmark</td>
<td>69</td>
</tr>
<tr>
<td>NSW</td>
<td>65</td>
</tr>
</tbody>
</table>

*San Francisco’s recycling rate is estimated due to information not released by Recology

12.2 Strategy considerations

12.2.1 Circular Economy

Scotland’s Circular Economy Strategy is unique among its European partners in two ways: it explicitly includes a target on overall waste reduction (and is the only jurisdiction in the benchmarking group to do so), and it explicitly includes a target on food and organic waste. In addition to this, Scotland’s goal to achieve Zero Waste by 2050 through a circular economy approach is pragmatic and forward thinking, considering all aspects of the production cycle.

Many aspects of Scotland’s strategy would be transferrable to NSW. However, NSW would need to consider the regulatory arrangements that would support the strategy and work with local councils to move towards mandated source separation and reduce the rates of waste contamination. Scotland’s targets around reducing overall waste generation, and also reducing food and organic waste are significant and a recommended approach for NSW. Scotland’s targets are also set against a transparent baseline with an interim goal of reducing waste by 2025 and the overall goal of zero waste by 2050.

The Netherlands is also seeking to reduce waste generation through a circular economy approach. The target to reduce all raw materials used in production by 50% by 2030, is a major component of its strategy. The success of this target will be determined by the policy levers that support it. Slovenia, similar to the Netherlands, has only recently released a ‘roadmap’. This roadmap provides a broader socio-economic picture of a circular economy, with waste management an element of the broader vision. Whilst an approach that would be interesting to consider across NSW, in the context of waste management, it does not provide enough specificity to form a decisive view on how it could benefit NSW.

Denmark’s strategy perhaps does not lend itself to the NSW context, in its current form. The strategy’s focus on resource efficiency is important and a key element of a circular economy approach but its commitment to incineration will potentially inhibit a shift towards significant improvements in waste recycling.

Ontario’s strategy for circular Economy articulates a zero waste target by 2050. Whilst this strategy is quite similar to circular economy strategies of European countries, it does raise the importance of stimulating end-markets and reviewing product standards to ensure that recyclate has equity of access to the market. Ontario has not yet provided this stimulus and achieved the desired outcomes.

12.2.2 The Waste Hierarchy and the Three R’s

San Francisco perhaps presents one of the more unique approaches of the benchmarking group. Instead of pursuing a circular economy approach, San Francisco is pursuing a ‘zero waste’ goal. Given that San Francisco is a city governed by the one local authority, compared to other jurisdictions analysed, the simple approach is fit for purpose.

The success of San Francisco’s kerbside collection program and single provider of waste management has allowed for a streamlined approach to collection, separation and processing. The use of diversion rates however, may potentially obscure the effectiveness of San Francisco’s waste management facilities in sorting waste, or processing waste. Diversion rates also ensure that focus remains almost entirely on management of waste once it is in the cycle. To truly reach zero waste, San Francisco will have to make a significant change in its current strategy to actively pursue a reduction in the use of raw materials, an increase in reuse and a reduction in overall waste generation. In summary, the “fantastic three” kerbside collection is the key tenet of this strategy, and whilst successful in increasing the diversion rate, it is reliant on significant regulation to ensure its success. The use of a single service provider for collection and processing, supports a consistent approach across the city and has contributed to the success achieved to date.
In comparison to San Francisco, European countries Slovenia, Denmark, the Netherlands and Scotland present a united approach to adopting a circular economy. This is largely due to the European Union’s 2018 Circular Economy Package and the 2015 EU Action Plan for a Circular Economy.\textsuperscript{231}

Singapore’s approach is not as significant to NSW at the strategic level. With a focus on the waste hierarchy, and a dominant use of recycling and incineration for energy recovery, Singapore’s approach to a waste strategy perhaps is not advanced as others in the benchmarking group. Whilst the waste hierarchy as a concept remains relevant, it continues to justify landfill and incineration as methods for treating waste. With most societies seeking to become ‘zero waste’, landfill is almost eliminated as an option for waste management.

