PURSUING ZERO WASTE IN A DIVERSE LANDSCAPE

Prepared for Walmart by RRS
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Walmart

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PROLOGUE

CORPORATE RATIONALE

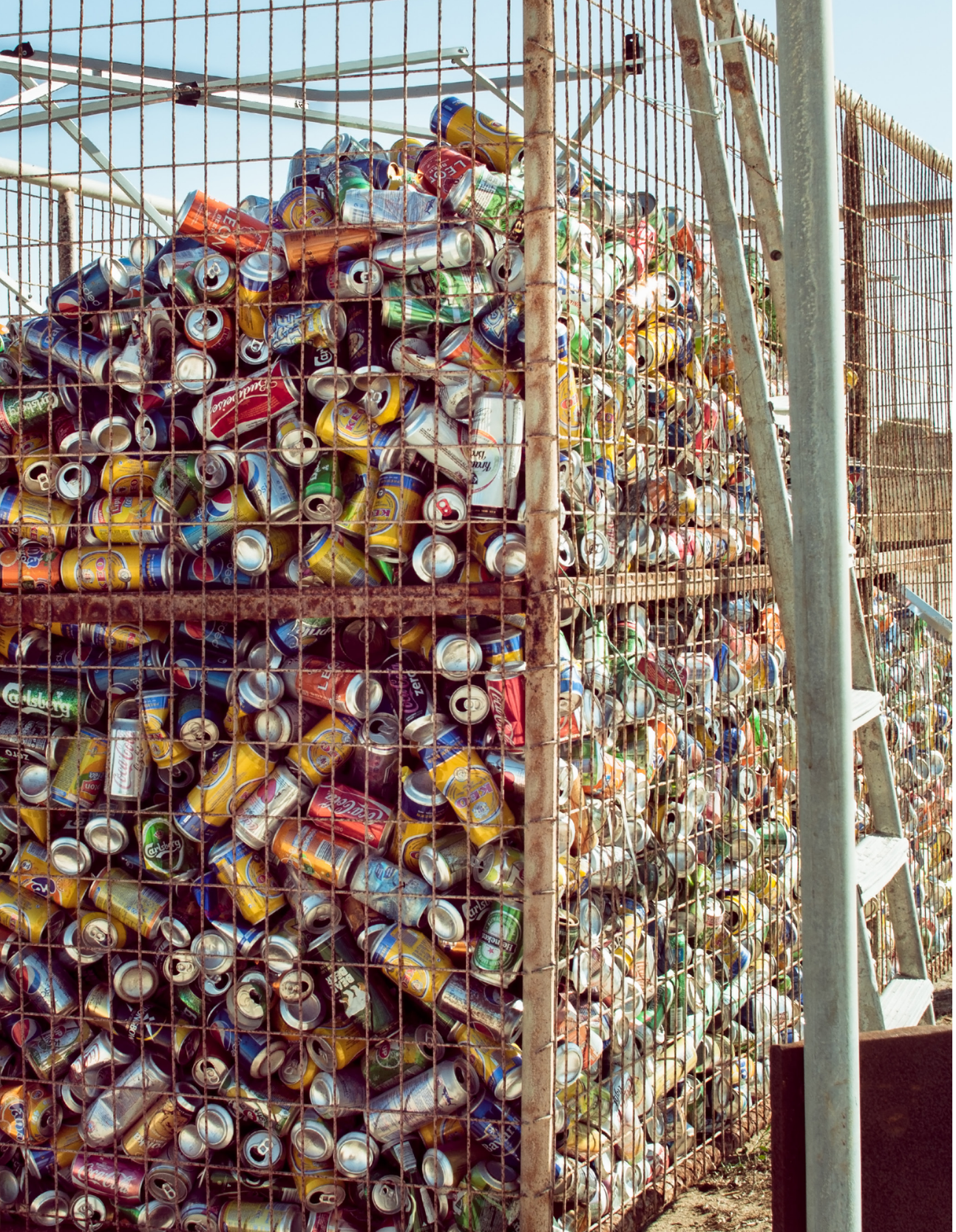
As the issues of marine debris, resource scarcity, and the globalization of waste and its transport have gained prominence with sustainability professionals, they have also become a greater priority in the eyes of the public and governments around the world. Global companies recognize that the economic opportunity of the future is found in emerging economies that often have large populations moving into the middle class and a newfound ability to acquire goods and services. Unfortunately, along with this economic growth comes more waste generation.

What is less widely recognized is the disparity in waste and recovery infrastructures of countries around the globe and the cultural waste habits of consumers. These disparities have led to profound environmental concerns like marine debris, terrestrial litter, and severe greenhouse gas and toxic emissions from poorly managed landfills and dumps. They have also contributed to a growing awareness of the systemic poverty and social inequity for waste workers in many societies. Even within certain countries, the waste infrastructure may vary dramatically. Knowledge of the waste and recovery infrastructure of each country in which a global company operates and the cultural waste habits of local consumers is material issue and an important piece of market intelligence for any global company to inform its corporate waste reduction strategy, advance its sustainability goals and operations, and business communications.

OUTLINE OF GENERIC APPROACH

This white paper summarizes research commissioned by Walmart in 2016 to characterize eleven markets where the company has an operational presence. This research which highlights solid waste policy and the state of waste and recovery infrastructure for commercial and consumer recycling and organics recovery informed Walmart's 2025 zero waste roadmap. The paper presents these markets through a conceptual framework that explains how waste and recovery systems evolve from underdeveloped, under-regulated systems to highly developed and regulated waste management systems. The paper will explain the shared features of Underdeveloped, Maturing, and Developed Waste and Recovery Systems and then present the unique details of each market in more depth. Key policy, infrastructure features, and market conditions will be highlighted with special attention to emerging trends and factors that make the market particularly unique. The information is not exhaustive, but intended to provide background information for those interested in making strides to improve waste management and recovery in diverse markets.

Understanding the waste and recovery infrastructure of countries in which a global company has operations and the cultural waste habits of consumers is an important piece of market intelligence to inform corporate sustainability strategy, operations, programs and communications.



KEY GLOBAL CHALLENGES

MARINE PLASTICS

In the past decade, marine plastics have emerged as one of the most challenging and thorny environmental issues facing nations, retailers and consumer packaged goods companies. The global reach of marine plastics, their tendency to accumulate in the environment, and growing evidence that they impact the food chain, suggest that like an iceberg – we are likely only experiencing the tip of their impacts today. To that point, the New Plastics Economy Report by the Ellen MacArthur Foundation estimates that by 2050, there will be more plastic in the ocean by weight than fish. While five countries – China, Indonesia, the Philippines, Vietnam, and Sri Lanka - have been identified as the largest sources of marine debris, all countries contribute to marine plastics to some degree, and countries with underdeveloped waste management systems and weak consumer waste practices tend to contribute substantially. The reaction to this has been a growth in material bans and extended producer responsibility legislation, impacting manufacturers, brands, and retailers.

GLOBALIZATION OF WASTE

Globalization has not been limited to the trade of goods. The trade of scrap and waste materials has grown dramatically over the past 30 years. Several countries have become dumping grounds for waste electronics, scrap materials, and recyclables from other countries. China's recent National Sword program and WTO ban of 24 scrap materials is in part a reaction to the import of low-quality scrap materials into the Chinese market and the public spotlight put on inadequate waste management infrastructure and practices and their impacts. The resulting unilateral import ban is an effort by the government to clean up the imported material streams, eliminate poor actors, and develop better policy and infrastructure. Other countries like India and several African countries are also importers of waste and have large informal recycling economies. And as several documentaries have pointed out, their unregulated environmental and labor practices can cause embarrassing situations for governments and companies when their waste electronics or recyclables end up in these markets.

GLOBAL WASTE MANAGEMENT CRISES

A critical issue facing many nations and companies is the global waste management crisis. The World Bank estimates that more than 3.5 million metric tons of solid waste is generated per day and that this figure will exceed 6 million metric tons per day by 2025[1]. Food waste is a big part of the problem. About one-third of food grown, or 1.3 billion metric tons, is thrown away or wasted each year, according to the U.N.[2] A major concern is the growth of waste in emerging markets; where generation is set to double by 2025 due to economic development and critical deficits exist in basic waste management infrastructure. In many cases, increases in waste generation have outpaced infrastructure development and there is often insufficient financing to remediate existing dumps or sanitary landfills to modern standards.

Waste management is typically a local matter, but issues such as marine plastics have highlighted the inadequacy of local waste management and governments in some cases to address waste challenges with consequences far beyond sovereign boundaries. As companies share in the development of emerging economies, they find their corporate reputations linked for better or worse with local issues. The challenge of waste management and recovery infrastructure development in emerging economies is a relatively new area for companies to consider, and a crucial part of participating in and building a sustainable future.

UNDERSTANDING INTERNATIONAL SOLID WASTE & RECOVERY SYSTEMS

OVERVIEW OF FRAMEWORK

The basic elements of a solid waste system evolve as waste and diversion systems become more sophisticated. These elements include foundational criteria like solid waste and recycling policy and solid waste infrastructure and other criteria like hazardous waste management, recycling, and organics management. Solid waste systems are complex. Breaking them down into elements that are familiar and identifying the key issues related to them helps businesses better understand the opportunities to advance their waste and diversion goals. Thus, we have characterized solid waste systems against a consistent set of criteria in order to highlight critical issues, needs and opportunities.

The following identifies five solid waste and recovery criteria and the related performance indicators which help to define them at various stages of sophistication, which we call Underdeveloped, Maturing and Developed solid waste systems. Through these criteria and performance indicators, it is possible to discern differences in systems. It is our hope that through this conceptual framework, the solid waste performance and recovery opportunities across markets can be more clearly identified. In addition, the framework may be used to help understand the solid waste and recovery systems of markets not yet evaluated in this white paper. *Note, these criteria evaluate measures of solid waste and recycling systems and should not be confused with the nomenclature of economic systems.*

Criterion: Solid Waste & Recycling Policy

This foundational criterion refers to federal/state/local solid waste policies that establish the authority and responsibility for managing industrial, commercial and residential waste. It may include a diverse array of waste policies that define categories of wastes, how they should be handled, and the rules for landfills or alternatives. It may also include advanced materials management policies like extended producer responsibility.

General Performance Indicators:

1. Level of Solid Waste & Recycling Policy present in a country
2. Level of Implementation of Solid Waste Policy
3. Level of audit and enforcement of the Solid Waste Policy

Criterion: Solid Waste Infrastructure

Appropriate solid waste infrastructure is essential to ensure appropriate and hygienic disposal of municipal solid waste. Infrastructure includes everything from regular collection of waste, appropriate transport, to disposal in a well-maintained and environmentally well-managed facility. The criterion refers to the type of solid waste infrastructure a country possesses, as well as the relative level of access to solid waste management services for both commercial and residential waste. There is a continuum of solid waste management infrastructure from countries that rely largely on dumps and sanitary landfills to those that have highly engineered landfills and or extensive waste-to-energy facilities (WTE).

General Indicators

1. Presence of dumps, sanitary landfills, to engineered landfills/WTE
2. Percentage of population with access to solid waste management

Criterion: Hazardous/Universal Waste Systems

Removing hazardous materials from commercial and residential waste is important to ensure human health and environmental safety, especially if landfills or dumps are unlined and subject to frequent fires. The presence of hazardous materials programs and the extent to which special handling and management for these materials is enforced is an indicator of more mature solid waste systems. These systems aim to capture hazardous chemicals like solvents, hazardous pesticides, electronics, batteries containing lead/nickel-cadmium/silver/lithium or mercury. This is a partial list for illustrative purposes only. The list of hazardous and universal wastes varies by market and is defined by regulatory guidelines.

While there may be policies requiring the special management of hazardous or universal wastes, the actual implementation of programs and the enforcement of regulations may be lacking. The range of programs are present, the level of implementation and enforcement of applicable regulations, and the extent to which programs are available within a country are important indicators of the level of maturity of a waste management program.

Framework Describing the Evolution of Solid Waste and Recovery Systems

GENERAL INDICATORS					
	Solid Waste Planning Level of implementation Audit and Enforcement	Evolution from dumps to engineered landfills/WTE Percent of population with access to solid waste management	Systems for collecting and managing hazardous materials Universal waste collection and management Extent of programs within country	Systems for collecting and sorting recyclable materials Formality of recycling programs Level of access to recycling within country Level of education and participation in recycling	Systems for collecting and managing organic materials Formality of organics programs Level of access to organics management within country Level of education and participation in organics diversion
CRITERIA	**01. SOLID WASTE AND RECYCLING POLICIES**	**02. SOLID WASTE INFRASTRUCTURE**	**03. HAZARDOUS MATERIALS/ UNIVERSAL WASTE**	**04. RECYCLING INFRASTRUCTURE**	**05. ORGANICS MANAGEMENT INFRASTRUCTURE**

General Indicators

1. Presence of program(s) to collect and manage hazardous and universal wastes
2. Level of implementation and enforcement of hazardous and universal waste programs
3. Extent of program availability within country

Criterion: Recycling Infrastructure

Recycling is a fundamental strategy for conserving resources and reducing waste. There is a long history of removing, reusing, and recycling valuable materials from trash and a wide variety in how recycling occurs around the world. The World Bank estimates that there are millions of waste pickers globally who make their living by gleaning recyclables from streets and landfills using very rudimentary methods. In developed markets, consumers may sort recyclables into multiple categories and leave them on the curb or take them to drop off centers where they are sorted into marketable commodities in highly mechanized material recovery facilities. There is no one way to recycle.

Recycling inevitably develops alongside solid waste systems. The level of formalization of the collection and sorting systems, and the degree to which consumers have access to recycling infrastructure and are educated to participate, are useful indicators and provide important insights into how businesses need to adapt their waste and recycling programs to different markets.

General indicators

1. Presence of systems for collecting, sorting and marketing recyclable materials
2. Formality of recycling program
3. Degree of access to recycling throughout country
4. Level of consumer education and participation in recycling

Criterion: Organics Management Systems

Despite the fact that food waste and organics are known to be a significant component of both the residential and commercial waste across the globe, systems to divert food waste are still relatively infrequent. Composting and animal feed remain the most common ways to manage organics across all markets reviewed. Using food waste for animal feed is an effective diversion strategy when appropriate partners can be found and required feed regulations met. Though infrequent, anaerobic digestion with biogas recovery is increasingly being utilized as a strategy to manage food waste as well as animal waste.

Given the increasing focus on food losses and food waste, information on the presence of systems to collect and manage organics, and the level of access to those programs, provides insight for companies that are considering food waste and organics diversion.

General Indicators

1. Systems for collecting and managing organic materials
2. Formality of organics program
3. Degree of access to organics management throughout country
4. Level of education and participation in organics diversion

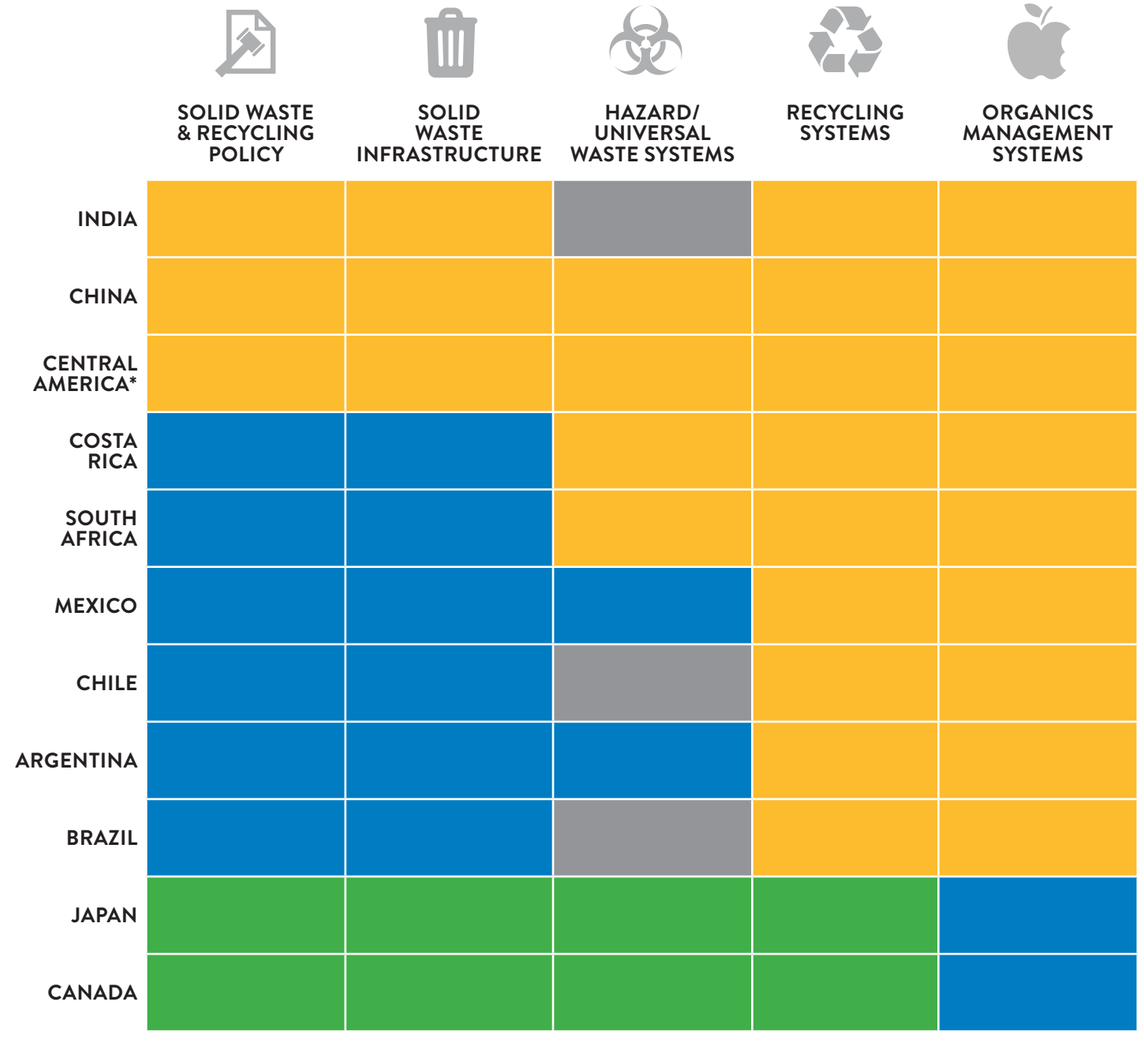
WHAT DEFINES A DEVELOPED SOLID WASTE AND RECOVERY SYSTEM?

The framework criteria are quite general markers in the evolution of solid waste systems as represented in Underdeveloped, Maturing and Developed markets. The following table of indicators is not absolute, but intended to provide guidance on the stages of development of a country's solid waste and recovery system and how they were evaluated for this study. Because definitive measures are difficult to obtain, in many cases, indicators are relative to the presence or absence of regulation, infrastructure, or systems representative of the most advanced solid waste and recovery systems.

OVERVIEW OF THE SOLID WASTE AND RECOVERY SYSTEM OF ALL MARKETS

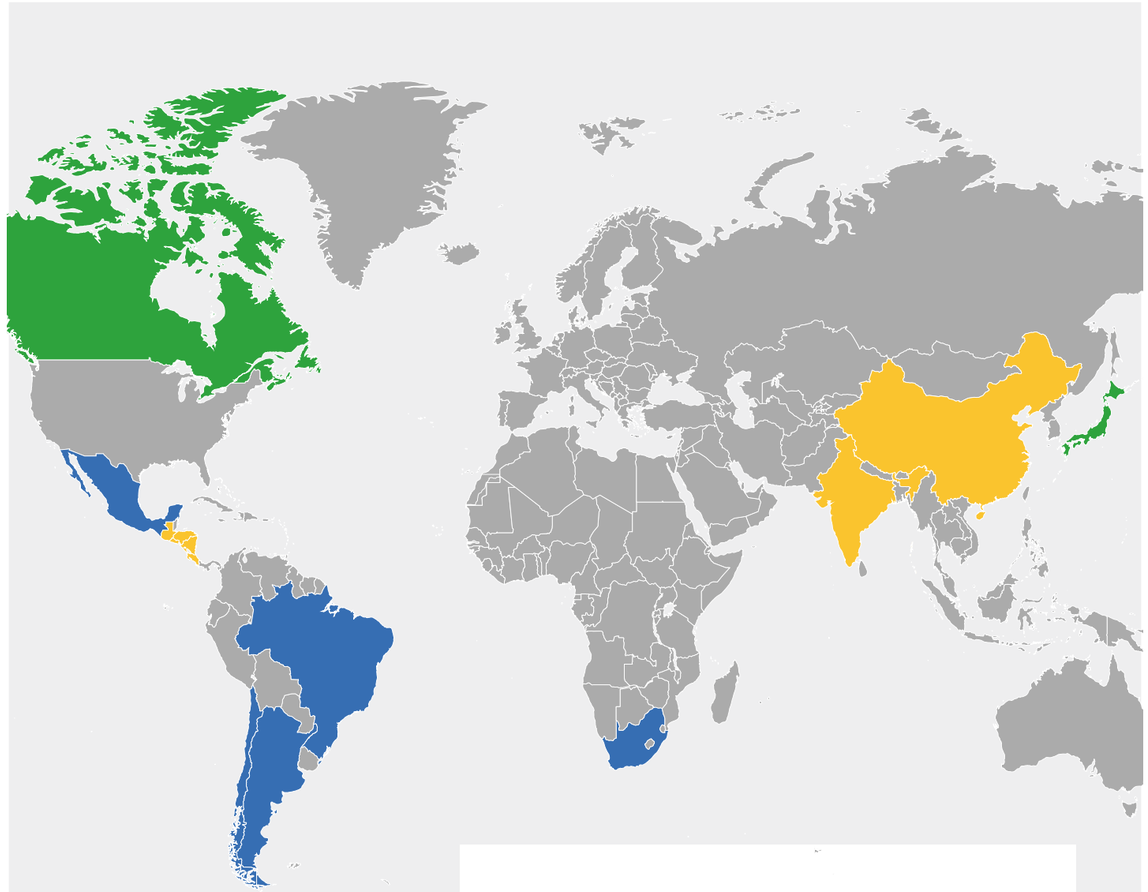
The following chart shows the results of applying the framework criteria and indicators to all of the markets researched in this study. In some instances, not enough data could be found to make a determination. The availability and quality of waste and recovery data varied widely between markets. Wherever possible, government statistics or internationally recognized waste sources were used. Articles from a variety of media, scholarly papers, and interviews with individuals considered experts on certain markets were also used. The resources for each market are referenced in each individual section.

Comparing Solid Waste and Recovery Systems Across Common Criteria



*Note: Central America includes: Guatemala, El Salvador, Honduras and Nicaragua

Shared Features by State of Waste and Recovery Market



UNDERDEVELOPED SYSTEMS
China, India, Costa Rica, Central America (Nicaragua, Honduras, El Salvador, Guatemala)

MATURING SYSTEMS
Argentina, Brazil, Chile, Mexico, South Africa

DEVELOPED SYSTEMS
Canada, Japan

Note: Colored areas indicate the scope of research

	UNDERDEVELOPED	MATURING	DEVELOPED
DEMOGRAPHICS & STATISTICS	• Rapidly urbanizing • 25-45% of population is rural • Low to middle income • Rapid to moderate population growth • High rates of poverty, and extreme poverty • Projected growth in waste generation significant	• Rapidly urbanizing • 80% of population lives in cities • Middle income • Moderate population growth • Moderate to high rates of poverty • Projected growth in waste generation significant	• Urbanized • More than 80% of population lives in cities • High income • Low population growth • Low poverty rates • Projected growth in waste generation is low or flat
SOLID WASTE AND RECYCLING POLICY	• Basic or developing solid waste policy • Generally weak implementation and enforcement at local level	• Developing solid waste policy • Implementation and enforcement at local level variable – especially between large cities and rural areas	• Advanced solid waste policy • Robust implementation at local level • Focus on waste diversion and recovery • EPR for products & packaging
SOLID WASTE INFRASTRUCTURE	• Waste crises due to inadequate infrastructure • Sanitary landfills and dumps are common • Unmanaged waste and open burning common • Waste management focused in urban areas	• Inadequate infrastructure and landfill space scarcity common in urban centers • Sanitary landfills and dumps are common • Large cities have more advanced systems • Rural areas lag in development	• Landfill scarcity near large urban centers • Highly engineered landfills or incineration with or without energy recovery • Advanced waste management services widely available
RECYCLING	• If present, in urban centers • Waste picking and informal sector • Little to no mechanization • Diversion statistics often unavailable • Diversion estimates range from NA to 21%	• Focused on urban centers • Mix of waste picking and curbside and drop off programs • Little to some mechanization • Diversion statistics available • Diversion rate ranges 3-10%	• Curbside and drop off recycling program common across country • Highly mechanized MRFs • Diversion statistics readily available • Diversion rate greater than 20%
ORGANICS MANAGEMENT	• Little to no organics management • If available, mostly composting or animal feed	• Limited composting and often focused on green waste • Little to no food waste management. If available, likely animal feed	• Composting program relatively common • Food waste programs emerging and diversion to animal feed common.
CONSUMER AWARENESS	• General need for awareness building on appropriate waste disposal practices • Low to no consumer access to recycling • Little to no awareness of recycling	• Consumer access to recycling limited to urban centers • Moderate to no awareness of recycling	• High access to consumer recycling programs • High consumer awareness of recycling

Summary Table: Current State of All Countries

	JAPAN	CANADA	ARGENTINA	BRAZIL	CHILE	MEXICO	SOUTH AFRICA	CHINA	INDIA	COSTA RICA	CENTRAL AMERICA*
Area	377,800 km²	9,984,670 km²	3,761,274 km²	8,515,800 km²	756,100 km²	1,964,400 km²	1,220,813 km²	9,563,000 km²	3,287,300 km²	51,100 km²	423,490 km²
Population	126.9 M	36.3 M	43.8 M	207.6 M	17.9 M	127.5 M	55. 9 M	1,378.6 M	1,324.1 M	4.86 M	42.4 M
Pop Density	348 people/km²	4.0 people/km²	16.0 people/km²	24.8 people/km²	24.1 people/km²	65.6 people/km²	46.1 people/km²	146.9 people/km²	445 people/km²	95.1 people/km²	100.1 people/km²
Urban Population	93.5%	82%	91.6%	86%	89.5%	79%	64.8%	56%	32.7%	76.8%	58.5%
Largest Cities	Tokyo 38.0M Osaka 20.2M	Toronto 5.9M	Buenos Aires 15.2 M	São Paulo 20.3M Rio de Janeiro 12.6M	Santiago 7.0M	Mexico City 21.0M	Johannesburg 8.0M	Shanghai 23.7M Beijing 20.4M Chongqing 13.3M Guangdong 12.5M Shenzhen 10.8M Tianjin 11.2M	New Delhi 25.7M Mumbai 21.0M Kolkata 14.9M Bangalore 10.1M	San Jose 2.2M	Tegucigalpa 1.2M Managua 1.4M Guatemala City 3.3M San Salvador 1.8M
Extreme Poverty Headcount	NA	NA	1.70% (2014)	4.3% (2015)	1.3% (2015)	3.0% (2014)	16.6% (2011)	1.9% (2013)	21.2% (2011)	1.6% (2015)	9.1% (WAvg) (2014/15)
Economic Class	High Income	High Income	Upper Middle Income	Upper Middle Income	High Income	Upper Middle Income	Upper Middle Income	Upper Middle Income	Lower Middle Income	Upper Middle Income	Lower Middle Income
National MSW Generation	44.32 million metric tons/year (2014)	25 million metric tons/year	16.8 million metric tons/year	76.0 million metric tons/year	6.5 million metric tons/year	42.1 million metric tons/year (2012)	59.0 million metric tons/year (2012)	172.4 million metric tons/year (2013)	155.1 million metric tons/year	1.6 million metric tons/year (2012)	23.1 million metric tons/year (2011)
Per Capita Generation	0.96 kg/person/day	1.90 kg/person/day	1.15 kg/person/day	1.00 kg/person/day	1.02 kg/person/day	0.92 kg/person/day	2.94 kg/person/day	0.34 kg/person/day	0.34 kg/person/day	0.86 kg/person/day	1.49 kg/person/day
Est 2025 MSW Change	-0.6%	-6%	+52%	+55%	+39%	+41%	0.0%	+67%	+106%	+32%	+16%
Primary Waste Management Method	Incineration/ Engineered Landfill	Engineered Landfill	Sanitary Landfill	Sanitary Landfill/ Dump	Sanitary Landfill/ Dump	Sanitary Landfill/ Dump	Sanitary Landfill	Sanitary Landfill/ Dump/ Incineration	Sanitary Landfill/ Dump	Sanitary Landfill/ Dump	Sanitary Landfill/ Dump
National Waste Diversion Rate	20.6%	34.0%	3.0 - 6.0%	3.0%	2.0%	3.6%	10%	Possibly ~20% through waste picking	Est. 21.0%	8% (in San Jose)	Not Available
Extended Producer Responsibility	Yes Selected packaging and other products	Yes 5 provinces Packaging and other products	No	Yes Packaging and other products	Yes Packaging and other products	No	Yes Bags and voluntary for other packaging	Emerging for packaging and selected products - target 2025 for implementation	Yes Selected packaging	Yes Selected packaging	No

*NOTE: CENTRAL AMERICA INCLUDES: GUATEMALA, EL SALVADOR, HONDURAS, AND NICARAGUA

BUSINESS CASE

CORPORATE RATIONALE

Leading manufacturing and retail organizations are exploring and utilizing multiple strategies as they seek to reduce waste in their operations via expanded efficiencies, reuse programs and enhanced recycling tactics. Embracing zero waste principles can help organizations to reduce costs, generate profits and achieve their sustainability goals. Donation and recycling programs are also helping to improve employee engagement as they provide an easy way for employees to make positive impacts in their local communities.

HOW INFORMATION IN THIS REPORT CAN BE USED BY ORGANIZATIONS

- Businesses and multinational organizations are reaching high levels of waste diversion in Europe and North America, and they are looking for ways to duplicate this success in South America, Asia and Africa. This report can serve as an informational reference on understanding the waste and recycling management systems in selected countries. It provides visibility into the level of infrastructure development, legislative activities and undertakings of key industry influencers.

- This report also highlights a social component of waste management – the livelihood of waste pickers. Martin Medina estimated that between 1-2% of the urban population of developing countries, somewhere between 15-64 million people, make a living collecting, sorting,recycling, and selling materials that someone else has thrown away. There is growing recognition that waste pickers contribute to the global economy, public health, and sustainability.[3] Global companies can take these issues social into considerations as they seek to develop effective and comprehensive zero waste strategies.

- The current report not only describes the current state of the waste and recycling industry but also provides insights on how socio-economic factors, policy trends, and community engagement initiatives are influencing the evolution of solid waste management systems.

- Companies and other organizations are developing financing mechanisms for waste and recycling solutions in the markets they operate. These efforts contribute to strategies that address waste and can be implemented to advance the pursuit of circular economies across the globe.

Unique Market Characteristics: Underdeveloped Solid Waste and Recovery Systems

UNIQUE MARKET CHARACTERISTICS

UNDERDEVELOPED SOLID WASTE AND RECOVERY SYSTEMS

CENTRAL AMERICAN REGION – EL SALVADOR, GUATEMALA, HONDURAS, NICARAGUA

For the purposes of this paper, the markets of El Salvador, Guatemala, Honduras and Nicaragua are summarized as the Central American Region (CAM).

The CAM Region has a population of more than 42 million spanning a relatively large region that ranges from tropical conditions at sea level to mountainous cloud forests and volcanoes. It is a region that is marked by high levels of poverty, a legacy of political instability, and more recently, violence. More than 56% of the region's population lives in urban areas and is relatively densely populated. The largest municipalities in each country are their capitals, San Salvador, Tegucigalpa, Managua, Guatemala City, each with a population of approximately one to three million.

Solid waste management is characterized by underdeveloped infrastructure, the presence of poorly managed dumps, and minimal waste recovery. The limited diversion that does take place occurs primarily through the informal sector. Data and policy are largely unavailable as the region faces high levels of poverty, low economic growth, and violence. Addressing these issues has taken precedent over solid waste and recovery.

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview and Access to Waste Management Services

The four Central American countries covered in this section produce a total of approximately 21.5 million metric tons of waste annually.[4] The countries' per capita waste generation ranges from 1.10 to 2.0 kg/person/day, although the most recent data available dates back to 2001, so current generation may be considerably higher.[5] Roughly 70% of each country has collection for this waste.[6] Per capita generation is expected to grow rapidly (by at least 16%) by 2025, posing a challenge in a region with poor waste management infrastructure and systems that are ill-equipped to handle this growth.

Waste Management Infrastructure

Waste and recycling infrastructure is significantly underdeveloped across all countries in the region. Sanitary landfills are the exception rather than the rule, and

FIGURE 2: AVERAGE COMPOSITION OF NICARAGUAN MSW (2012)[7]

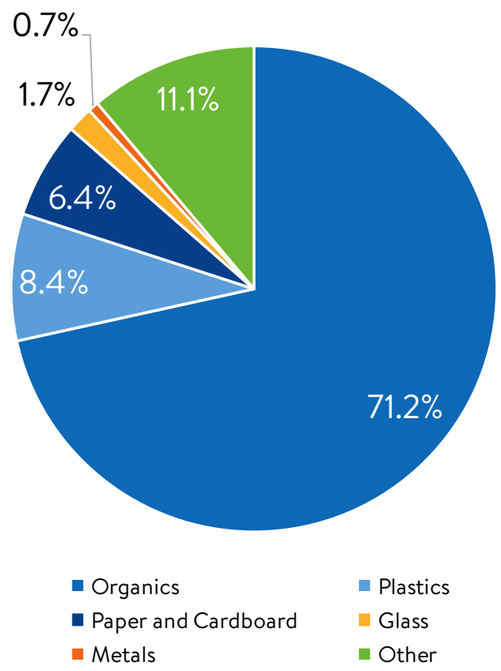


FIGURE 1: COUNTRIES OF CENTRAL AMERICA

CENTRAL AMERICA

dumping is common. The region is home to many large dumpsites with significant communities of informal waste pickers. Honduras, Guatemala, and Nicaragua have several dumpsites on the World's 50 Biggest Dumpsites list, according to the International Solid Waste Association's Waste Atlas.[8]

El Salvador has the best infrastructure in the region. Its capital city, San Salvador, sends 75% of its waste to sanitary landfills.[9] The country has plans to expand some of these landfills. Additionally, with help from the Inter-American Development Bank, there have been programs for the construction of 42 composting and recycling centers serving 124 municipalities and a proposal for the construction of 6 new sanitary landfills.[10]

Waste Composition

Central American waste composition data is largely unavailable or out of date. The most recent data is available for Nicaragua is shown in Figure *2*. Composition data is also available for Guatemala in Figure *3*, but is from 2001, so is likely not reflective of the current waste stream. However, in both countries, organic material is the largest fraction of generated waste. The amount of organic waste in the Nicaraguan waste stream is noteworthy at more than 70%.

Recycling

Much of Central America's waste is improperly managed, with dumping and burning common throughout the region. A breakdown of solid waste disposal methods by country is illustrated in Figure *4* and Figure 5.

Recycling is not embedded in the culture of Central American countries, especially in rural areas, as recycling systems are underdeveloped across the region. Current countrywide diversion rates are not available, but are low for all countries, especially outside of urban areas. The limited recycling that does occur is carried out primarily by waste pickers. In Nicaragua, for example, the capital of Managua recovers 16% through the informal sector but a mere 3% through the formal sector.[11] Guatemala has higher diversion rates than other countries due to a significant presence of informal waste pickers.

Waste Pickers

Although waste pickers are responsible for most of the region's recycling, the profession of *waste picker of recyclable materials* is not officially recognized in these countries. No data are available on the number of waste pickers in these countries but research suggests significant populations in Honduras, Nicaragua, and Guatemala and at least moderate populations in El Salvador earn their livelihood this way. Women and single mothers are often overrepresented among waste pickers. There are some poorly organized cooperatives across Central America, all with rudimentary infrastructure.

Organics Management

Organics management systems are underdeveloped across Central America and organics recovery is essentially nonexistent. However, diversion of food waste for animal feed with the appropriate partners and regulatory and composting is available in some markets. Food donation is important in the region due to the high rates of poverty.

REGULATORY ENVIRONMENT

Few solid waste policies have been enacted in Central America. Those that have been introduced are typically not well-enforced at the local level. Figure *6* provides an overview of the solid waste policies in Nicaragua and El Salvador. Extended producer responsibility is not used in this region.