Singapore’s approach is more relevant in regard to policy levers employed and waste management services delivered in high density areas. Singapore is early in its recycling journey and has significant education and infrastructure investments to make to deliver increased recycled and reduced incineration. The release of Singapore’s detailed implementation map later this year may be useful in identifying alternate policy levers.

Whilst San Francisco’s success is unclear, given the lack of transparency involved in disclosed diversion rates, the strategic intention behind source separation and kerbside collection has been successful. Slovenia’s system of source separation confirms this point, having made significant progress over the last two decades.

All jurisdictions present lessons for NSW. The staged approach to achieving a circular economy adopted by The Netherlands should be of particular interest to NSW, with the policies of other jurisdictions providing NSW with an indication of specific programs that might help achieve a successful staged circular economy.

### 12.2.3 Recommendations for NSW Strategic Direction

**Circular Economy**

Transitioning to a Circular Economy will ensure a holistic approach is taken to waste management, production and consumption. Targets to reduce raw materials, or reduce overall waste demonstrate a significant commitment to delivering a closed loop cycle. This is critical to delivering a true circular economy. As has been noted above, many strategies focus heavily on the recycling and recovery elements of a circular economy and fail to appropriately address the importance of waste prevention, reduction and re-use of materials. If NSW were to consider leveraging a circular economy strategy, it would be essential that prevention and reduction are of equal importance as recycling and recovery.

### 12.3 Policy lever considerations

The table below summarises the policy levers employed across the benchmarking group. Indicators are based on published information and feedback from international experts and key stakeholders. For example, Denmark has not articulated a strategic direction towards a zero waste program, nor has the Netherlands. Where strategies have previously included the ‘waste hierarchy’ for a foundation, this has also been included, noting that most jurisdictions are no longer relying on the waste hierarchy as it conflicts with their zero waste program or circular economy approaches.

12.3.1 Recommendations for NSW

Common levers employed across the benchmarking group, which would reduce NSW’s barriers to recycling and improve waste disposal practices include:

- regulated waste management systems that direct actions to support policy objectives and provide strong incentives to avoid non-compliance;
- legislating requirements for source separation of MSW and C&I for food and organic waste, recycling and general waste, and regulating contamination rates across these streams;
- extended producer responsibility for products and packaging in a structure similar to Ontario or the Netherlands; and
- financial disincentives such as a landfill or incineration tax.

San Francisco’s PAYT scheme offers an interesting opportunity for NSW. Consumers refuse rates end up funding the entire waste management system. The scheme is structured in a way

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**Table 7: Comparison of policy levers for waste management**

<table>
<thead>
<tr>
<th></th>
<th>San Francisco</th>
<th>Ontario</th>
<th>Singapore</th>
<th>Scotland</th>
<th>Denmark</th>
<th>Slovenia</th>
<th>Netherlands</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Strategy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>Waste Hierarchy</td>
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<tr>
<td>Zero Waste Program</td>
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<td>Circular Economy</td>
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<tr>
<td>Legislative Framework</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandatory requirements for source separation</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>❌</td>
<td>✔</td>
<td>✔</td>
<td>❌</td>
<td>❌</td>
</tr>
<tr>
<td>Mandatory Requirements for recycling</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>❌</td>
<td>✔</td>
<td>✔</td>
<td>❌</td>
<td>❌</td>
</tr>
<tr>
<td>Landfill Ban</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>✔</td>
<td>❌</td>
<td>✔</td>
<td>✔</td>
<td>❌</td>
</tr>
<tr>
<td>Single-use Material Bans</td>
<td>✔</td>
<td>❌</td>
<td>❌</td>
<td>✔</td>
<td>❌</td>
<td>❌</td>
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<td>❌</td>
</tr>
<tr>
<td>Financial Incentives</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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</tr>
<tr>
<td>Landfill tax</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Packaging Tax</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Pay-as-you-throw</td>
<td>✔</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>✔</td>
</tr>
<tr>
<td>Innovation Funds</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>❌</td>
</tr>
</tbody>
</table>