FIGURE 3: AVERAGE COMPOSITION OF GUATEMALAN MSW (2001)[12]

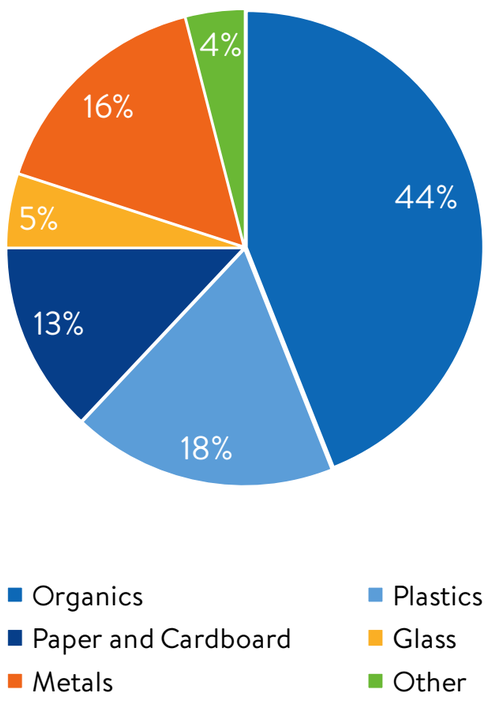


FIGURE 4: SOLID WASTE DISPOSAL METHODS BY COUNTRY – GUATEMALA AND NICARAGUA[13]

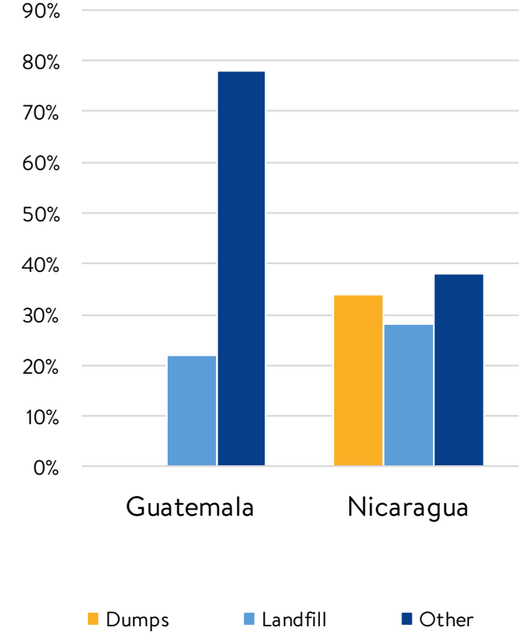
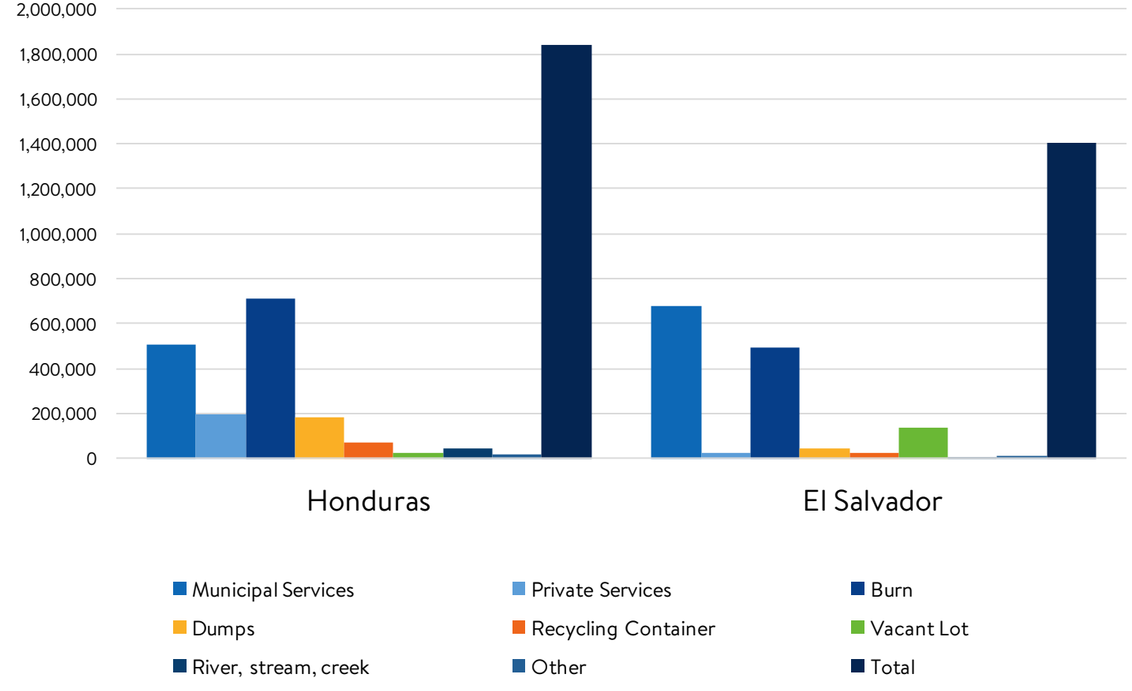


FIGURE 5: SOLID WASTE DISPOSAL METHODS BY COUNTRY – HONDURAS AND EL SALVADOR[14,15]



There are many challenges to creating and implementing solid waste policy in Central America. Chronic poverty issues have relegated solid waste and recycling issues to a lower priority. Foundational infrastructure issues are the key barrier to effective solid waste management, and most governments and localities are not in a position to implement more advanced solid waste practices without significant outside financing and education. Policies that do exist are poorly enforced at the local level. With rapidly expanding urban populations, there is an increasing sense of concern with growing litter, sanitation, and health-related problems due to co-disposal of medical and other hazardous wastes with municipal waste. As a consequence, solid waste management is becoming an increasingly urgent priority.

FIGURE 6: CENTRAL AMERICAN SOLID WASTE POLICIES AND FEATURES[16,17]

NICARAGUA	EL SALVADOR
National policy on integral management of solid waste 2004-2023 Features of the policy: • Focus on final disposal • Promote separation at the source • Share responsibility • Encourage composting practices • Elimination of child labor • Elimination of burning practices	**Guide for the management of solid waste with final disposal in 2007 safety cells** Features of the policy: • Focus on final disposal • Promote separation at the source • Encourage composting practices • Elimination of burning practices

KEY PLAYERS

International Organizations

- International Solid Waste Association (ISWA) www.iswa.org

Plastics

- Avangard Innovative – PET Star - locations across Central America

Glass

- Grupo Vidriero Centroam americano (Vical) - (http://www.grupovical.com/)

KEY TRENDS AND OPPORTUNITIES

- Solid waste policy is generally weak and unenforced.
- Solid waste infrastructure is inadequate across the region and waste generation is expected to increase substantially by 2025.
- Waste and recycling infrastructure is significantly underdeveloped across all countries in the region. Helping to improve basic waste management infrastructure is a critical priority.
- Investment by the Inter-American Development Bank has significantly improved solid waste management in San Salvador and composting is emerging.
- Investment models comparable to those used in El Salvador are needed to help address the waste management infrastructure inadequacies of the region. The co-disposal of medical and hazardous waste with municipal waste is a serious concern, especially if food animals or waste pickers are present.
- The region continues to experience very high levels of poverty, hunger and low economic opportunity. Supporting local/regional economic development through recycling, end market development and strategies like food donation would be welcome.
- There is a great need for economic opportunity, education and health care for the poor and those who work in the informal sector where women and children are disproportionately represented.

UNIQUE MARKET CHARACTERISTICS

UNDEVELOPED SOLID WASTE AND RECOVERY SYSTEM

COSTA RICA

Costa Rica is a small country in Central America divided into seven provinces, 81 cantons (small districts), and 470 districts (postal codes). Well known for its eco-tourism and federal commitments to preserve its environment, Costa Rica is working to improve its solid waste and recovery systems. San Jose is the nation's capital and the largest city. Of the roughly 4.8 million people living in Costa Rica, 54% reside in the Great Metropolitan Area around San Jose.[18] While economically and politically more stable than many of its Central American neighbors, Costa Rica still struggles with poverty, with higher poverty rates in rural parts of the country.

Costa Rica is facing a solid waste management crisis. The crisis is highlighted by the country's inadequate solid waste infrastructure, and creates many social and pollution-related issues. Solid waste management policies are emerging, but have led to landfill and dumpsite closures without providing sufficient support for the development of new infrastructure. As a consequence, burning and dumping are still common practices. Recycling is not embedded in the culture of Costa Rica, though recent legislation is establishing a foundation for a recycling economy. Organics management systems are essentially non-existent; however, there is slow but consistent progress in developing solid waste infrastructure, hazardous waste systems, and waste policy.

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

Waste generation in Costa Rica tripled between 1990 and 2006 and continues to grow.[19] In 2006, the country produced 3,780 metric tons of waste per day, or 1.4 million metric tons per year.[20] The daily average per capita waste generation is 0.86 kg/person[21]; per capita waste generation is higher in the Great Metropolitan Area than in more rural areas[22] (Figure *2*). Due to population growth and tourism, waste generation may double from 2001 levels by 2025.[23]

FIGURE *2*: DAILY PER CAPITA AND TOTAL WASTE GENERATION IN COSTA RICA (ACTUAL AND PROJECTED)[24]

	DAILY PER CAPITA WASTE GENERATION (KG/PERSON/DAY)	DAILY TOTAL WASTE GENERATION (METRIC TONS/DAY)
Costa Rica	2007: 0.85 2022: 1.04	2007: 3,600 2022: 5,600
Great Metropolitan Area	2007: 0.97 2022: 1.13	2007: 2,200 2022: 3,100
Outside Great Metropolitan Area	2007: 0.71 2022: 0.96	2007: 1,600 2022: 2,500

FIGURE 1: PROVINCES OF COSTA RICA

Waste Management Infrastructure

Solid waste infrastructure is maturing in Costa Rica. The limited waste and recycling infrastructure that exists is concentrated near San Jose.

Only five sanitary landfills meet the country's environmental and health standards, four of which are located in or around San Jose.[25] Outside of the Great Metropolitan Area, waste management has historically been a combination of loosely-managed or unmanaged dumpsites and open burning. Waste-to-energy (WTE) projects were banned until 2015.[26] Municipalities have not charged fees at levels sufficient to support waste collection, hauling and infrastructure development. In rural areas, many people are too poor to pay for waste disposal and burn their garbage instead. While dumps are being closed, the lack of waste management infrastructure is compounded by challenging logistics and underfinanced municipalities. The result is a far-reaching waste management crisis.

Three-quarters of Costa Rica has access to solid waste collection.[27] Just over half of household waste is sent to landfill (55%), and for the remainder, dumping and open burning are common practices.[28] It is estimated that 25% of waste is dumped in rivers.[29]

Waste Composition

Waste composition data is only available for the Great Metropolitan Area (Figure 3). In this area, organic material makes up more than half of the waste. Recyclables account for another 35% of waste. Despite existing policy and tracking systems for hazardous waste, ordinary and hazardous waste are usually mixed in municipal collection due to a lack of enforcement and processing solutions.

Recycling

The best recycling infrastructure is in the country's central region. San Jose Municipality operates two main material recovery facilities (MRFs) in the county: El Centro de Acopio del Centro Urbano Ambiental (CUA) located in the neighborhood of Cuba and the Transfer Station for Recyclable Materials in Hatillo.[32] Both places recover paper and cardboard, plastics, metals, glass and aseptic beverage cartons. These activities are carried out with the support from local communities. Transportation, logistics, and sorting are poorly developed, and Costa Rica lacks domestic recycling end market infrastructure. Closure of the New World Recycling polyethylene terephthalate (PET) plant (Costa Rica's only PET reprocessing facility) in 2014 eliminated an important end market.[33] Many recyclable materials such as aluminum and steel are exported for processing, particularly to China.

Current country-wide diversion rates are quite low. A study published in 2006 showed that Costa Rica recycled about eight percent of its total waste in 2005[34], while others estimate recycling rates to be about 10%.[35] Municipal collection for recyclables exists in the Great Metropolitan Area but it is less common in rural areas. Figure 4 illustrates the composition of the recyclables collected in 2013 and Figure 5 lists the recycling rates of these materials for the same year. Organics recovery is extremely uncommon in Costa Rica and the majority of organic material is disposed in landfills.

Waste Pickers

In Costa Rica, waste pickers, also called "buzos" or "trash divers" gather cardboard, aluminum, paper and glass. They comb through unsorted mixed waste under challenging conditions, usually on dumps or landfills. The number of waste pickers in the country is unknown, but many are migrants from the neighboring country of Nicaragua. Waste pickers are not recognized by the government in Costa Rica and waste picking is prohibited. There are no waste picking cooperatives in Costa Rica. Despite efforts to discourage waste picking, waste pickers organized their first formal conference in 2013.[37]

Organics Management

Organics management systems are largely unavailable in Costa Rica though there have been some composting pilots near San Jose.

FIGURE 3: AVERAGE MUNICIPAL SOLID WASTE COMPOSITION, GREAT METROPOLITAN AREA (2006)[30]

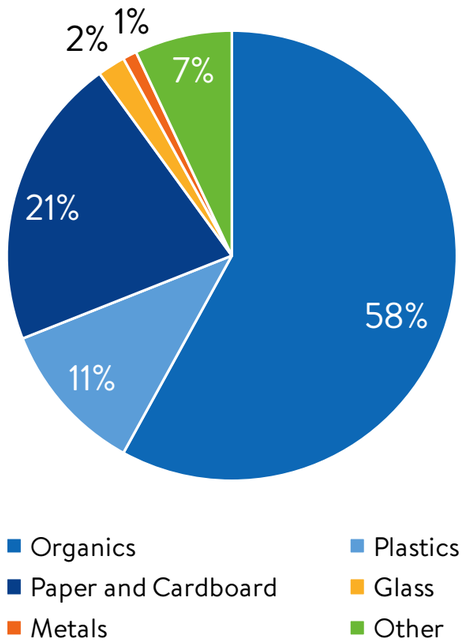


FIGURE 4: RECYCLABLE MATERIALS COLLECTED (KG) IN COSTA RICA (2013)[31]

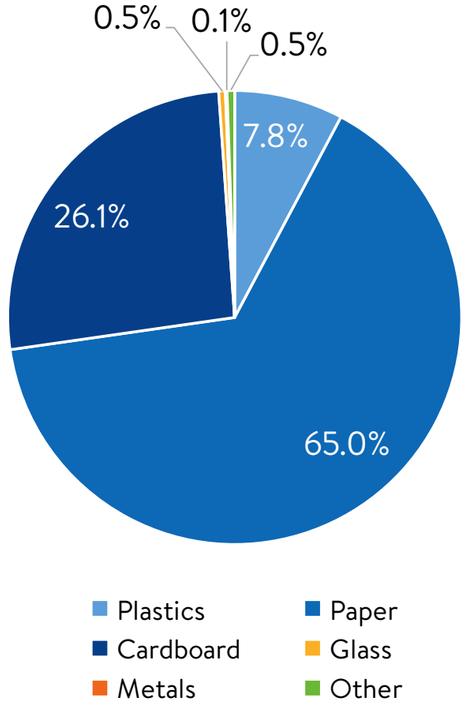
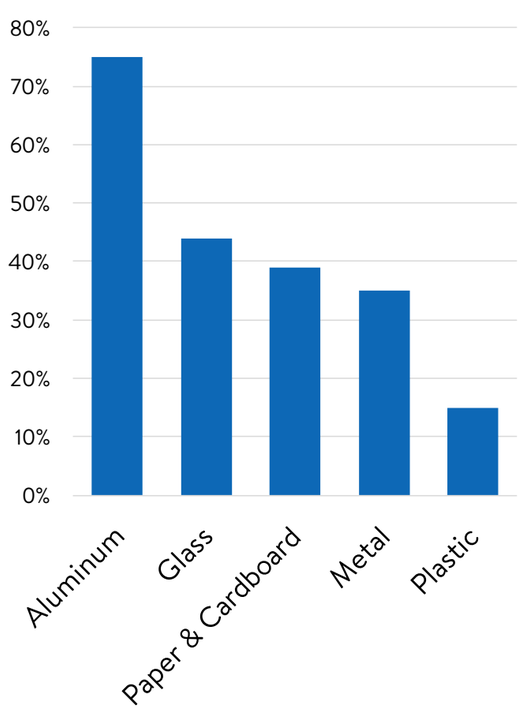


FIGURE 5: RECYCLING RATES OF VARIOUS MATERIALS IN COSTA RICA (2013)[36]



REGULATORY ENVIRONMENT

Costa Rican solid waste policy focuses on waste disposal over recycling. The framework for solid waste management in Costa Rica is established through the following instruments:

- 2010-2021 National Policy for Integrated Waste Management
- Law for Integrated Waste Management No. 8839
- Costa Rica Solid Waste Plan (Plan de Residuos Sólidos or PRESOL)
- Municipal Solid Waste Management Plans in 43 of 81 cantons

The most recent of these documents is the National Policy for Integrated Waste Management, which does the following:

- Focuses on final disposal
- Promotes separation at the source of waste generation
- Promotes new jobs and development of new markets and recyclable product materials
- Establishes Extended Producer Responsibility
- Addresses development of clean infrastructure
- Makes municipalities responsible for collection, transportation and disposal of solid waste. They can perform these services directly or contract third parties. They must provide some form of selective collection.
- Prohibits burning of any type of waste (although this practice still persists in the country)

While the National Policy has led to significant reforms, challenges remain. State and local governments have low levels of commitment to developing solid waste plans and improving solid waste management practices. Slow bureaucratic systems negatively impact environmental assessments. Municipalities lack the financial support to improve inadequate infrastructure, particularly in rural areas. Furthermore, waste management policy has not been enforced, so municipalities have little reason to implement the policy.[38] The inability of local government to finance and develop infrastructure is particularly problematic in areas where policy has led to the closure of landfills and dumps. The result is a lack of alternative solid waste and recovery infrastructure, and the availability and quality of the systems is uneven throughout the country.

KEY PLAYERS

International Organizations

- International Solid Waste Association (ISWA) www.iswa.org

National Organizations

- Ministry of Health (MINSALUD) – Health Ministry
- Ministry of Environment, Energy and Telecommunications (MINAET)
- Institute of Municipal Development and Assistance (IFAM)
- Ministry of National Planning (MIDEPLAN)
- Ministry of Public Education (MEP)
- Ministry of Agriculture and Livestock (MAG)
- National Institute of Census and Statistics (INEC)
- Costa Rica Chamber of Industry (CICR)
- Costa Rican Union of Private Sector Enterprise (UCCAEP)
- Program of Action for Climate, GIZ Costa Rica

Local Governments

- List of recycling drop off points across the country: http://www.ley8839.go.cr/index.php/actores-sociales/gestores-ambientales

Plastics

- **Avangard Innovative** – PET Star – locations in Costa Rica and across Central America

Glass

- **Grupo Vidriero Centroam americano (Vical) -** (http://www.grupovical.com/)

Electronics

- **Gollo** - In 2013, Gollo group had 120 collection centers accepting electronic products. (http://www.gollotienda.com/)

Mixed Material

- **Kimberly Clark Recycling Program** Costa Rica had 31 collection centers in 2012 that collect. (paper, cardboard, plastic, glass, aluminum, Tetra Pak brik) (http://www.halyardhealth.com/)

KEY TRENDS AND OPPORTUNITIES

- Costa Rica is experiencing a landfill and waste management crisis.
- Current countrywide diversion rates are very low.
- The country's central region, where San Jose is located, is more developed and has better recycling infrastructure than the rest of the country. Outside the Great Metropolitan Area, landfill management and recycling is less developed and poorly controlled landfills and dumping are more common.
- Recycling is not embedded in the culture of Costa Rica today but it is emerging. Recent waste management and carbon legislation is establishing a foundation for a recycling economy.
- Given the environmental ethos of Costa Rica and the importance of tourism, there is opportunity to promote both commercial and post-consumer recycling.
- Regional end markets are lacking for collected materials and the recent closure of a PET reclamation facility hurt the industry. Development of end markets and related economic development would be welcome in the region.
- Education for appropriate sanitation and recycling is an ongoing need.
- Corrugated, metals (especially aluminum), and selected rigid plastics and polyethylene (PE) films can be commercially recycled in San Jose and other urban centers with the appropriate partners.

UNIQUE MARKET CHARACTERISTICS

UNDERDEVELOPED SOLID WASTE AND RECOVERY SYSTEM

CHINA

Chinese territories are about the same size as the U.S. However, it has a population of 1.37 billion people, roughly four times the population of the U.S. It is a country that has experienced rapid industrialization in the past 25 years as well as a significant shift of its population from rural to urban areas. China is home to more than six cities of more than 10 million people, including Beijing and Shanghai, each with more than 20 million people. China is expected to have a population of 1.5 billion by 2025, two-thirds of whom will live in urban areas.

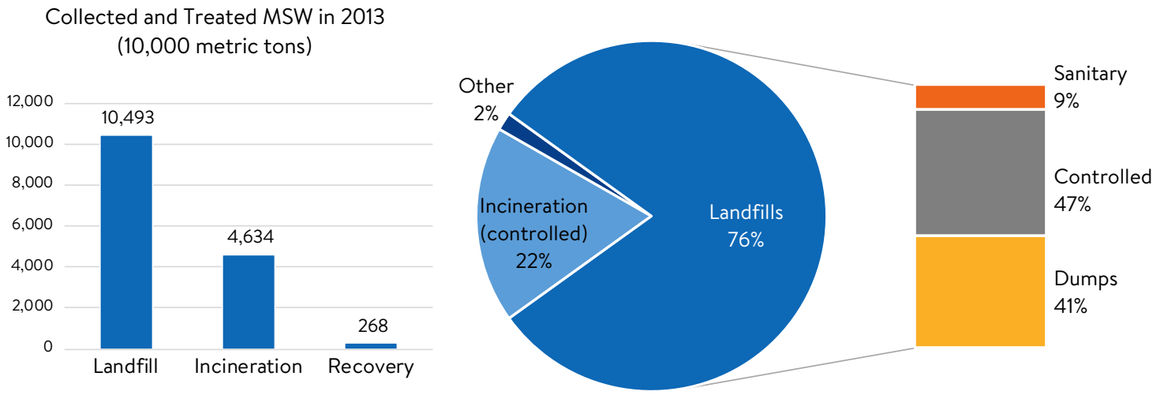
Waste generation is growing rapidly in China, especially in urban areas where there is a rapidly growing middle class. Urbanization and waste generation have grown faster than the country's solid waste policy and waste and recovery infrastructure. There is low business and consumer awareness of recycling, but as the central government has implemented new policies, including extended producer responsibility (EPR), it is expected that infrastructure and consumer awareness will improve rapidly.

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

In 2013, China generated 172.4 million metric tons of solid waste.[39] Not surprisingly, China's largest industrial and residential centers are also the largest generators. Per capita waste generation ranges from 0.4 to 4.3 kg/day depending on where a resident lives.[40] Recent estimates are that China's annual urban solid waste generation has reached nearly 200 million tons and will exceed 230 million tons by 2020.[41] By 2030, it is projected that China will generate more than twice the amount of waste than the U.S. for the same year[42]. China's waste infrastructure, which is based largely on sanitary landfills, dumps, and more recently, waste-to-energy, is insufficient to handle the amount of waste that is currently being generated.

FIGURE 2: SOLID WASTE TREATMENT AND INFRASTRUCTURE IN CHINA, 2013.[43]



Note: Represents the 87% of waste that is treated.

FIGURE 1: REGIONS OF CHINA

Policies, consumer education, and infrastructure need to evolve in order to keep up with the projected rate of waste growth.

Access to Waste Management Services

Collection services and infrastructure favor waste disposal over recycling. Waste collection is inconsistent in China. Some Chinese cities, like Beijing and Shanghai, have well-structured systems for collection, transport, treatment and disposal of waste. A weak link in many Chinese cities is the lack of adequate collection vehicles (compactors) and transfer stations. Approximately 49% of the population on mainland China has solid waste management services, while 100% of residents in Hong Kong and Macau receive collection.[44] Residential access to recycling collection is limited. This, combined with poorly developed recycling infrastructure, has contributed to low recycling awareness in citizens.

Waste Management Infrastructure

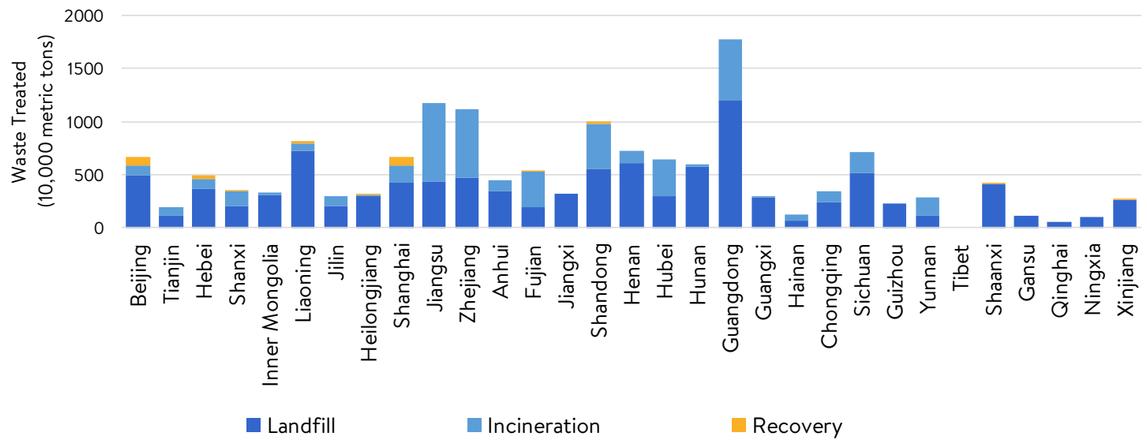
Landfills are the dominant type of solid waste infrastructure, though the infrastructure is changing rapidly. In 2013, of the 172.4 million metric tons of waste generated about 89% was treated. Of that, most was disposed in landfills or dumps (Figure 2).[45] In 2013, there were 765 solid waste facilities, of which 580 were landfills, 166 were incinerators (without energy recovery, and 19 were some other type of facility.[46] Lanfill space and dump space near rapidly growing cities is scarce, often poorly managed.

Waste-to-energy is developing rapidly and will be a significant waste treatment method in the coming decade. Although the capital cost of waste-to-energy is relatively high, the central government of China has been proactive with regard to increasing waste-to-energy capacity. The government has created an incentive, a credit of approximately $30 per MWh of electricity generated from waste-to-energy rather than energy from fossil fuels.[47] As of 2015, China operated 20 waste-to-energy plants across 15 cities, and another 120 plants were either completed, under construction, or proposed for construction.[48] As waste-to-energy quickly becomes a preferred waste treatment option for many population centers, China will have to develop more stewardship awareness in its populace if recycling is to compete with waste-to-energy.

Waste Composition

Data on waste composition is limited for China. There is little recent data that shows the break out of residential, commercial and industrial waste. In the past, composition of China's waste varied regionally based on factors such as the amount of industry and the dominant regional energy source, as shown in Figure 4. Areas relying on coal have coal ash as a large portion of "other" wastes, whereas areas that use natural gas have much lower portions of "other" waste. In the past, there was also a high amount of organic material in the waste. The composition of China's waste is expected to change as the country transitions to natural gas and becomes more developed, which will affect what solid waste treatment and disposal options China can use.

FIGURE 3: WASTE TREATMENT METHODS USED REGIONALLY IN CHINA, 2013. "RECOVERY" INCLUDES TREATMENT VIA WASTE-TO-ENERGY, RECYCLING, AND ORGANIC COMPOSTING.[49]



Recycling

Although over half of China's waste is composed of compostable and recyclable materials, very little diversion is currently taking place. In July 2017, the World Trade Organization announced a Chinese ban on the import of 24 scrap materials. This has been done in part to help develop domestic recycling and reduce dependence on imported materials according to the Chinese government. In addition, the government commented that this is part of a broader policy to target cities for waste sortation and recycling, especially in the Industrial, Commercial, and Institutional sector.

Residential recycling infrastructure is generally not well-developed outside of a few cities, but street recyclers collect paper and cardboard from residences. For example, since 2014 the government of Shanghai has been attempting to develop a centralized recycling system with a 3-year sorting target of 95%.[50] However, public awareness of this recycling program has remained relatively low.

Commercial recycling is more common than post-consumer recycling in China. Businesses with manufacturing or retail operations in industrial and urban areas can find waste partners to support the recycling of corrugated cardboard, polyethylene films, and selected rigid plastics like polyethylene terephthalate (PET) and polypropylene (PP).

Waste Pickers

Most recycling occurs informally by waste pickers and as much as 20% of China's waste may be recycled this way.[51] The Global Alliance for Waste Pickers estimated in 2015 that there may be as many as 2.5 million people who work as waste pickers in China. Organized cooperatives are unusual, and waste pickers tend to be highly marginalized and impoverished.[52] The materials most commonly collected include paper, plastics, cardboard, glass, and metals.

Organics Management

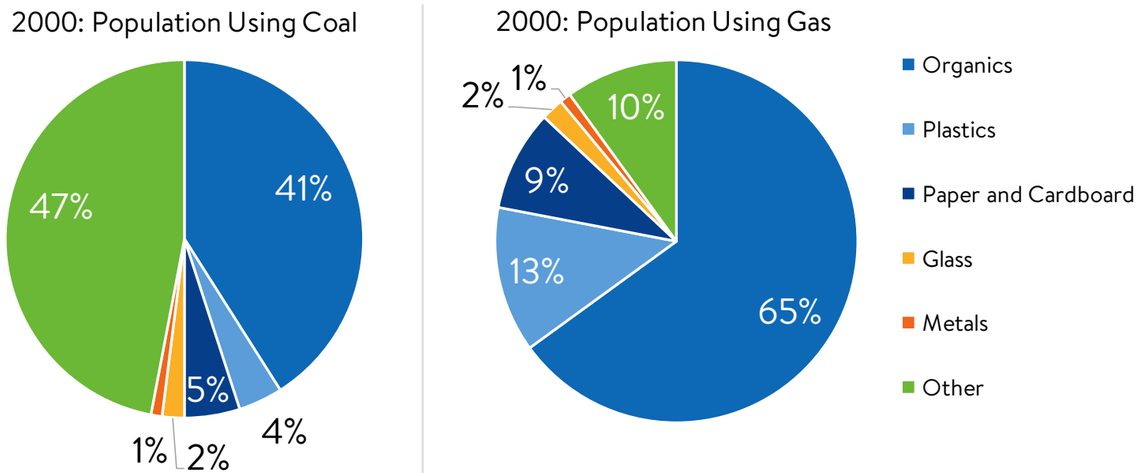
In urban areas – where up to 65% of municipal solid waste is organics[53] – most organic material goes to landfill (either controlled landfill or open dumping). Little to no organics management infrastructure exists. Unofficial organic diversion occurs in rural regions via animal feed or compost heaps at small farms and other operations.

REGULATORY ENVIRONMENT

Solid waste and recycling policy in China is underdeveloped but growing. There are four main waste management laws:[54]

- Environmental Protection Law of the People's Republic of China (issued in 1989): Encourages the use of recycled and environmentally-friendly products; establishes that municipal solid waste management is to be organized by local governments; and requires enterprises to prioritize the introduction of clean energy, adopt processes and facilities with higher resource efficiency and low pollution discharges, and apply comprehensive waste utilization and waste disposal technologies.

FIGURE 4: CHINA'S WASTE COMPOSITION, 2000[55]



- Law of the People's Republic of China on Prevention of Environment Pollution Caused by Solid Waste (issued in 1995, amended in 2004): Promotes the adoption of measures to prevent or reduce environmental pollution by solid waste.
- Cleaner Production Promotion Law of the People's Republic of China (issued in 2002): Encourages clean production and reduced discharge of solid waste.
- Circular Economy Promotion Law of the People's Republic of China (issued in 2008): Promotes more efficient resource utilization for sustainable development.

Solid waste policy exists through administrative regulations as well:[56]

- Municipal Waste Management System: Addresses waste reduction as well as advancing separation, collection and transport; selects treatment methods (sanitary landfill, clean incineration, and biological treatment); strengthens the management of food waste in urban and rural areas.
- National Catalogue of Hazardous Wastes: Requires proper labeling of hazardous waste, hazardous waste management and discharge prevention plans, and reporting; the State has a license control system for the units involved in collection, storage and treatment of hazardous waste; establishes plans for centralized treatment facilities.
- E-Waste: Catalogs waste electrical and electronic equipment collected by multiple channels for centralized treatment.

Although China has federal waste management laws and policies in place, there are numerous challenges in implementing them. Implementation is at the local level and inconsistently applied. The policies are generally broad and open to interpretation, leading to difficulties in enforcement. These factors create significant variations in solid waste management, priorities, and access to services across the country.

Extended Producer Responsibility

In early 2017, the State Council launched an extended producer responsibility (EPR) plan.[57] Manufacturers will be required to design durable products with sustainable packaging, use renewable raw materials, standardize recycling programs, and disclose recycling data. The first four products to receive priority under the program are electronic products, automobiles, lead-acid batteries, and packaging materials. Electronics manufacturers will need to encourage recycling collection in communities, offices and commercial buildings, and transportation hubs. Automobile makers will be required to recycle scrapped cars and use the recycled parts in their new products. National recycling goals for lead-acid batteries and paper packaging will be developed. According to the plan, an EPR framework should begin to take shape by 2020 and full laws and regulations should be formed by 2025. The EPR plan also aims for a 50% recycling rate by 2025.

KEY PLAYERS

International Organizations

- United Nations University Institute for Sustainability and Peace, Sustainable Cycles (http://isp.unu.edu/about/organization/scycle/)
- Asia Infrastructure Investment Bank
- International Solid Waste Association (ISWA, www.iswa.org)

National Organizations

- China Ministry of Environmental Protection

Plastics

- China Recycling Development Co., Ltd. (CRDC)
- Wellpine Plastic Industrial Co., Ltd.
- Incom Recycle Co.
- Hawkvale Limited

Paper and Cardboard

- Nine Dragons Paper Holdings Limited

Metals and Glass

- Kuusakoski Recycling

KEY TRENDS AND OPPORTUNITIES

- National solid waste laws and policies exist, but are currently weakly implemented and enforced at the local level.
- The National Sword and WTO ban is seen as a strong effort by the government to address solid waste issues, related environmental issues and develop a domestic recycling economy.
- The Central Government is increasingly taking action, including the launch of EPR for electronic products, automobiles, lead-acid batteries, and packaging materials in 2017.
- Little diversion is taking place in China and consumer awareness of recycling is low.
- Dumps, sanitary landfills and incineration are the predominant waste disposal methods.
- Waste-to-energy is on the rise.
- Residential recycling infrastructure is rare. Much of China's recycling occurs informally.
- Business to business recycling is most common for corrugated and films.
- The Chinese World Trade Organization Ban for 24 scrap materials is being implemented in part to stimulate the Chinese recycling economy, particularly targeting the Industrial, Commercial,and Institutional (ICI) sector in cities. This may represent an opportunity for businesses to work within this new regulatory climate to divert and to potentially source recovered materials.
- To support better management of solid waste and plastics in particular, there is need to emphasize education and messaging on appropriate waste management practices.
- As recycling infrastructure develops there will be a similar need to support the development of recycling education, messaging and behavior.

UNIQUE MARKET CHARACTERISTICS

UNDERDEVELOPED SOLID WASTE AND RECOVERY SYSTEM

INDIA

India has the second largest population in the world with 1.32 billion people. About one third of the country's population lives in urban areas, with the largest cities including New Delhi, Mumbai, Kolkata, and Bangalore. Although India remains heavily rural, the country has a high average population density of 445 people per square kilometer. According to the World Bank's Poverty Headcount indicator of extreme poverty, about 21% of the population lived on less than $2.00 per day as of 2011.[61]

India's solid waste and recovery systems are underdeveloped across all the framework criteria. Recycling is largely informal. The country's 2.86 million informal sector workers (mostly waste pickers) play a significant role in ensuring materials are collected, and remain marginalized in solid waste plans, policy and programs though efforts are underway to change this in some regions. Solid waste infrastructure is available but insufficient for the volumes and types of waste received. Landfills are generally unlined and are often not well-managed and susceptible to fire, and there are many open dumpsites. Compost sites are numerous, but problems with both quality of incoming material and output have been significant, particularly in urban settings. Solid waste policy exists but has generally been ineffective due to challenges at the local level and lack of enforcement. The challenges of an underdeveloped waste management infrastructure are exacerbated by a huge and growing population and a rapidly emerging economy, creating a persistent solid waste management crisis across many parts of the country.

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

The amount of waste produced in all of India is unknown. As of 2011, the Columbia Earth Institute estimated that the cities with populations over 100,000 (which account for more than 70% of the Indian population) generate 68.8 million metric tons of municipal solid waste (MSW) per year.[62] This is equivalent to a daily waste generation of 188,500 metric tons or 500 grams per capita in these cities. Due to economic and population growth, the World Bank projected that waste generation will triple by 2025 (from a 2005 base level).[63]

Waste generation is highest in the north region of India at almost 7,000 metric tons per day, and is lowest in the eastern region at less than 500 metric tons per day.[64] Not surprisingly, per capita waste generation in urban areas is higher than in rural areas. It ranges from a low of 0.342 kg/day in rural areas to 0.605 kg/day in the most densely populated cities.[65]

FIGURE 2: REGIONAL URBAN DAILY WASTE GENERATION AND COMPOSITION[66]

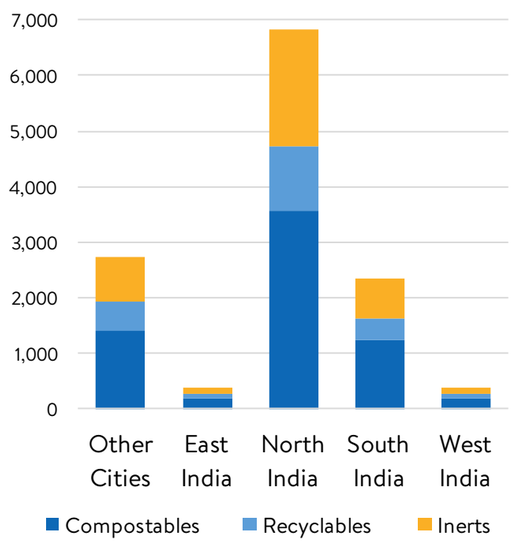


FIGURE 1: PRIMARY REGIONS OF INDIA

Access to Waste Management Services

Waste collection is more prevalent in urban areas than rural ones - about 70-90% of waste in urban areas, and about 50% of waste in rural areas, is collected for disposal.[67] Low collection rates in rural areas are a reflection of insufficient local budgets for hiring and training professional waste staff, and much of the collection falls to waste pickers.[68]

Waste Management Infrastructure

Waste management infrastructure in India is lacking in both scale and quality. Cities and municipalities generally spend much of their limited budgets on street sweeping and collection and very little on infrastructure and disposal. Furthermore, with over 50 urban agglomerations with over one million people each[69], landfill space is difficult to site. The combination of a huge population, a rapidly emerging economy, and limited infrastructure has resulted in a solid waste management crisis. In fact, in most of India's states, at least 10% of the land area is consumed by waste – up to 72% in one state.[70]

Unsanitary landfills and dumps are the primary mechanism for disposal of collected waste. In 2011, an estimated 91% of all urban MSW collected in India was either landfilled or dumped.[71] There are 76 landfills in India but only eight landfills are considered engineered.[72] The majority of these landfills are unsanitary landfills (not lined or well-managed) or open dumpsites, both of which are associated with landfill fires, litter, and groundwater contamination. The Deonar dump in Mumbai has such high levels of methane that it has a chronic problem with landfill fires. Waste-to-energy (WTE) has been used minimally in India with very poor success due to poor design for Indian waste streams, lack of operation and maintenance funding, and technical know-how. There were half a dozen WTE combustion plants in India in 2013.[73]

Waste Composition

Over half of India's municipal waste is considered recyclable or compostable. Organic material (i.e., food waste and green waste) is the largest fraction of the waste stream and makes up 40% of the waste.[76] Plastics and paper are the predominant recyclables generated, comprising 9% and 8% of Indian's waste respectively.[77] Relatively small quantities of glass and metal are produced. The remaining 42% of materials are not recoverable.[78] Figure 4 shows how waste composition varies across Indian cities, though in all cases the primary materials are food waste and inert materials like ash and dust.