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232 This table is reliant on information sourced elsewhere in this report and only presents a summary of key findings based on research.
to incentivise recycling and de-incentivise generating waste for landfill, accompanied by the Mandatory Recycling Ordinance and the Construction and Demolition recycling ordinance. This is not dissimilar to the NSW landfill levy (albeit the difference in approaches to utilisation of the levy proceeds is noted) and the approach of some individual Councils to charging ratepayers different amounts for waste collection dependent on the size of their rubbish bin.

Scotland, Ontario, Slovenia and Germany provide examples of a highly regulated waste management sector. Scotland’s requirements to separate at source, and also for the commercial sector to separate food and organic waste of more than 5kg per week, along with other bans and taxes have resulted in a transparent and clear approach to implementing a circular economy. Significant penalties and mandated requirements for recycling across all three waste streams, are contributing to an increase in recycling rates.

Denmark has taken a unique approach of not mandating a producer responsibility scheme, and instead bearing the cost of collection and recycling for products and packaging. This approach is reflective of their reliance on waste to energy as a valuable form of managing waste. In addition to this, placing the onus on producers to pay for their waste would reduce the profitability of the waste to energy market, which is a key source of energy for the nation. This is not an approach that would be recommended for NSW. Denmark does, however, provide interesting examples of financial stimulus to encourage businesses to be more resource efficient.

As has been noted in the Situational Analysis Report, NSW has a significant challenge in recycling plastics and packaging. San Francisco, Ontario, Scotland, Slovenia and the Netherlands all have robust policy and regulatory responses to address plastic packaging in the form of mandated separate collection, mandated recycling and a producer responsibility scheme. In addition to these examples, Germany presents an interesting case study of legislated responsibility for producers to manage end of life product disposal, or risk disqualification from the domestic market (see Section 8.3 of Volume II).
12.4 Infrastructure

As demonstrated in the analysis of each country below, there has been a varied approach to the technology and end disposal method utilised from jurisdiction to jurisdiction:

Table 8: Comparison of jurisdictions by key infrastructure

<table>
<thead>
<tr>
<th>Material Recovery Facility</th>
<th>San Fran</th>
<th>Ontario</th>
<th>Singapore</th>
<th>Scotland</th>
<th>Denmark</th>
<th>Slovenia</th>
<th>Netherlands</th>
<th>NSW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mechanical Biological Treatment</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>Anaerobic Digestion and/or Compost</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Incineration – Waste to Energy</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Landfill</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Jurisdictions such as Slovenia, the Netherlands, Scotland and Ontario have access to a wide range of infrastructure. Interestingly, Slovenia and Scotland unlike the Netherlands do not treat much waste through the process of incineration despite having access (even if limited) to the relevant technology. MRFs, MBT and Anaerobic Digestion are common across most of the jurisdictions reviewed.

One trend that is becoming clear is the move away from landfill and incineration as a waste management method. Whilst deriving energy from waste is still utilised, this should be a method of last resort and only after other circular economy methods have been exhausted. The current focus of technology innovation has been on the creation of end markets and to support waste minimisation and separation at source and recycling infrastructure, including plastics recycling facilities.

Recommendations for consideration by NSW include investing in advanced MRFs such as those in Slovenia and San Francisco, MBT and infrastructure for Anaerobic Digestion. Whilst NSW relies on landfill for most end-disposal, significant policy changes should be implemented to change this. Landfill, despite NSW’s capacity, produces significant CO₂ emissions, is contrary to a circular economy approach and should be the least desirable option for NSW.

The use of waste-to-energy infrastructure warrants a broader discussion and consideration as, whilst it is an alternative energy source, infrastructure that produces limited CO₂ is incredibly costly and its future utilisation may be linked to only specific circumstances.