Recycling

Recycling collection is dependent on the informal sector of about 2.86 million workers, many of whom are waste pickers.[79] Recycling occurs through several avenues, as illustrated in Figure 5. Waste that is handled through formal collection services is brought to transfer stations, landfills, and dumpsites, where waste picking can occur. Alternatively, waste pickers separate recyclables from uncollected MSW on streets and at informal sites. Recyclables can be directly bought by waste buyers or taken back to small stores. In any of these cases, the recyclables are sold to waste brokers and then sent to end markets.

It is estimated that India achieves a 21% recycling rate through the formal waste collection system and a 56% recycling rate through all recycling channels.[80] Since the actual amount of waste generated in India is not known and the amount of recycling is not well documented, it must be emphasized that any estimate of a national recycling rate is approximate.

Waste Pickers

Waste pickers recycle some 10 million metric tons per year.[81] Waste picking is concentrated in India's mega cities. Waste cooperatives exist, but are not widespread. Efforts are underway to grow them, most notably in New Delhi, Pune and Ahmedabad.[82]

Organics Management

The development of composting infrastructure has been a priority in India. There are approximately 80 composting

FIGURE 3: OVERALL WASTE COMPOSITION IN INDIA[74]

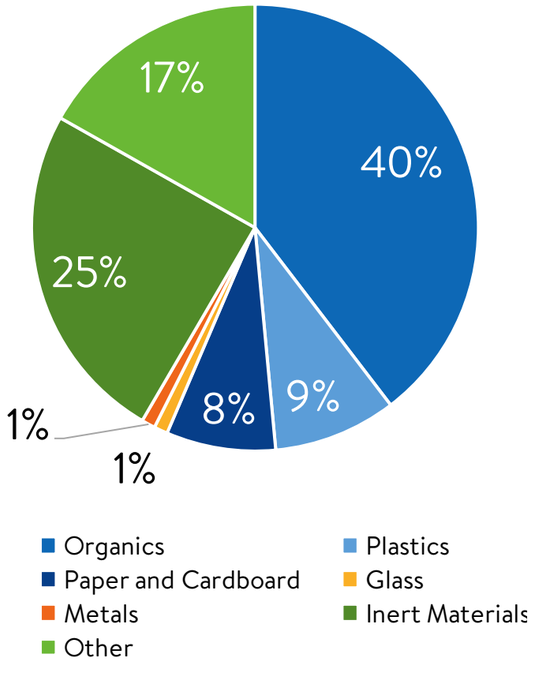


FIGURE 4: WASTE COMPOSITION IN SELECT INDIAN CITIES[75]

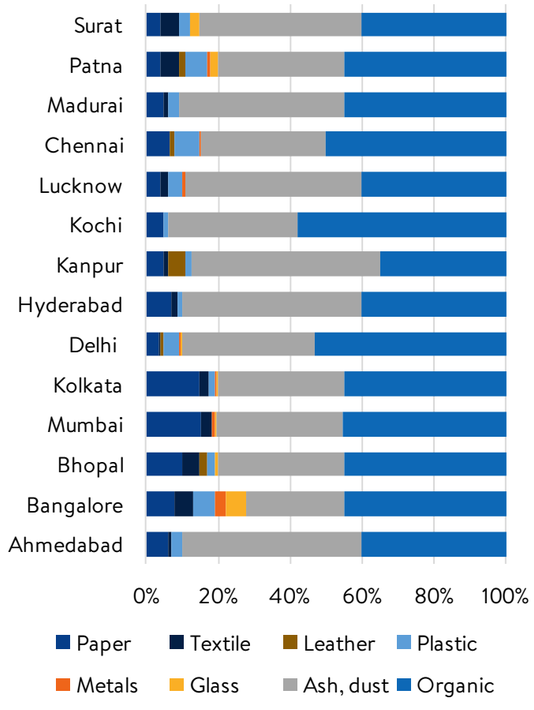
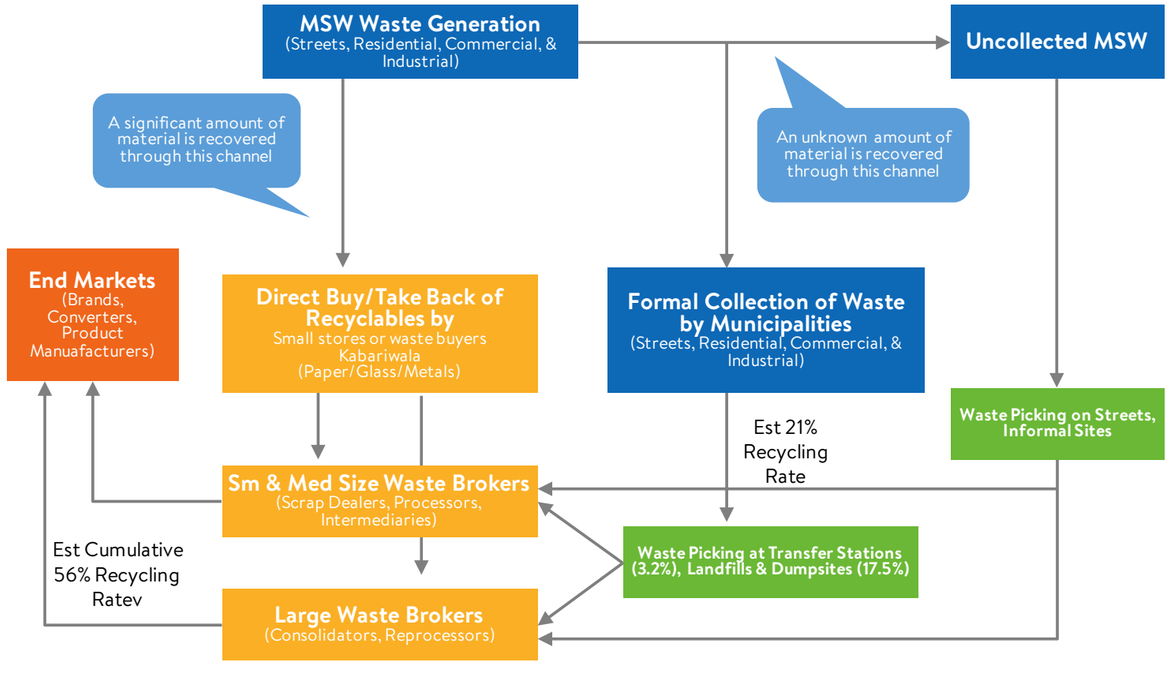


FIGURE 5: INDIAN RECYCLING VALUE CHAIN[83]



sites nationwide.[84] Most of these sites, however, are mixed waste composting sites. Yield from these systems is very low due to the mixed nature of inputs, and the resulting compost tends to be highly contaminated and thus unfit for food production. Anaerobic digestion to generate energy is found on small farms is limited to pre-consumer food waste and animal waste in rural areas.

In 2011, it was estimated that up to six percent of collected MSW was handled through mixed waste composting.[85] An estimated 0.5% of India's waste undergoes anaerobic digestion.

REGULATORY ENVIRONMENT

India has basic municipal solid waste rules in place. Emerging federal regulations have gone beyond establishing basic systems and responsibilities, and aims to support the role and integration of waste pickers in solid waste management and promote infrastructure development and improvement. The targeted infrastructure improvements include an increase in the construction of composting systems, new refuse-derived fuel (RDF) plants, waste-to-energy, construction of sanitary landfills, as well as capping some landfills for landfill gas collection with increased financial support from the Government of India. However, these policies face numerous obstacles and change is slow.

Mumbai generates 10,000 metric metric tons of waste per day. Located near the center of Mumbai and its large dump, Dharavi is one of the largest slums in Asia. It is also the home to the largest group of informal recyclers in Asia. It is estimated that up to 80% of Mumbai's waste is recycled into usable materials. There are thousands of small recycling plants and even more individuals who collect recyclable materials each day. Twenty percent of the community is estimated to be involved in waste management or recycling.[86]

The Ministry of Environment and Forests' Municipal Solid Waste (Management and Handling) Rules 2000 place the main responsibility for solid waste management on municipalities. The rules require municipalities to provide the infrastructure and services for collection, storage, segregation, transport, treatment, and disposal of MSW and to submit annual compliance reports.[87] Enforcement is the responsibility of state governments' urban development departments in metropolitan cities, or the district magistrates or deputy commissioners within their jurisdictions. Compliance deadlines have passed, and many objectives remain unachieved. The rules do not specify how municipalities should fulfill their obligations. Many municipalities do not have the budget to improve solid waste services.

The 2000 Rules were updated by the Solid Waste Management Rules in 2016. The prior mandates put on municipal areas now extend to urban agglomerations, census towns, notified industrial townships, and a large number of other designated areas. The rule update requires specific waste management facilities to be built within two to three years, depending on the local bodies' population size. The new rules require waste to be sorted into three categories prior to collection: "wet" (biodegradable), "dry" (items like paper, plastic, and metal), and hazardous. Waste generators will be charged a collection fee at a price to be set by the local government, and a fine for littering or failing to segregate waste.

Extended Producer Responsibility

India has implemented extended producer responsibility (EPR) for packaging. All manufacturers of disposable products such as tin, glass, and plastics packaging as well as brand owners who introduce such products in the market shall provide necessary financial assistance to local authorities for the establishment of waste management systems, and brand owners who market their products in non-biodegradable packaging material must establish a system to collect the packaging waste.

Additionally, India has established EPR for plastic under the Plastic Waste Management Rules in 2016.[88] Producers, importers, and brand owners that introduce plastic packaging, sachets, or pouches in the market must establish a system for collecting the plastic waste generated from their products. The Plastic Waste Management Rules of 2016 do not establish any targets.

Extended Producer Responsibility for E-waste

Extended producer responsibility (EPR) was introduced with the E-Waste (Management and Handling) Rules in 2011 to address the growing e-waste problem.[89] India is the fifth largest generator of e-waste in the world, discarding 1.7 million metric tons of electronics and electrical equipment per year, according to a 2014 UN report.[90] The legislation makes producers responsible for collection and reprocessing of e-waste, including establishing collection and processing systems. Progress has lagged, and the rules were updated by the E-Waste (Management and Handling) Rules of 2016. The more recent rules set targets for producers to collect and recycle 30% of end-of-life products in the first two years, and 70% by the seventh year.

KEY PLAYERS

International Organizations

- International Solid Waste Association (ISWA) www.iswa.org
- Word Bank
- Earth Engineering Center (EEC) of Columbia University
- Asian Development Bank
- United Nations Development Programme (UNDP)
- International Monetary Fund (IMF)

National Organizations

- The Alliance of Indian Wastepickers (AIW)
- SWaCH Cooperative in Pune, India
- Waste-to-Energy Research and Technology Council (WTERT)
- The National Environmental Engineering Research Institute (NEERI)

Plastics

- There are 1,777 known plastic recyclers in India.
- Most facilities are located in Tamil Nadu (588), Gujarat (365), Karnataka (302), Kerala (193)and Madhya Pradesh (179).
- The Dharavi Dumpsite: India's largest plastics recycling operation (all informal), focused on collection of all kinds of post-consumer plastics (except films) from local area and beyond.
- Albir Trading Company: Focused on HDPE and PP; receives plastic flakes from Dharavi and converts to pellets or sheets.
- Plastics for Change – plasticsforchange.org (work with waste pickers)

Paper and Cardboard

- Menons
- Origin Home Care Services

Metals and Glass

- Nfs Metals Enterprise

KEY TRENDS AND FINDINGS

- India suffers from a severe solid waste management crisis due to a large and growing population, a rapidly emerging economy and severe lack of well managed landfill space.
- The scale and need for improvements to infrastructure is significant.
- Clean Development grants and federal funding to upgrade dumps to engineered landfills such as Srinagar are the start of another positive trend.
- Organized groups of waste pickers are also not common. And many waste pickers are seasonal.
- Door-to-door collection for waste management services charge a user fee to citizens to cover the collection costs and bring in a level of accountability. However, this is not common.
- To better manage waste and especially plastics,there is need to support education and messaging on appropriate waste management practices.
- As recycling infrastructure develops there will be a need to support the development of recycling education, messaging, and behavior.
- There are several non-profits working in India on entrepreneurial approaches to recycling (especially plastic) and community development.

UNIQUE MARKET CHARACTERISTICS

UNDERDEVELOPED SOLID WASTE AND RECOVERY SYSTEM

SOUTH AFRICA

South Africa has 9 provinces, 44 district municipalities, 8 metropolitan municipalities and 226 local municipalities. With a population of about 56 million, it is an emerging economy and one of the world's leading mining and mineral-processing countries. It is neither energy or food secure and suffers from significant poverty.

The problem with food insecurity is severe. More than 22% of South Africans ran out of money to buy food at some point in 2014, according to Statistics South Africa. Unemployment was 27.7% in the first quarter of 2017[91] and income inequality is very high. Rural areas of South Africa are significantly more impoverished than urban areas. About 14.1% of South African households live in informal dwellings and 6.9% live in traditional dwellings.[92]

A series of national policy measures have been implemented to improve the understanding of waste characterization, enhance waste monitoring, improve the licensing or closure of landfills as appropriate, and encourage materials recovery. Municipalities are charged with implementing integrated solid waste policies, however 87% of municipalities lack capacity or infrastructure to pursue waste reduction. Thus, 90% of all waste in South Africa is landfilled and only 10% recycled.[93] Furthermore, waste is expected to grow by 30% over the next decade.[94]

Unlined landfills are common and dumping is still a problem, particularly in rural areas. Three of the world's 50 largest dumpsites as ranked by the Waste Atlas are in South Africa.[95] Organized recycling programs are in their infancy, but post-consumer container recycling has been developing under voluntary extended producer responsibility (EPR) models for polyethylene terephthalate (PET), glass, and steel cans.

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

An important national baseline waste study was done in 2011.[96] According to the study, 59 million metric tons of general waste was generated, of which about 90% was landfilled and 10% was recycled. However, when industrial and commercial waste were included, the study reports that 98 million metric tons of waste was landfilled in 2011. Approximately 45% of municipal solid waste is produced in the Gauteng Province, where Johannesburg is located.

According to projections by the World Bank, the rate of waste generation will grow by more than 30% from 2001 levels by 2025.[97]

FIGURE 2: SOLID WASTE GENERATION BY STATE, IN METRIC TONS[98]

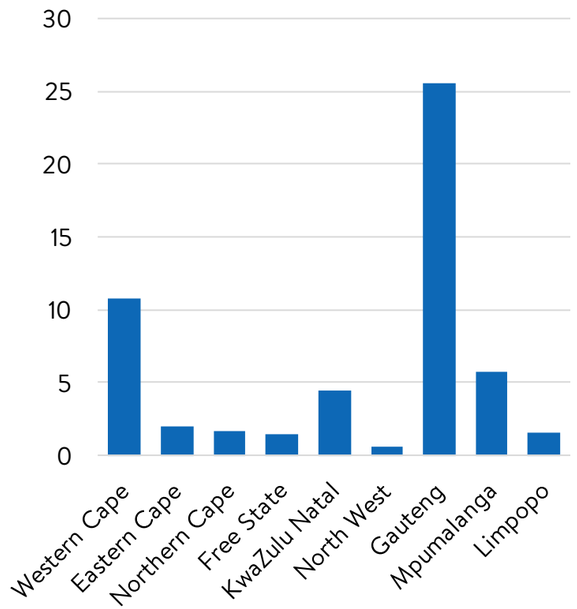


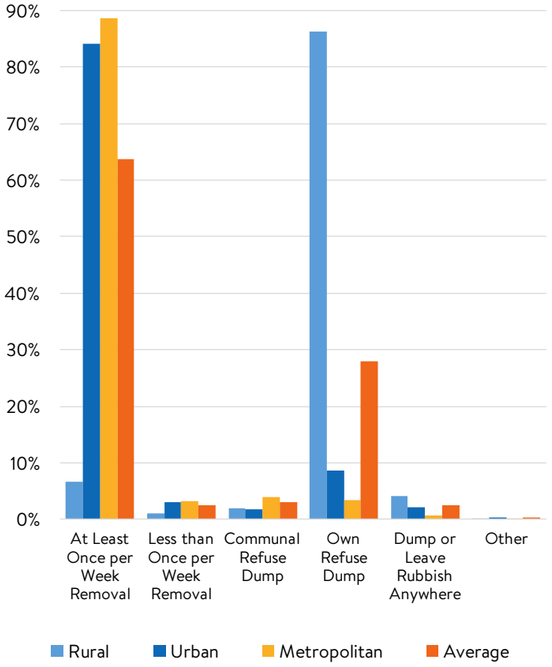
FIGURE 1: REGIONS OF SOUTH AFRICA

Access to Waste Management Services

There is significant disparity between urban and rural populations in terms of access to solid waste collection and disposal services. The best access to solid waste collection and disposal is in larger urban centers like Johannesburg and Cape Town. Small rural towns do not offer waste services, and lack of waste collection in informal settlements – around 4 million people live in informal communities primarily on the outskirts of large municipalities – leads to widespread illegal disposal.[99] Nationally, 64% of households in South Africa have access to weekly waste collection.[100]

Likewise, there is regional disparity in the ability to pay for waste collection and disposal services. Ninety-one percent of households have regular collection of general waste.[101] However, the fact that only 30% of South Africans have access to free solid waste management results in high rates of dumping.[102] Most urban South Africans have to pay for their waste management services.

FIGURE 3: DISTRIBUTION OF HOUSEHOLD REFUSE REMOVAL, 2015[106]

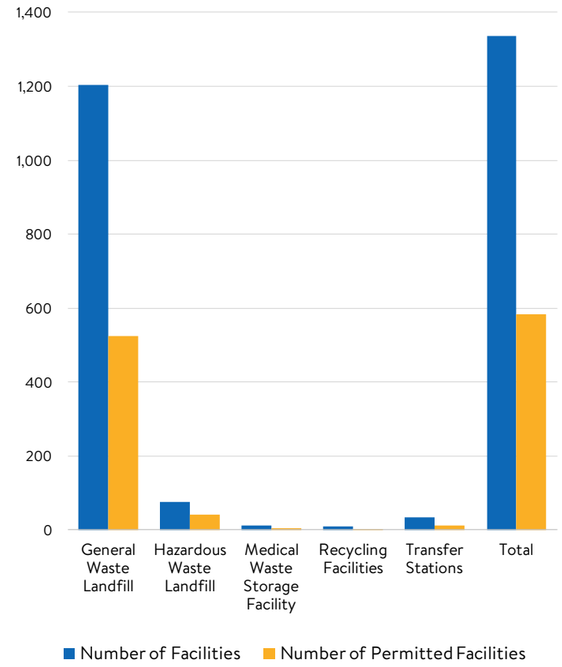


Almost 30% of South Africans surveyed had their own refuse dump which contributes to many of the problems that go along with self-managed waste, like open burning and litter.[103] Some urbanized areas are facing landfill availability crises (i.e., Stellenbosch) and as a consequence are increasing landfill fees. In a 2014 survey, waste removal problems and littering concerned 38.6% of households - an increase from 28.8% of households in 2003.[104]

Waste Management Infrastructure

Waste management infrastructure is inconsistent across the country. Many landfills are unlined, as it was not historically required. A 2007 capacity assessment estimated the number of waste handling facilities to be greater than 2,000, and found that 1,500 of those were unlicensed.[105] In some urban areas, investment is being made in landfill gas technology, waste-to-energy and anaerobic digestion with the support of clean development grants.

FIGURE 4: PERMIT STATUS OF WASTE MANAGEMENT FACILITIES[107]



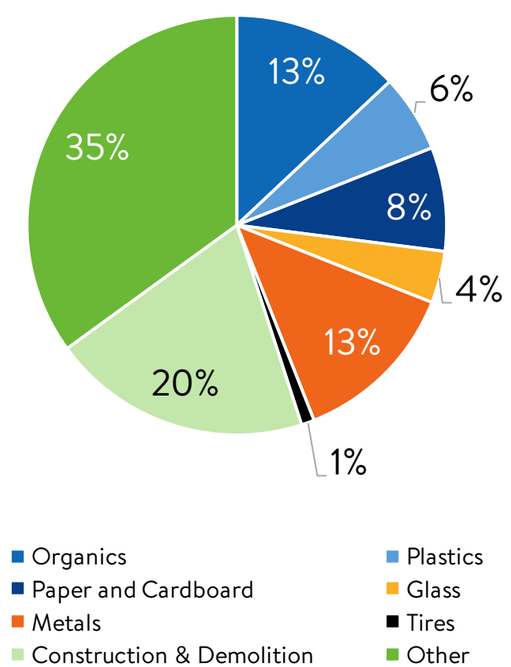
There are very high numbers of dumpsites, especially in rural areas, and illegal burning, especially of tires, is also a concern. The government is working aggressively on documenting dumpsites, and either licensing for them appropriate operation or closing them.

Significant efforts have also been made to improve waste reporting. In South Africa, the Department of Environmental Affairs (DEA) reports annual targets for licensing and closures. Municipalities have been developing management plans and gradually making progress toward legislative targets for solid waste improvements.

Waste Composition

In South Africa, about 35% of general waste is considered non-recyclable, 20% is construction and demolition (C&D) waste, and organic waste ranges between 13% and up to 39%, depending on the region.[108] Large amounts of construction and demolition debris are contributing to landfill capacity crises in urban centers.

FIGURE 5: GENERAL WASTE COMPOSITION, 2011[109]



Recycling

There is not a strong culture of recycling in South Africa. Only 10% percent of the country's waste is recycled[110] and most recycling is done by informal sector. There are private companies and waste picker organizations that offer curbside recycling in Cape Town, Johannesburg and Pretoria. Waste pickers are an important part of the recycling economy. Johannesburg's waste management service provider advertises a series of drop off and buy back sites around South Africa that are focused on container collection. But in general, post-consumer recycling infrastructure is limited outside of major urban areas.

The most commonly recycled materials are steel cans, paper, glass, and plastic containers. Resources are lacking to expand recycling services outside urban areas, yet there are efforts to expand drop-off sites for recycling, and recycling has been a growing business in South Africa despite economically challenging times. Integrated Waste Management is driving the capture of waste as a source of recovered materials and much needed energy. The DEA has set a national diversion target of 15% by 2019.

With more than 4,000 drop-off sites across the country, the glass recycling rate was 40.9% in 2014.[111] About 90,749 metric tons of PET was recovered in 2016, equivalent to a recycling rate of 55.[112] In 2014, 315,600 tons of plastics was diverted from landfills, for a 22.5% plastics recycling rate.[113] About 90.2% of this recovered material was recycled in South Africa and the rest was exported. About 72% of metal packaging was recycled in 2014.[114] According to the Paper Recycling Association of South Africa (PRASA), the 2014 combined paper, paperboard & corrugated recycling rate was 64%.[115]

Private companies offer recycling collection in some cities, including Cape Town, Johannesburg and Durban. The City of Cape Town was the first municipality in South Africa to offer recycling collection, through a pilot program. However, budget constraints halted expansion of this program. Johannesburg, Cape Town and eThekwini have started recycling pilot programs, yet only 2% of Johannesburg's waste was recycled as of a 2011 report.[116]

However, voluntary producer organizations (VPROs) have been leading the way in establishing a recycling system for PET, glass and steel containers through drop-off centers and buy-back programs. VPRO members pay fees to subsidize the system and create end markets, and voluntary recycling targets were created to avoid legislated producer responsibility requirements. For example, a non-profit glass packaging industry initiative

led by South Africa's major glass producers, Consol Glass and Nampak Weigand Glass, is a partnership between DEA, glass manufacturers, fillers and recyclers. Members pay a levy at the point of purchase per ton of glass bottles and the voluntary producer organization provides glass banks throughout South Africa where consumers can receive cash for glass.

In 2010, PET industry, including Coca-Cola, resin producers, converters and bottlers, formed the precursor to PETCO (PET Plastic Recycling South Africa). The organization exists to promote PET recycling. Converters who manufacture PET bottles, bottlers, and importers pay a voluntary levy per ton of PET resin purchased; resin producers and brand owners contribute in the form of annual grants. Revenues support recyclers, recycling projects, and promote PET recycling education and outreach programs. In 2016, they achieved a 55% recycling rate within South Africa and are currently on target to meet DEA recycling target of 70% by 2022 and Plastics South Africa's goal of zero plastics to landfill by 2030.

Despite voluntary producer organizations making strides to recover more post-consumer materials, most recycling occurs through industrial, commercial and institutional (ICI) channels. Most materials recycled were metals from the ICI sector. The estimated value of discarded recyclables is more than ZAR 25.2 billion/year.[117]

Waste Pickers

South African Waste Picker's Association data indicates about 60,000 people make a living as waste pickers.

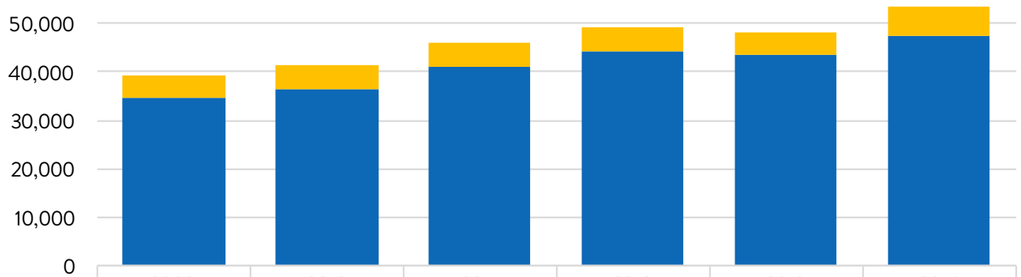
According to the Institute of Waste Management of South Africa, Asiye eTafuleni (AeT), a Durban based NGO that works with waste pickers, estimates that the average South African waste picker can earn an income of up to ZAR120 per day (USD 8.68).[118] Waste pickers contribute to higher levels of recycling within cities and towns, and help divert waste. Several landfill operators and recycling organizations hire waste pickers and use them as part of their operations.[119]

A major threat to waste pickers is the trend of privatizing municipal solid waste management systems that often results in private companies 'owning' the waste that waste pickers used to sort through themselves. AeT works with informal recyclers to improve public perception of waste pickers in Durban and improve waste picker livelihoods. Some of the improvements have included: provision of custom-designed trolleys, safety gear and identification cards, organizing recyclers into working groups, and participation of the waste pickers in public presentations and events.

The South African Waste Picker's Association was formed in 2008 and helps to organize waste pickers nationally and keep track of the different cooperatives across South Africa (there are currently 13 registered cooperatives). The Department of Trade and Industry funds qualifying cooperatives, including purchasing material recovery facility equipment.

The large numbers of waste pickers have created both political and social barriers to alternate waste disposal practices and strategies that might displace waste pickers. It is challenging to achieve the appropriate level of mechanization for effective solid waste management and also include waste pickers.

FIGURE 6: EMPLOYMENT IN SOUTH AFRICA PLASTICS RECYCLING SECTOR[120]



	2009	2010	2011	2012	2013	2014
Formal Employees	4,841	4,812	5,062	5,047	4,510	6,037
Informal Employees	34,500	36,600	40,950	44,100	43,488	47,420

Organics Management

Nationally, organic waste is estimated to be 13% of general waste.[121] Food waste management is underdeveloped across the country, and the vast majority of organic waste is landfilled. At the same time, there are both national and regional compost companies offering services to the public, and garden waste is collected and composted in some provinces like the Western Cape. DEA has published draft guidelines for composting (http://sawic.environment.gov.za/documents/1825.pdf). Small-scale anaerobic digestion facilities have been installed in some rural areas.

REGULATORY ENVIRONMENT

South Africa's national solid waste policy, the National Environmental Management Waste Act of 2008, came into effect in 2009. The Waste Act follows the waste management hierarchy by promoting cleaner production, waste minimization, reuse, recycling and waste treatment, with disposal seen as a last resort in the management of waste. Waste is divided into two classes based on the risk it poses - general waste and hazardous waste.

Tracking progress against annual solid waste and recycling targets is an area of current focus.
Since 2010, the government has implemented numerous pieces of legislation to address landfill and disposal issues as well as to encourage the development of a secondary materials economy.

Progress has been slow but steady and co-disposal of hazardous industrial waste with municipal solid waste is still practiced. There are annual targets and reporting on specific chemicals management. However, due to historic co-disposal of hazardous and mining wastes with general waste there is still work to be done.

Implementation of solid waste policy is the responsibility of municipalities. Most municipalities do not have the capacity or infrastructure to pursue waste minimization. Every municipality is required to file an Integrated Development Plan to show how it plans to reduce, recycle, and manage its waste. Many municipalities are still developing plans. Aggressive policy steps have been taken in the past decade to address dumping issues and upgrade waste management infrastructure through policy reforms. There have been significant accomplishments in the areas of waste characterization and reporting.

Extended Producer Responsibility

As described above, voluntary producer responsibility plays a significant role in driving recycling forward. For e-waste, the e-Waste Association of South Africa was established in 2008 to help develop a sustainable e-waste management system. One of its initiatives has been to explore a voluntary producer responsibility system for electronics. The high cost of building recycling plants for e-waste poses a major challenge. Currently a plan is in draft form that would establish a small fee at the time of purchase that would fund the setup of recycling facilities. A group of computer manufacturers has also been working on an e-waste plan.[122]

In addition to VPR, there is a mandatory extended producer responsibility (EPR)program for plastics bags which was started in 2003.

KEY PLAYERS

International Organizations

- African Development Bank
- International Solid Waste Association (ISWA) www.iswa.org

National Organizations

- The South Africa Department of Environmental Affairs (DEA)
- South African Local Government Association
- National Recycling Forum
- Institute of Waste Management of South Africa
- The Recycling Association of SA (RASA)
- Recycling Action Group (RAG)
- e-Waste Association of South Africa (eWASA)
- South African Plastics Recycling Organization (SAPRO)
- Plastics Federation of South Africa

Local Governments

- Provincial governments
- District municipalities
- Metropolitan municipalities
- Local municipalities

Plastics

- Packaging Council of South Africa (http://www.packagingsa.co.za/)
- PET Plastic Recycling South Africa (PETCO) (http://www.petco.co.za/home)
- Plastics | SA (http://www.plasticsinfo.co.za/)
- Polystyrene Packaging Council
- Buyisa-e-Bag
- Nampak Recycling

Paper and Cardboard

- Paper Recycling Association of South Africa (PRASA) (http://www.recyclepaper.co.za/)
- Mondi Recycling (www.paperpickup.co.za)
- Sappi (www.sappi.com)

Metals and Glass

- Collect-a-Can (http://www.collectacan.co.za/)
- The Glass Recycling Company (http://www.theglassrecyclingcompany.co.za/)
- Consol (www.consol.co.za)
- Metal Recyclers Association of South Africa (http://www.mra.co.za/)

Other

- Redisa integrated industry waste-tyre management plan (IIWTMP)
- E-Waste Association of South Africa (www.e-waste.org.za)

KEY TRENDS AND OPPORTUNITIES

- South Africa is an emerging economy that suffers from food and energy insecurity as well as high levels of poverty.
- Waste is expected to grow by 30% over the next decade.
- 90% of all waste in South Africa is landfilled and only 10% is recycled.
- Landfills are largely unlined and dumps are common, particularly in rural areas. Three of the world's 50 largest dumpsites are in South Africa
- A series of national policy measures have been implemented to improve waste characterization, monitoring, documentation, licensing, improve or close landfills as appropriate, and to encourage materials recovery.
- Municipalities have been charged with implementing the integrated solid waste policies. But 87% of municipalities lack capacity or infrastructure to pursue waste reduction.
- Waste and recycling infrastructure is significantly better in and around Johannesburg, Cape Town and Durban than in other parts of South Africa.
- Organized recycling programs are in their infancy; private companies offer recycling collection in some cities, including Cape Town, Johannesburg and Durban.
- Most recycling occurs through Industrial, Commercial, and Institutional (ICI) channels.
- Voluntary EPR programs exist for steel cans, glass and PET.
- Waste pickers are a critical part of the recycling economy.
- Commercial recycling of corrugated, metals, selected plastics and glass is available in the larger urban centers. Transportation logistics can be a barrier once out of urban centers.
- Given the high rate of food insecurity, food donation and support of pantries can be an important strategy as part of a food waste diversion program.
- Consumer awareness of recycling is low so efforts to raise awareness of recycling programs and supporting the development of local recycling infrastructure, including the informal sector, and end markets can help expand the domestic recycling economy.

Unique Market Characteristics: Maturing Solid Waste and Recovery Systems

UNIQUE MARKET CHARACTERISTICS

MATURING SOLID WASTE AND RECOVERY SYSTEM

ARGENTINA

Argentina contains 23 provinces with 379 administrative subdivisions, 2,200 municipalities, and one autonomous city, Buenos Aires. Ninety-two percent of Argentina's population resides in urban areas, with one third living in Buenos Aires.[123]

Historically one of the wealthiest South American countries, Argentina suffered recurring economic crises during most of the 20th century. Severe depression culminated in 2001 bringing 60% of the population into poverty. In 2011, international estimates of the poverty rate were between 23-30% of the population living below the poverty line. The economy rebounded until 2010 but has slowed since 2011. Argentina is a highly literate country with an export-oriented agricultural sector and diversified industrial base.

National waste generation rate of 1.15kg/person/day generates 16.8 million metric tons/year. National waste diversion is at 3-6%. Significant regional differences exist in waste management and recycling infrastructure: Buenos Aires is relatively well developed, while elsewhere, the infrastructure is much less developed, with poorly engineered landfills and dumping more common. The persisting severe economic crisis in Argentina means that urban landfills need investments in equipment and emissions management to minimize impacts to the environment and human health.

Buenos Aires is the largest city in Argentina, with a population of 2.8 million.[124] However, the Buenos Aires metropolitan area has a population of 15.8 million[125] and produced 17 thousand metric tons of waste per day or about 40% of the municipal solid waste (MSW) in the country in 2010.[126]

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

In 2010, Argentina had an average per capita waste generation rate of 1.15kg/day, generating a 16.8 million metric tons/year.[127] Solid waste management is maturing, but is highly variable across country. The Pampas region, which includes Buenos Aires, is relatively well-developed while other regions are lagging. Overall, nearly two-thirds of waste is disposed in sanitary landfills.[128] According to World Bank projections, the rate of waste generation will double by 2025 (from 2001 levels).[129]

Additionally, the average e-waste generation is 8.4 kg/person/year (compared to an average of 7.1 kg/person/year in Latin America).[130] Argentina doesn't yet have an e-waste recycling system and so most of this material is disposed in landfills and dumpsites along with MSW.

FIGURE 2: DISPOSITION OF WASTE GOING TO LANDFILL IN ARGENTINA, BY WEIGHT[131]

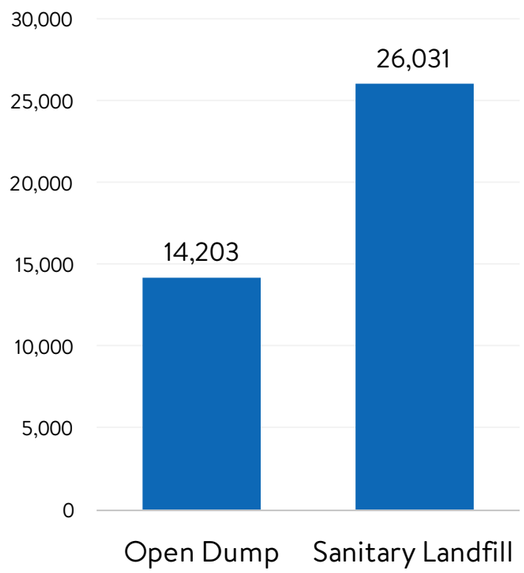


FIGURE 1: PROVINCES OF ARGENTINA

Access to Waste Management Services

Almost all (99.8%) of Argentina has solid waste collection, and more than 70% of collection occurs daily.[132] However, only 65% of the waste is disposed in sanitary landfills — the rest is taken to open dumps.[133]

Waste Management Infrastructure

The country has significant geographic disparities when it comes to solid waste. The more prosperous South-Center Region generates more waste while the North and the Cuyo-Mesopotamia Region has fewer collection services and sanitary landfills and generates less waste. Approximately 68% of municipal solid waste is produced in the Pampa Plain–Center Region where Buenos Aires is located. In the Cuyo-Mesopotamia area, approximately 45% of waste goes to open dumps and only 15% is landfilled. Meanwhile, in the East, Center, and South (includes Buenos Aires) with 68% of the population, roughly 79% of the waste is landfilled.[134] In general, smaller municipalities in Argentina dispose of their waste in less well-managed landfills or open dumps, while urban centers have engineered landfills.

The San Carlos de Bariloche Dumpsite receives around 54,700 metric tons of waste annually and is on the International Solid Waste Association's list of World's 50 Biggest Dumpsites.[135] The dumpsite is located 1.5 km from the nearest settlement and it is a risk to both Gutierrez Lake and Nahuel Huapi Lake.