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233 This table is reliant on information sourced elsewhere in this report and only presents a summary of key findings based on research.
12.4.1 Discussion on Waste to Energy

Waste to energy is a broad term that encompasses more than just incineration. Some forms of waste-to-energy also fit into different element of the waste hierarchy. As noted in the report previously, anaerobic digestion and composting are becoming the primary treatment methods to recover the value of food and organic waste. The trend demonstrated across the EU, specifically in places like Scotland and Slovenia, is an increase in food and organics being treated by anaerobic digestion and producing compost. The same is also seen in San Francisco (noted in Section 6.6) with the work that Recology is doing to convert food and organic waste into compost essentially supplying the Napa Valley.

High temperature destruction or incineration is another form of ‘other energy recovery’, which produces solid, liquid or gaseous substances that can be used for energy. Denmark, the Netherlands and Singapore are prime examples of jurisdictions that utilise this technology to power their countries. Whilst this remains a key source of energy for jurisdictions such as Denmark, it is not a renewable resource, as waste is still made from finite resources. Incineration also releases CO2 emissions, though academic literature notes that it is difficult to quantify these emissions given the various composition of waste that is incinerated. Incinerators are also expensive, with the City of Copenhagen’s Amager Bakke incinerator (though advanced technology) costing the city 500 million euros. As Copenhagen is learning, the relative value of the materials being incinerated in terms of recycling or re-use in contrast to the cost of incinerating them for disposal or energy is an important consideration.

Incineration for final disposal has a potential role to play in the treatment of waste. However this role is becoming smaller over time as the amount of residual waste is decreasing. In spite of the moves towards a zero waste society, and a more circular economy for the foreseeable future there will always be some residual waste that requires treatment, and a treatment option that is better preferred over landfill.

Somewhat surprisingly, waste to energy infrastructure investment has been on the increase in the EU. However, these facilities are being developed with greater capacity for anaerobic digestion and energy recovery and lesser capacities for final disposal. With the EU’s transition towards a circular economy, the amount of waste generated is being reduced, the amount of waste for recycling is increasing and the resource efficiency and sustainability of products is improving, making significant investment in new incineration infrastructure potentially unwise. There have also been significant lessons learnt on waste to energy technology. Pyrolysis and gasification technology has not been proven at scale.

12.4.2 Stimulating Infrastructure Growth and a Market for Recyclates

An OECD report published in 2018 found that the recent National Sword policy from China has significantly disrupted the global market for recyclables. Currently there is a lack of coordination across the waste management sector. Potential suppliers of recycled plastics have not sufficiently invested in sorting and recycling capacity because the profitability is minimal. Potential buyers such as manufacturers have limited incentives to use recycled plastics because of the uncertainty about their availability and quality. Jurisdictions across the benchmarking group are making efforts to reduce the uncertainty about availability and improve the quality of recyclables across the entire value chain.

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Key challenges associated with stimulating or building a market for recyclates include:

- the quality of the recyclables;
- availability of infrastructure to sort and process co-mingled recycling;
- regulations and standards for recyclate products; and
- cost-efficiency of virgin materials compared to recyclates

In order to address these challenges, various jurisdictions across the benchmarking group are employing a range of different policy and market levers.

In Scotland, SEPA is working with local councils to regulate sorting of waste and improve the quality of recyclables (as noted in Section 7.2). Regular inspections are held to ensure the quality of recyclables and penalise service providers that are not meeting obligations outlined in the *Materials Recovery Code*.235

In San Francisco, SF Environment have made significant investment in education campaigns to improve source separation and also increase the quality of recyclables. The waste management service provider Recology has also made investment up to the cost of US$14 million in facility upgrades to reduce contamination of waste streams and attract a broader market of local manufacturers who are looking to use recyclable materials.