Garbage collection in the city of Buenos Aires is mostly privatized (5 private companies and 1 owned by the local government).[136] The Metropolitan Area Ecological Coordination Society (CEAMSE) is a company created by the city of Buenos Aires and its province to manage urban solid waste in the metropolitan area. Only 8% of the total waste entering CEAMSE plants is recovered, yet CEAMSE recycles the greatest quantity by weight in the country.[137]

FIGURE 3: DISPOSITION OF WASTE GOING TO LANDFILL IN ARGENTINA, NUMBER OF MUNICIPALITIES[138]

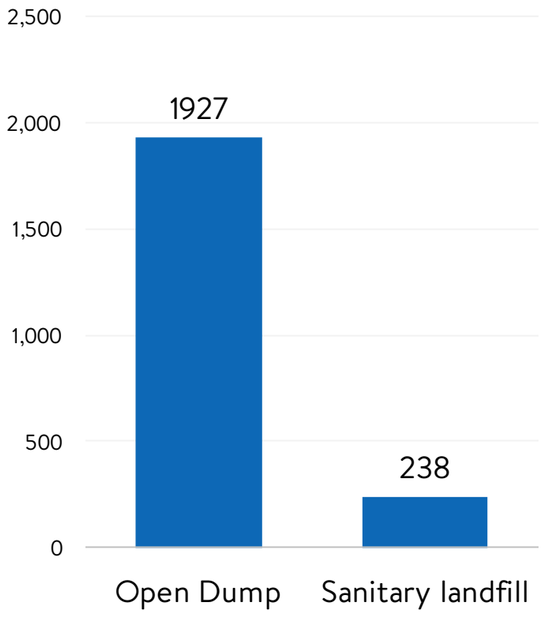
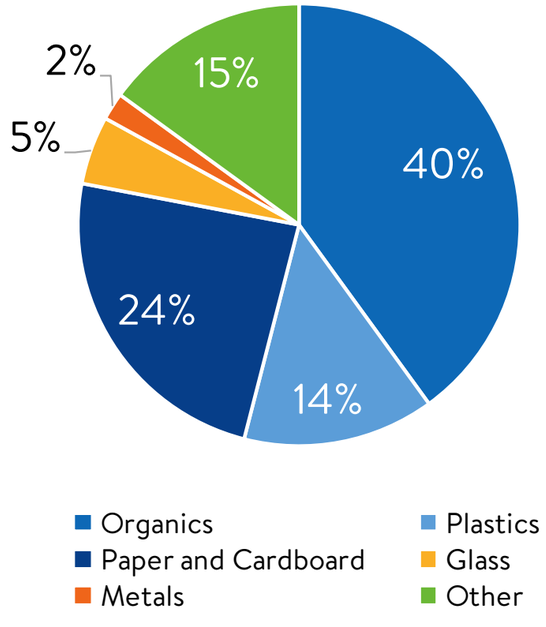


FIGURE 4: AVERAGE COMPOSITION OF ARGENTINIAN MSW[139]



Waste Composition

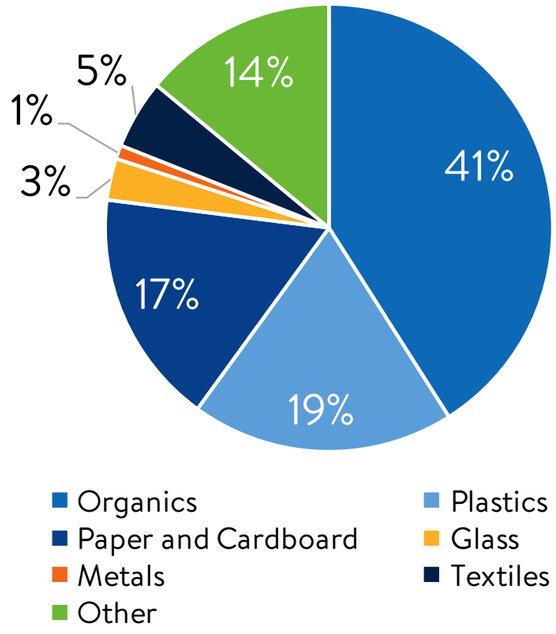
The average waste composition in Argentina differs slightly from the more urban and higher income areas around Buenos Aires. Organics, paper, and plastics remain the largest components.

Recycling

Recycling systems are underdeveloped across most of Argentina. Most of the country's recycling infrastructure is in Buenos Aires and in the South and Center region. It is unclear what portion of the population has access to recycling, but only an estimated 3-6% of material is diverted from landfills or dumps.

Recycling is not embedded in Argentina's culture. However, the importance of conservation and stewardship is being taught in schools and it will likely emerge as an important trend to consumers within the decade. Argentinian's are increasingly aware that they are the home to the vast and sparsely populated region of Patagonia, which contains some of the most unspoiled natural areas in the world.

FIGURE 5: BUENOS AIRES METROPOLITAN AREA COMPOSITION[140]



Waste Pickers

Recycling in Argentina is dependent upon organized associations of waste pickers or "cartoneros" as the presence of mechanized material recovery facilities is low. Waste pickers represent an industry of $178 million per year and recover around 13% of the waste generated in Buenos Aires alone. They work in disposal sites and at separation plants, and they remain a visible sign of poverty. It is estimated that recycled material recovered by informal recyclers accounts for a space savings up to 30% at the landfills while reducing collection and transportation costs. More than 20 waste picker cooperatives exist across Argentina.

In Buenos Aires, the profession of "*cartoneros*" is officially recognized. There are an estimated 40,000 waste pickers in the city of Buenos Aires.[141] They collect, haul, sort, and sell recyclable commodities in formal cooperatives and through informal means. There is some indication of a trend toward formalization of waste picking across the country. A breakthrough came during a 2012 landfill crisis which forced Buenos Aires to improve its recycling and formally bring in the 12 operating cooperatives into the city's waste management system.[142] The 5,000 organized waste pickers pay taxes and in return receive an average monthly salary of 4,500 pesos (around USD 500), health benefits, and pension benefits.[143]

As of 2014, Buenos Aires operated 5 warehouses called Green Centers where recyclables are sorted from trash rather than on the streets.[144] Buenos Aires is also providing transportation, uniforms, gloves, and helps negotiate the prices for commodities. More green centers are being built as the system expands.

Cooperatives outside of Buenos Aires need investment support to improve mechanization and more effectively separate materials.

Organics Management

Organics are mostly disposed in landfills and dumpsites. In 2001, the most important composting plant in the country was built at the CEAMSE landfill (located in Buenos Aires), with the capacity to process 1,000 metric tons per day.[145] Small composting programs are growing in rural areas, but no government data are readily available on the status of organics management. The government, however, did publish a residential composting guide for municipalities.[146]

Due to relatively high level of poverty and food insecurity in parts of the country, food donation is an important strategy in Argentina. There are numerous food bank networks. Transportation logistics and lack of refrigeration can be a limiting factor in allowing food donations to food banks outside of Buenos Aires.

REGULATORY ENVIRONMENT

Argentina's federal solid waste and recycling policy is maturing. However, implementation and enforcement lag behind the ambitious goals established by legislation.

Law 992, passed in 2002, formalized the role of waste pickers[147] and established diversion targets from 2004 baseline (50% by 2012, 75% by 2017, and a zero waste goal by 2020[148]). Other goals of this legislation included increasing recycling, increasing the amount of materials returned to industry, and banning incineration until 75% diversion is reached. It requires source separation for select large generators, separation of organics, and an eco-tax on non-recyclable materials.

In 2004, Argentina created the National Strategy for Integrated USW (Urban Solid Waste) Management known as ENGIRSU.[149]
Highlights of the policy include:

- Minimize solid waste generation while maximizing its value.
- Closure of all open dumps and infrastructure revitalization.
- Social inclusion - Integrated "cartoneros" waste pickers into policy.
- Formulation of solid waste master plans for each province.
- 10 years for jurisdictions to comply with the disposal of household waste law and 15 years to comply with all the other provisions of the law.

Unfortunately, lack of political and social stability has not allowed effective ENGIRSU implementation, but the years following this national strategy saw a number of initiatives and investments that benefited waste management and recovery infrastructure. As a result, many open dumps containing hazardous wastes in Buenos Aires City and Province have been remediated, and a recycling plastic company opened a plant for treatment of PET bottles in Buenos Aires Province.
Implementation of ENGIRSU is the responsibility of the Ministry of Environment and Sustainable Development via a National Unit for Comprehensive Management of MSW (UNGIRSU).

The San Juan Provincial Plan started operation and material recovery facilities (i.e. recycling facilities) were brought online in Mar del Plata and San Carlos de Bariloche.

In 2012, an Electronic Waste Law (Ley Basura Electrónica) was proposed but failed to pass in the Congress.[150]
In general, lack of political and social stability has prevented effective solid waste and recovery policy implementation. There is low commitment from state and local governments to improve solid waste management through enforceable policy or implementation. The legal framework is characterized by overlapping requirements at national, provincial and municipal levels, hampering its effectiveness. The Inter-American Development Bank estimates that 65% of the municipalities in Argentina have their own solid waste plan, but they depend on financial resources from the provincial governments for implementation.[151] The result is insufficient basic solid waste and recovery infrastructure, uneven distribution of infrastructure within the country, and a lack of organics infrastructure.

KEY PLAYERS

International Organizations

- Inter-American Development Bank
- International Solid Waste Association (ISWA) www.iswa.org

National Organizations

- National Secretary of the Environment and Sustainable Development (SAYDS)
- Argentina Association of Sanitary Engineering and Environmental Sciences (AIDIS)
- Argentina Civil Association Pro PET Recyclers (ARPET)
- Association for the Study of Solid Waste (ARS)
- Technical Association for Waste Management (ATEGRUS)
- Argentina Chamber of Industry of Recycled Plastics (CAIRPLAS)

Local Governments

- Ecological Coordination for the Nation's Metropolitan Area (CEAMSE)
- Environment Business Chamber (CEMA)

Plastics

- Cámara Argentina de la Industria de Reciclados Plásticos (CAIRPLAS)
- ArbisPlast
- BEFESA ARGENTINA S.A
- BARESI S.R.L.

Paper and Cardboard

- Bornhauser S.A.
- Cellulosa de la Mesopotamia S.A.
- INTERPACK S. A. - PAPELERA DEL SUR

Food Banks

- Fundación Banco de Alimentos: http://www.bancodealimentos.org/

KEY TRENDS AND FINDINGS

- Argentina is a maturing market for solid waste handling and recycling, but faces several hurdles.
- The economic downturn has significantly hindered further development of modern landfills, recycling collection, and organics management infrastructure.
- Buenos Aires is leading the way in terms of solid waste management and material recovery with relatively stronger infrastructure than in other parts of the country.
- Buenos Aires is also a leader in accepting waste pickers as a formal and important part of the system for materials recovery and seeing potential for economic development in the industry.
- Solid waste policy enforcement and data gathering will be necessary in order to effect meaningful change to solid waste infrastructure and recycling culture in the country.

UNIQUE MARKET CHARACTERISTICS

MATURING SOLID WASTE AND RECOVERY SYSTEM

BRAZIL

Brazil is a large country and is home to one of most biodiverse ecosystems on earth. Its rapidly developing economy is already the 5th largest economy in the world and is dependent on raw material extraction, agriculture, and a growing manufacturing and service industry. It has a population of approximately 200 million people spread across more than 5500 municipalities, and two megacities, São Paulo and Rio de Janeiro.[152] Historically, the wealthiest 10% of the Brazilian population has enjoyed 40% of wealth while the poorest 10% of the population has less than 1% of wealth. According to recent estimates, 21% of population lives below the poverty line and 4.3% of the population lives in extreme poverty.[153] Poverty disproportionately impacts the Northeast, North, and Center-West of the country. Child labor is a problem in Brazil: as of 2009, estimates were that 960,000 children under the age of 14 were employed, with waste picking a common form of child labor.[154]

The waste management and recycling infrastructure is highly variable across Brazil. Dumps and controlled landfills are prevalent in the northeast, and sanitary landfills and recycling are most prevalent in the Southeast near São Paulo. The national diversion rate is below 5%. Waste picking and the informal sector are recognized by the federal government and constitute a critical part of the recycling value chain in Brazil. Organics diversion is generally rare, though interest is growing in organics recovery. There are municipalities, particularly in the southeast, where composting is more common. After many years of debate, Brazil passed its first comprehensive Solid Waste and Recycling legislation in 2010. Improving waste and recovery infrastructure and integrating waste pickers into the waste management system are key priorities. Extended producer responsibility legislation has also been introduced for a variety of products, including packaging.

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

Brazil produced 76 million metric tons of waste in 2013, which translates to approximately 1.00 kg of municipal waste generated per person per day.[155] The southeastern region of Brazil, which is home to the metropolitan areas of São Paulo (20.3 million people) and Rio de Janeiro (12.6 million people), generates a significant portion of the waste in Brazil, with the Northeastern states coming in a distant second. Compared to its baseline of 2001, the World Bank estimated that MSW tonnages in Brazil would more than double by 2025.[156]

FIGURE 2: 2008 MSW COLLECTED BY REGION (METRIC TONS/DAY)[157]

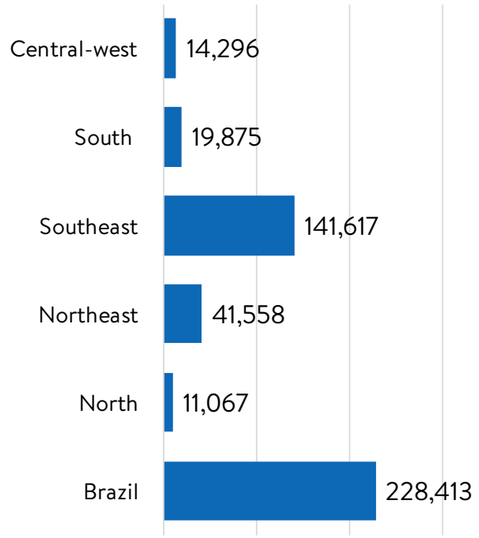


FIGURE 1: PRIMARY REGIONS OF BRAZIL

São Paulo is the largest city in Brazil and the fifth largest mega city in the world. The greater Metro area has 20.3 million inhabitants, 12 million whom live in the municipality of São Paulo. It has a density of about 7500/km^2.[158] The municipalities that make up the São Paulo metropolitan area are responsible for generating nearly 20% of the municipal solid waste (MSW) collected in Brazil.[159] About 77% of municipalities in the São Paulo metropolitan area offer selective collection.[160] Within São Paulo, the government supports numerous recycling cooperatives who play a critical role in general waste management and the collection and sortation of recyclables. In the São Paulo Metro region, diversion is estimated at 3.8% and within the São Paulo Municipality the diversion rate is only 1.7%.[161]

Access to Waste Management Services

Access to waste management services is generally good in Brazil, with the best access is concentrated in cities, especially those in the southeast. However, the government estimates that 10% of Brazilians (or about 20 million people) do not have access to regular waste collection.[162]

Waste Management Infrastructure

Waste management infrastructure is maturing in Brazil, but is highly variable and has significant room for improvement. While well-developed in the South and Southeast, its sophistication lags elsewhere, particularly some of the ecologically sensitive areas in the North and Northwest. More than 50% of waste is disposed in sanitary landfills and investment is needed to make further gains. Local authorities are responsible for waste management yet only 965 of 5570 municipalities have local sanitation laws in place.[163] One of the challenges to infrastructure improvements is that local governments have limited capital resources to build new and more modern landfills or invest in recycling.

Therefore, dumps are a common disposal method in Brazil, including the capital Brasilia. As of 2010, there were more than 2800 dumpsites, most of which are in the northeast of Brazil. Their remediation has become a target of recent solid waste legislation. The more urbanized southeastern region of Brazil has seen significant improvements in infrastructure over the past decade, but faces significant challenges with landfill space given the population to be served.[166] In 2010, there were 1254 controlled landfills in Brazil (these are typically unlined but have some type of covering) and 1540 sanitary landfills which are engineered and located primarily in the South and Southeast.[167] São Paulo has been an important catalyst for improving waste management infrastructure and promoting better organized recycling, and is expected to continue this role over the next decade.

Waste Composition

Of the 76 million metric tons of MSW that were generated in 2013, 69 million tons were collected for management.[168] The majority (54%) of MSW generated in Brazil is organics and about 30% of MSW is suitable for recycling.[169,170] Recyclable materials include metals, glass, paper, and selected plastics.

Recycling

Recycling infrastructure is generally underdeveloped across most of the country and only about 13% of the population has access to recycling.[171] Not surprisingly, the most robust recycling infrastructure such as drop-off and limited curbside collection is found in the more developed urban areas in the South and Southeast. Recycling and other recovery infrastructure will likely continue to improve in this region over the next decade. Consumer awareness of recycling is best in and around São Paulo but otherwise is generally very low across Brazil.

'Selective collection' refers to programs that separate dry recyclables (i.e. metal, glass, and plastic) from wet

FIGURE3: 2008 BRAZILIAN MSW GENERATION AND DISPOSITION BY REGION (METRIC TONS/DAY)[164]

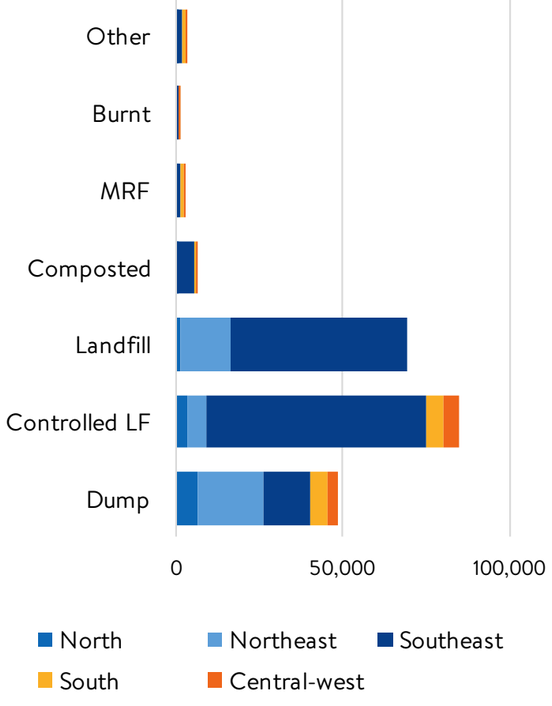


FIGURE 4: AVERAGE COMPOSITION OF MSW IN BRAZIL[165]

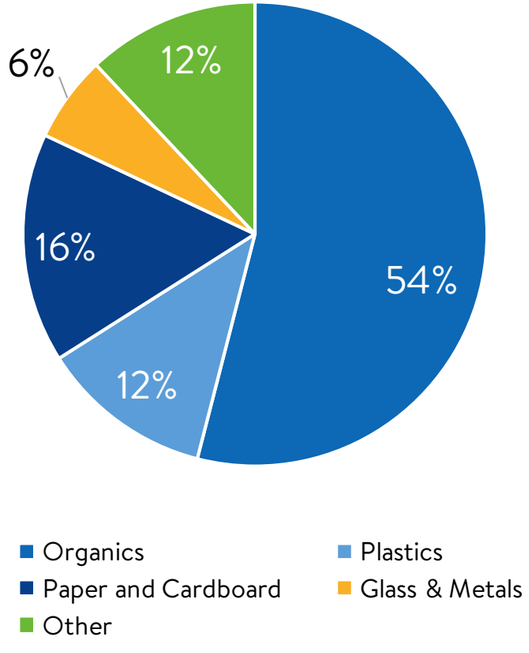
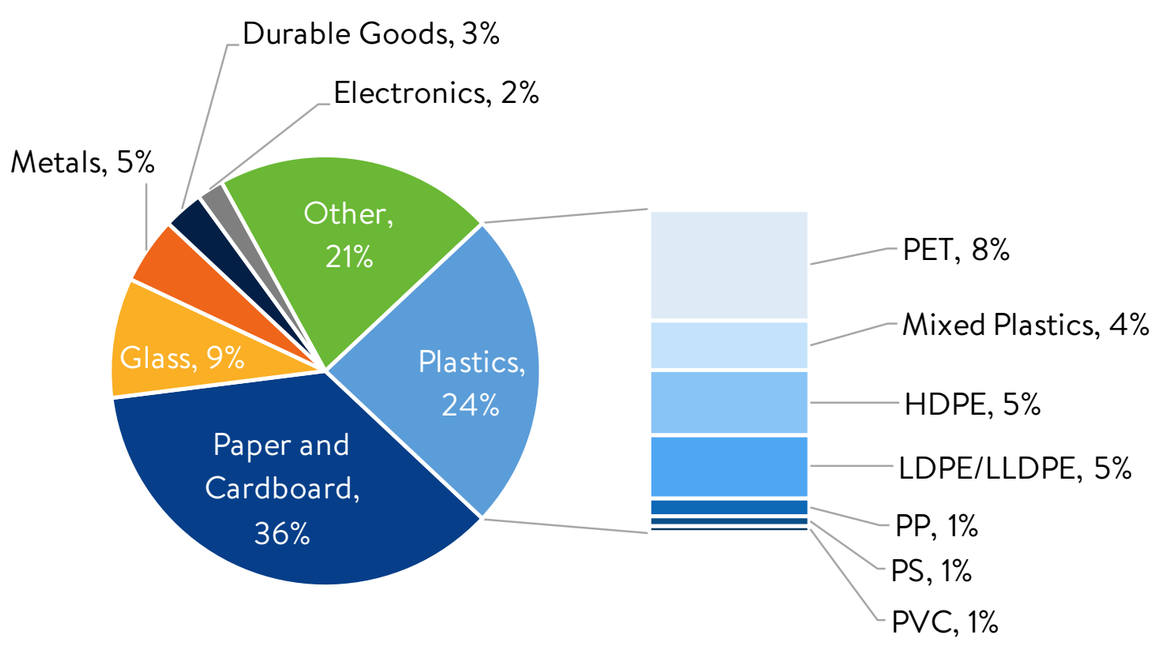


FIGURE 5: MATERIALS RECOVERED THROUGH RECYCLING TOTALING 700,000 METRIC TONS/YEAR (2014)[172]



wastes (i.e. food and other organics). In Brazil, 17% of municipalities offer selective collection serving 13% of the population (28 million), again focused in the south and southeast. The majority (65.7%) of these municipalities work with organized waste pickers. Among municipalities that have selective collection, 80% have "door-to-door" collection while 45% have drop-off sites.