In addition to this, work that is being done in Denmark and Canada to encourage green public procurement is stimulating the market and creating a demand for recycled products, as discussed in 11.3.1.

### 12.4.3 Recommendations for NSW

All infrastructure for treating waste should contribute to a jurisdiction’s strategic direction to prevent and reduce waste production. Infrastructure investments should:

- target the areas or waste streams that present barriers to achievement of zero waste goals (e.g. processing of mixed waste to increase resource recovery);
- enhance the value and circulation of materials in the waste economy (e.g. technology that improves yields or reduces contamination); and
- infrastructure that supports the reuse or recycling of waste.

Assessment needs to be undertaken to identify the areas of the waste management system that require policy support. In addition to this, thorough market analysis should be undertaken to develop a plan to stimulate a recyclate market.

Energy from waste facilities have a role to play in treating residual waste as it is preferable to landfill and provides the associated benefit of energy recovery. It is not recommended that a strategy or policy is developed to invest in energy from waste facilities with the primary purpose of energy recovery. If NSW is to invest in waste from energy facilities the objective should be to safely dispose residual waste and contribute to diverting waste from landfill.

### 12.5 Transport of waste

Approaches to the transport of waste in the benchmarked jurisdictions were similar to those utilised in Australia (i.e. waste collected by truck, aggregated at a collection point and transferred to the end treatment location by truck or, in some cases, rail). An advantage of

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most of the jurisdictions is the proximity of waste infrastructure to the source of generation. There is considerable cross-border transfer of waste within the EU. Certain jurisdictions such as Singapore and San Francisco do not provide relevant information on the transport of waste due to their geographic profile.

**Transporting Waste by Rail**

London has been transporting waste out of the city for processing since the 1970s. In 1977, the Greater London Council established one of the first European Waste Transfer stations at Brentford compacting and loading waste into enclosed containers for transportation by rail. Currently DB Schenker operates a nightly train to Appleford in Oxfordshire to move waste out of the city. DB Schenker also carries Manchester’s household waste on daily services from four transfer stations at Northenden, Bredbury, Pendleton and Deal Lane to Roxy, a distance of about 85 miles. The East London Waste Authority runs its household waste disposal transportation by rail in partnership with Haul and Shanks. This contract provides a daily service from Dagenham to Clavert and removes over one hundred lorries from city congestion every day. The East London Waste Authority is responsible for waste generated by the boroughs of Newham, Barking and Dagenham, Redbridge and Havering.

**Transporting Waste by Road**

In Canada more broadly in 2008, $33CAN was spent per capita on the collection and transportation of waste by road. In 2010 expenditures on waste were $2.9 billion across Canada. Approximately $36CAN was spent per capita on collection and transportation on waste.

Jurisdictions utilise road, sea and rail to transport waste which is compacted, compressed or baled for transfer. Decisions on the form of transport is dependent on the relative cost of transportation and in the case of the EU, consideration is also given to the CO2 emissions produced by various transportation options. As noted, in London, rail is the preferred option for transportation, due to the cost efficiency and the already established rail network that relieves pressure from heavily congested roads.

**Importing Waste**

The EU has introduced legislation that regulates the shipment of waste between member states as well as from member states to countries beyond the EU. A control system must be established to supervise what type of waste is being imported into member states. Much of this legislation is based on the proximity principle, that waste should be treated and disposed as close to where it was produced as possible. This means that for certain categories of waste such as packaging waste, electric and electronic waste and end-of-life vehicles, legislation is written in such a way that this waste will not be counted against mandatory recycling targets unless it is treated and recycled in an environment that meets EU standards, de-incentivising the export of waste to countries beyond the EU.

An increase in recycling of MSW in Denmark has resulted in an increase in the quantities of waste imported into the country of incineration. Danish incineration plants have experienced an increase in their excess capacity and are working to achieve full capacity via importing.

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237 Ibid


waste. In 2015 Denmark imported residues for incineration in its facilities, with an increase by 32,000 tonnes from 2013 to 2015\textsuperscript{240}. General waste suitable for incineration increased from 234,000 tonnes in 2013 to 492,000 tonnes in 2015\textsuperscript{241}.

Importing waste may cause significant cost to most jurisdictions, but the desire for the waste-to-energy industry to operate at full capacity makes this a necessary option for Denmark to maintain reliability of the energy market.

**Exporting Waste**

In the wake of national sword, the UK similar to NSW has exported packaging waste to other countries and increased internal incineration rates. In 2017–2018 the UK exported 683,000 tonnes of packaging waste. Indonesia, Malaysia, Poland and Turkey have provided alternative export markets for packaging waste. \textsuperscript{242}

The UK Trans-frontier Shipment of Waste Regulations 2007 outline the procedures, offences, penalties and relevant authorities involved in governing the Trans-frontier shipment of waste. The UK Plan on Shipments of waste sets out Government policy in relation to imports and exports for disposal.

SEPA has prepared guidance for Scotland on the various controls that apply to the import and export of waste. There are two categories of controls, green list controls and notification controls. Green list controls are the lowest level of control that can apply to waste imports and exports. They apply to some imports and exports of non-hazardous waste for recovery.

Notification controls are a much higher level of control than green list controls. They apply to all permitted imports and exports of hazardous waste being moved for recovery, any type of waste being moved for disposal and some import and exports of non-hazardous wastes for recovery. \textsuperscript{243}

### 12.5.1 Recommendations for NSW

In view of NSWs unique geographic profile, consideration should be given to the relevant costs of transportation of waste. Rail is a solution for a number of jurisdictions where high performing rail networks were already established and road congestion was a significant barrier. However, given the current rail network in NSW, this option requires thorough review. NSW like other jurisdictions across the benchmarking group will find that South East Asian nations that have been receiving recyclables no longer have the capacity to do so.

Jurisdictions such as San Francisco, UK, Ontario, Slovenia and the Netherlands are investing in local infrastructure to process and treat recyclable materials. In addition to this, investment in education campaigns on source separation to reduce contamination are also being made across the benchmarking group. Lastly, certain jurisdictions such as the UK, Denmark and San Francisco are undertaking market analysis exercises to determine the extent of the current and potential end-market for recyclates and what sort of stimulus is required to develop and build these markets (such as the Green Procurement policies in Denmark and Ontario). A comparable approach would be beneficial to NSW, however, the focus should address current barriers and opportunities to support the growth of an end market in NSW.


\textsuperscript{241} Ibid


12.6 Delivery of Waste Management Services and Contestability

The general model for delivery of waste services is:

1. Private sector contracting to a government body; or
2. Public sector performing the services.

In many jurisdictions benchmarked both models are used.

Some of the reasons, historically, for involvement of the private sector in the waste market has included:

- improvement of environmental and hygiene issues (particularly in developing countries);
- introduction of output focused contract models;
- introduction of technical innovation; and
- use of private sector financing for capital investment.

The table below summarises the relationship in each benchmarked jurisdiction between the regulator, the procurer of waste services and the provider of waste services.

Table 9: Jurisdiction comparison by procurement approaches

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Regulator</th>
<th>Procurer (generally of MSW services)</th>
<th>Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>San Francisco Environment (SF Environment)</td>
<td>SF Environment</td>
<td>PPP – permit system, no contract. Recology is the exclusive private sector provider of collection and disposal services. San Francisco has a unique “permit” system under its legislation – there is no contract. Rather, Recology have acquired the companies who own the permits over the years until it became sole owner of all 97 permits. In 2012 a referendum was held over whether to change the arrangement to introduce a competitive bid arrangement (with the City’s waste separated into 5 separate contracts for collection, processing, transportation and disposal). The proposal was overwhelming defeated and Recology’s arrangement remains in place.</td>
</tr>
<tr>
<td>Ontario</td>
<td>Resource Productivity and Recovery Authority</td>
<td>Municipality</td>
<td>Public and private sector. This has been the subject of much debate in Ontario in recent years. Ontario’s Auditor General has found that despite requests for regular reports to Council on contractor performance, this is not always enforced. Toronto’s Waste Management Services are public, although there have been proposals to privatise. Links have been drawn by some environmental groups to lower diversion rates in areas serviced by the private sector.244</td>
</tr>
</tbody>
</table>

12.6.1 Dutch Waste Management Market

Research indicates that the Dutch waste collection market is highly concentrated with both public and private firms operating. In 2010, 16 private firms and 25 public firms were active in the Netherlands. In 2010 the largest company for waste collection serviced 53 municipalities. Another company van Gansewinkel serviced 40 municipalities.

12.6.2 UK Waste Management Market

The waste management market in the UK is valued to be just under 10 billion pounds. Energy from waste, landfill and other disposal services are estimated to account for up to 45% of industry revenues. The largest overall revenue stream for waste management contractors is the non-municipal sector. The largest five companies (Veolia UK, Biffa Group, Suez

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Environment UK, Viridor and FCC Environment) represent over 40% of the turnover in the industry.

The UK has a highly competitive C&I and MSW collection sectors. Councils are increasingly turning to larger joint procurements, or transitioning to ‘in-house’ or ‘arms-length’ delivery models to reduce costs.

In 2017, the UK Competition and Markets Authority released a report on Local Authority Waste Contracts. The Report found that longer and broader domestic waste collection contracts, which can limit competition remain in use by local authorities and are associated with significantly higher spending. Overall the data showed that local authority spending on waste management services is broadly stable, recycling rates are increasing and customer satisfaction remains high. No evidence was found that authorities that deliver collection services themselves pay more than those who contract this service out. The report found that competition assists procuring authorities achieve value for money and drives innovation and improvement of service qualities. In order to make the most of potential competition, the report recommended that local authorities reduce the length of contracts tendered out and tender services separately where possible.

The rising landfill tax in the UK has led to the development of a number of large infrastructure projects for alternative waste treatment facilities, many of which have been developed under Private Finance Initiative contracts from local authorities. This infrastructure supports the treatment of food and organic waste through anaerobic digestion capability or mechanical biological treatment facilities. In certain cases (as noted in Section 7.3 on Scotland) policy decisions such as a landfill tax or bans on biodegradable material being landfilled has resulted in a sudden increase in investment in energy from waste facilities. These facilities are being developed at considerable cost and resulting in considerable contracting challenges given the current financial environment for many local authorities. Ensuring reasonable scale and cost of contracts is critical in jurisdictions such as Scotland.

Analysis of the shape of the UK waste management market indicates that large scale companies are in the best position to deliver waste management services across the entire value chain. Smaller and midmarket waste companies without strong regional or local investment will face difficulty in competing with the larger companies. Companies that deliver simple collection services, pre-treatment (sorting) and export out of the UK will also find it difficult to compete with local large scale rivals.

Competition, local government budget constraints and low recyclate prices are keeping the sector under pressure and causing difficulty for small and medium size enterprises. In addition to this, the upcoming Brexit will also create more challenges for exports.

### 12.6.3 Recommendations for NSW

Across the benchmarking group, consolidation of the waste industry is impacting the level of competition across the market and preventing market entry for new waste management providers, and access to small and medium sized waste management providers.

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248 Ibid


250 Ibid
Concentration of ownership of waste infrastructure and vertical integration in organisations is impacting the level of competition in the tender process. Concentration is high in particular regions such as the Netherlands. Competition is fierce amongst major providers as noted in the UK.

China’s national sword policy has significantly disrupted an already compressed recyclates market. Work is being done across the benchmarking group to stimulate local markets for recyclates and promote the development of local infrastructure that can better sort and process recyclable materials and recover energy from general, food and organic waste.

The global move towards zero waste goals and adopting a circular economy has caused a more significant need for local infrastructure to support recycling and treatment of residual waste. If NSW is considering such a strategic direction, it will need to consider how to stimulate market growth and competition for a diverse range of services to meet the increasing needs of local councils. To address these issues, NSW should consider various market levers that are available to stimulate a local market for recyclables, remove barriers to market entry for small to medium sized enterprises and ensure healthy competition amongst service providers to drive up quality. These issues are discussed further in Volume II.

12.7 Data strategy

Throughout the report, various approaches to data and strategies for publishing waste data have been discussed. All EU countries demonstrate good practice in regard to data to meet the requirements of the directive.

Scotland in particular, has a transparent and current dataset that is made available with guidance to the public. This data set provides granular detail on the three waste streams over a twenty year period, and various products and materials within these waste streams. Relying on local government and waste management service providers to provide the data, SEPA utilises this data to regulate the sector and performance manage against targets set out in the Zero Waste Plan and the Circular Economy Strategy.

Singapore introduced a requirement for all businesses to weigh their waste prior to disposal in bins (see Section 10.8). The purpose of this is both to encourage businesses to consider the amount of waste that they are generating and prevent it, and also for the National Environment Agency to have a better understanding of what waste is being produced, where and what the best methods for treatment are.

12.7.1 Recommendations for NSW

It is recommended that NSW consider the most appropriate ways to collect data from business and local councils on waste management services. This data should include the main indicators discussed in this report include volume of waste generated, waste separated correctly at source, volume of waste recycled, volume of waste reused, volume of waste recovered for energy and volume of waste disposed of via landfill.

The EPA would benefit from a better understanding of both the composition of waste being generated (by material type), its movement through waste management streams (collection, aggregation, processing, recycling) and its end use (disposal or recycling and reuse).

It is recommended that NSW consider developing a strategy on data that is supported by policy levers that mandates waste management services providers across the service system to provide data back to local councils and the State government on agreed indicators. This data should be published annually on a public platform. As seen throughout this report, and specifically in the case of Scotland and Singapore, close regulation of the waste management sector provides much greater oversight of the quality of service and the trends in waste generation and treatment. Whilst mandating the C&I and C&D sectors to weigh waste prior to disposal could cause significant resistance in NSW, preparing legislation to enforce data collection on waste would significantly benefit NSWs desire to become a zero waste state.
12.8 Conclusion

This benchmarking report has reviewed the waste management systems of seven different jurisdictions. Analysis has presented that the key measures for benchmarking are the current policy settings and levers employed to effectively manage waste, the volume of waste that is generated, the requirements for waste separation, the infrastructure available for waste recovery and the various roles and responsibilities that different levels of government have in the waste management sector.

As has been evidenced in this report, NSW is some way behind the other jurisdictions in terms of its waste management policy maturity. This said, other jurisdictions have each made a number of decisions that did not initially deliver desired results or worked in a complicated context to achieve relatively high rates of recycling and waste energy. A number of recommendations have been made for the EPA to consider throughout this report. What appears to be critical to an efficient waste management system is;

- a clear strategic direction that is supported by all levels of government, consumers and industry;
- commercially viable treatment options that are responsive to consumer needs and the waste management sector more broadly (including the end market);
- a concerted effort to reduce the overall amount of waste being introduced through financial incentives, education campaigns and effective producer responsibility schemes.

The 20-year waste strategy may benefit from the learnings from the benchmarked jurisdictions, including the challenges that can occur from poorly planned policy implementation and risk assessments. The countries that have been more effective in reducing waste to landfill have implemented policies that address all levels of the waste hierarchy. These countries have also recognised that implementation needs to occur in a phased manner to allow stakeholders time to respond (whether through restructuring business processes or making necessary investments in innovative infrastructure). Effective policies incentivise change but also need to be supported by transparent regulation and enforcement.