In 2014, paper/cardboard and plastics represented 60% of all the materials collected for recycling in Brazil. Polyethylene terephthalate (PET) is the mostly commonly collected and recycled plastic. Mixed plastics, high-density polyethylene (HDPE) and low-density polyethylene (LDPE) are also commonly collected and recycled. Glass is also widely recycled in Brazil. See Figure 5.

Recycling infrastructure and cooperatives are likely to expand in the most urbanized areas over the next decade as landfill availability becomes more constrained and the need for diversion grows. The evolution of recycling cooperatives with improved mechanization and more efficient and stable business models will be important to the future of recycling in Brazil.

As an example, São Paulo has made a commitment to the expansion and advancement recycling. It has set goals for the separation of "dry waste," i.e. recyclables, which include:[173]

- Implementing source-separated collection across the city by the end of 2016;
- Increasing the capacity of sorting plants in public buildings by 2016;
- Developing two additional sorting plants by 2016;
- Creating three new Mechanical Biological Treatment (MBT) plants in eco-parks by 2019; and
- Investing in new destinations for dry waste, including cooperatives.

Commercial Recycling

Commercial recycling of corrugated cardboard, paper, metals, glass, and selected plastic is possible in urban centers like São Paulo and Rio de Janeiro, where there are haulers and well-established recycling cooperatives. However, due to the congestion in these cities, the transportation logistics presents an obstacle. Outside of urban areas with established recycling systems, cooperatives and recycling organization are less common, and finding partners and markets for materials can be more challenging in some regions.

Waste Pickers

Waste pickers and recycling cooperatives play a key role in supporting both the collection of municipal waste and the sorting and commoditization of recyclables. In Brazil, the profession of "waste picker of recyclable materials" is officially recognized by the federal government and in recent solid waste legislation. Waste pickers collect, haul, sort, and sell recyclable commodities. In 2010, there were more than 500,000 waste pickers in Brazil. Of these, between 40,000 and 60,000 belong to one of more than 1,000 operating cooperatives or recycling associations.[174]

Approximately 40% of waste pickers live in the South or Southeast of Brazil — São Paulo alone is estimated to be home to 20% of the total.[175] In Brazil, most waste pickers are men (69%) and the remaining (31%) are women, with an average age of 39.[176] About 20% of waste pickers are illiterate.[177] The average waste picker income is $335.00/month.[178]

There was a 25% growth in the number of cooperatives between 2003-2013.[179] However, since the 2008 global economic downturn, hundreds of waste picker organizations have gone bankrupt. The most common arrangement between municipalities and waste picker organizations is one with no financial benefits and in some cases no legal contract. Waste picker incomes rely solely on sale of recyclable material. Recent research showed that only 7% of municipalities paid for the service provided. [180]

Organics Management

Composting is generally underdeveloped across Brazil. However, there are a total of 211 composting sites concentrated in two states. The state of Rio Grande do Sul currently has the best organics management infrastructure. Given the high levels of poverty in Brazil, food donation is an important avenue to prevent food waste, and many cities have food banks. With its new climate goals and concerns over declining landfill space, São Paulo is focused on developing more robust management of organics, including food waste. To support its desire to expand organics management, São Paulo has developed goals which include:[181]

- Separate organics collection in all districts by the end of 2023;
- Composting all the organics generated by street markets by the end of 2016;
- Installation of 8 small composting plants (50 tons/day) each by 2016;
- Installation of 4 large composting plants (2,400 tons/day) by 2023;
- Installation of 3 MBT plants in eco-parks, to produce biogas and fertilizers through anaerobic digestion by 2019;
- Stimulate home composting through distribution of home composting boxes and education, aiming for 33% reduction by 2023;
- Investment in new destinations for organic waste.

REGULATORY ENVIRONMENT

Since 2010, solid waste policies in Brazil have been improving and expanding after decades of inactivity. Brazil passed its first comprehensive solid waste and recycling legislation referred to as the Política Nacional de Resíduos Sólidos (PNRS) in 2010. The legislation seeks to improve both basic solid waste infrastructure, expand recycling, implement producer responsibility and provide avenues for the inclusion of waste pickers into waste management and recycling throughout Brazil.

The key elements of the legislation included:

- Infrastructure revitalization and elimination of unsanitary waste practices
- Closure of dumps and controlled landfills and replace with engineered sites by 2014.
- Authorization of states and local municipalities for implementation.
- Introduction of Extended Producer Responsibility (EPR) for select products
- Integration of waste pickers into solid waste management
- Investment for recycling and infrastructure

The Ministry of Environment is responsible for implementation of the PNRS. The Brazilian Environment Agency (IAMA) and the state and municipal environmental agencies are responsible for the regulations, licensing, and enforcement. Large municipalities like São Paulo have been most successful at implementation. In other areas, local implementation lags behind the policy itself, often due to a lack of a solid waste plan and adequate funding. In these areas, there is little basis for enforcement of solid waste policy.

Extended Producer Responsibility

Extended Producer Responsibility (EPR) is one of the strategies employed by Brazil to drive the recovery of specific products and packaging. Implementation is challenging given the lack of harmonization across municipalities and inconsistent infrastructure. Brazil has the most expansive EPR system in South America, with very complex implementation through negotiated "sectorial agreements."
Products currently designated under Brazil's EPR and take-back system include:

- Pesticides and their packaging
- Batteries
- Tires
- Lubricant oil and its packaging
- Packaging (steel, aluminum, glass, plastic, paper, etc.)
- Fluorescent lamps
- E-waste

EPR legislation has created complex implementation requirements. Once sectorial agreements are in place, implementation of reverse logistics is dependent upon cooperation between obligated producers and municipalities. Several regions are lagging in the implementation of local policy and the availability of infrastructure. However, recycling and diversion is expected to expand through the implementation of EPR. For packaging, recycling exchange programs exist that utilize "reverse logistics credits," which can be issued to waste picker organizations when they sell the materials. These credits can then be purchased by the obligated companies for the packaging they place on the market.[182]

Extended Producer Responsibility for E-waste

Brazil is the third biggest market for computers and e-waste and is growing about 7-10% per year. [183] E-waste is regulated under general EPR framework outlined in the PNRS. E-waste is defined as waste from household electronic products and components which are dependent on electrical current of up to 220 volts. Currently, there are 94 e-waste recycling companies in 13 states, mostly in the southeast part of the country. [184] Approximately 918,000 metric tons of e-waste was processed in 2013.[185]

KEY PLAYERS

International Organizations

- Inter-American Development Bank
- International Solid Waste Association (ISWA) www.iswa.org
- International NGOs

National Organizations

- CEMPRE – industry/government funded organization organizes waste picker cooperatives
- Waste picker cooperatives (see list in Appendix)
- Municipal governments
- Brazil Economic and Social Development Bank
- Brazilian Association of Public Cleaning and Special Waste Companies (ABRELPE)
- São Paulo Sanitation Technology Company (CETESB)
- Brazil Ministry of the Environment (MMA)

Local Governments

- The Waste Management Authority of the City of São Paulo (AMLURB)
- ECOURBIS – Waste management company for São Paulo
- LOGA (http://www.loga.com.br/) – Waste management company for São Paulo

Electronics

- Arrow Electronics, Inc.

Food Banks

- Banco de Alimentos de Jandira
- Banco de Alimentos de Santo Andre Banco de Alimentos de Santo André
- ONG Banco de Alimentos - http://www.banco-dealimentos.org.br/
- SESC Program Bureau Brazil, 27 locations throughout the country

KEY TRENDS AND OPPORTUNITIES

- The combination of poverty, the prevalence of dumps and inadequate infrastructure, and complex solid waste and recovery legislation has created a challenging environment in which to rapidly advance solid waste improvements. They are happening, but largely focused around the largest urban centers.
- The most robust waste management and recycling programs in Brazil are focused around the São Paulo region. Innovations in organics management are likely to develop in this region over the next decade as well.
- Outside of the São Paulo region, the prevalence of dumps and controlled landfills is high and recycling is uncommon. Investment is needed for foundational infrastructure improvements, especially outside of the São Paulo region.
- Investment in recycling infrastructure has been lagging across the country and most recycling is done manually. Support of cooperatives that are working to improve labor conditions, safety, and mechanization of recycling will also improve the overall efficiency of recycling.
- EPR for packaging is still in the implementation phase, and due to the complexity of sectoral agreements, some regions lag. Appropriate contracting and compensation between municipalities is needed to ensure stability to grow the recycling marketplace.
- Regional market development for recovered materials will help stabilize recycling markets.
- Best practices for megacities like São Paulo versus regular scale cities, and areas with underdeveloped infrastructure will vary due to infrastructure differences, lack of policy guidance, and access to markets.
- Consumer awareness of recycling and organics management is low. Education about dry/wet separation will help to advance both recycling and organics management.

UNIQUE MARKET CHARACTERISTICS

MATURING SOLID WASTE AND RECOVERY SYSTEM

CHILE

Chile is a long, narrow country that is bound by the Pacific Ocean to the west and the Andes to the east. Its narrow geography, lengthy coastline and towering mountain ranges define the country. The four primary geographic regions are shown in Figure 1. Chile is a natural resource intense country and suffers from high levels of pollution in its cities and industrial centers. About 90% of Chile's 17.5 million people live in its cities.[186] It is broken in to 15 regions, 54 provinces and 346 municipalities, the largest is the capital, Santiago, with 6.5 million people.[187] Santiago along with the cities of Valparaiso and Concepcion make up about 47% of the population. The World Bank classifies Chile as a high-income country with 1.3% of the population living in extreme poverty.[188]

Chile is highly dependent on landfills, most of which are considered sanitary landfills and unlined dumps. In 2009, Chile generated about 6.5 million metric tons of municipal solid waste (MSW)[189] and with the high rate of growth, the World Bank has projected waste will almost double by 2025 (from 2001 levels).[190] As of 2009, recycling was still in its infancy and with lagging solid waste policy this has created concern for local and city governments.[191] Only 2% of MSW in Chile is recycled.[192] Since 2009, several cities have taken steps to improve solid waste management and improve recycling. Consumers in Chile are increasingly aware of the need for improved solid waste management and recycling and have been supportive of programs in Vitacura (a suburb of Santiago) and other cities. In 2016, Chilean government passed extended producer responsibility legislation explicitly to reduce the amount of waste going to landfills and unauthorized dumps (vertederos).

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

A comprehensive waste study was performed in 2009.[193] The study shows that in 2009, Chile generated a total of 16.9 million metric tons of waste of which 6.5 million metric tons was municipal solid waste for a per capita generation rate of 384 kg/person.[194] The rest, 10.4 million metrics tons, was classified as industrial waste.[195]

Most waste is generated in cities where there is excellent access to waste management collection services as shown in Figure 2. In 2009, 2.8 million metric tons of waste was generated in Santiago alone, which is about 43% of MSW in Chile.[196]

FIGURE 2: CHILEAN MSW GENERATION BY REGION, 2009 (METRIC TONS)[197]

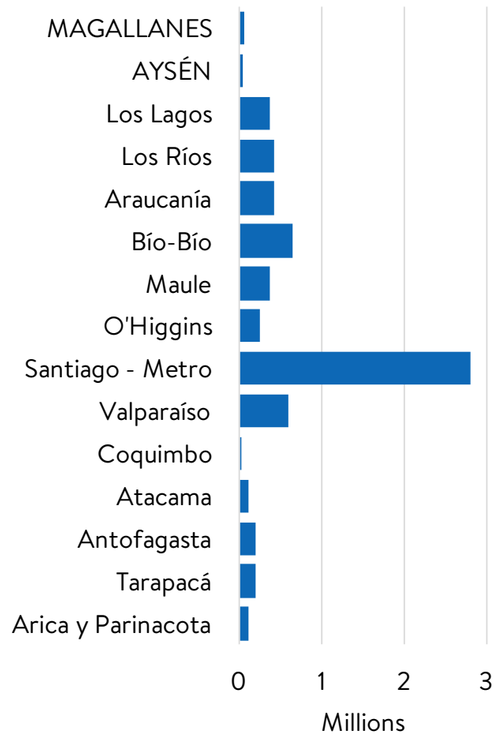


FIGURE 1: REGIONS OF CHILE

Access to Waste Management Services

In 2009, National Commission of Environment (CONAMA) estimated that 60% of households had access to collection services, with the highest access being in urban centers.[198]

Municipalities are responsible for collecting and disposing of waste. Until recently, waste prevention was not part of municipal consideration, as waste contracts offer no incentive to reduce waste since municipalities pay for every ton tipped to landfill. This has been changing in recent years.

It is estimated that 95% of the municipal solid waste generated in Chile is collected and managed in Chile.[199] Due to Chile's rapidly growing economy, however, the World Bank has projected significant growth in waste generation. Because of this, the CONAMA has been working hard to shift focus towards waste prevention and recovery and its efforts are starting to pay off.

Waste Management Infrastructure

Waste management in Chile relies primarily on sanitary landfills and unauthorized dumps. This is in part the result of historical solid waste policy that legitimized disposal in unlined dumps. As of 2009, CONAMA estimated that only 69% of the municipal waste was managed in sanitary or controlled landfills, 22% disposed in unauthorized dumps called vertederos, and an additional 9% was unmanaged.[200]

However, the Santiago metro region is advancing rapidly both in terms of improving its landfills and in waste diversion. There are three sanitary landfills around Santiago and numerous drop off locations for recycling.[201] The recycling rate in Santiago is estimated to be around 14%, well above the national average.[202]

Composting and waste-to-energy have traditionally played a very minor role in waste management in Chile.[203] However, with the high percentage of organics going to landfill, methane and landfill gas issues are significant.

Biogas and waste-to-energy from landfill gas are emerging and being encouraged through the Clean Development Mechanism, which also allows Chile to trade carbon credits.[206] The government continues to actively create incentives and policies to develop cleaner energy and manage its waste at the same time.

Transportation costs play a key role in waste management in Chile. It is estimated that transportation may be as much as 60% of the cost of waste management.[207] Because of the geography and haul distances, the cost of transporting waste or recyclables outside of the main cities of Santiago and Concepcion is even higher and has led to illegal dumping in some cases.

Waste Composition

More than half of all MSW generated in Chile is organics, as shown in Figure 3. According to the CONAMA, when organics, paper, glass, metals and other recoverable fractions are included, more than 50% of Chilean MSW is reusable or recyclable.[208]

CONAMA estimates that about 8,000 tons of electronics are disposed year over year.[209] There is little to no infrastructure for the collection and treatment of consumer electronics. There are some take back programs sponsored by brands for computers, but given the amount going to landfill, much work needs to be done.

Hazardous waste is considered industrial waste in Chile. It is separated and treated separately from MSW through a program called the System for Declaring and Monitoring Hazardous Waste (SIDREP). Like any compliance system, it only works if companies declare materials hazardous and there is a fair amount of non-compliance by companies choosing to illegally dump rather than pay the fees to properly dispose of e-waste.[210]

FIGURE 3: CHILEAN MSW INFRASTRUCTURE 2009[204]

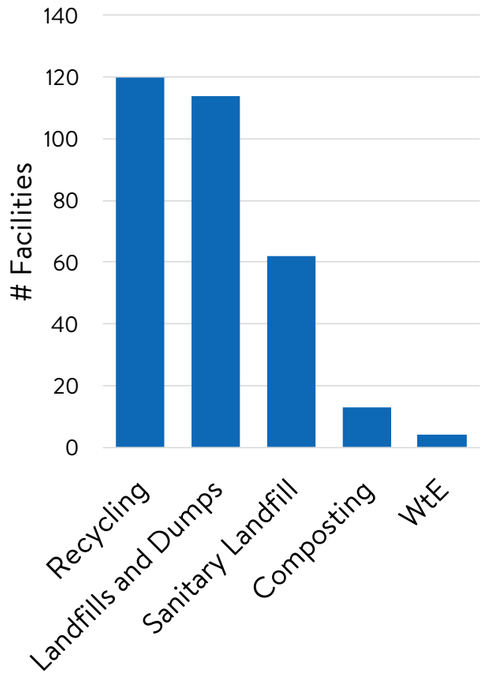


FIGURE 4: CHILE MSW COMPOSITION 2009[205]

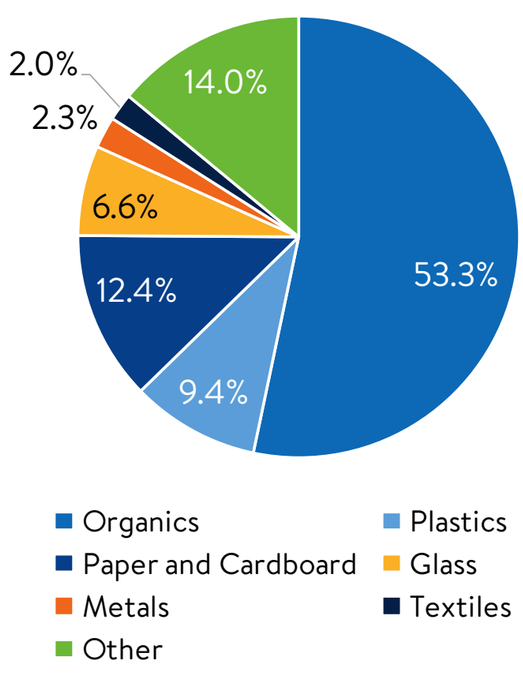
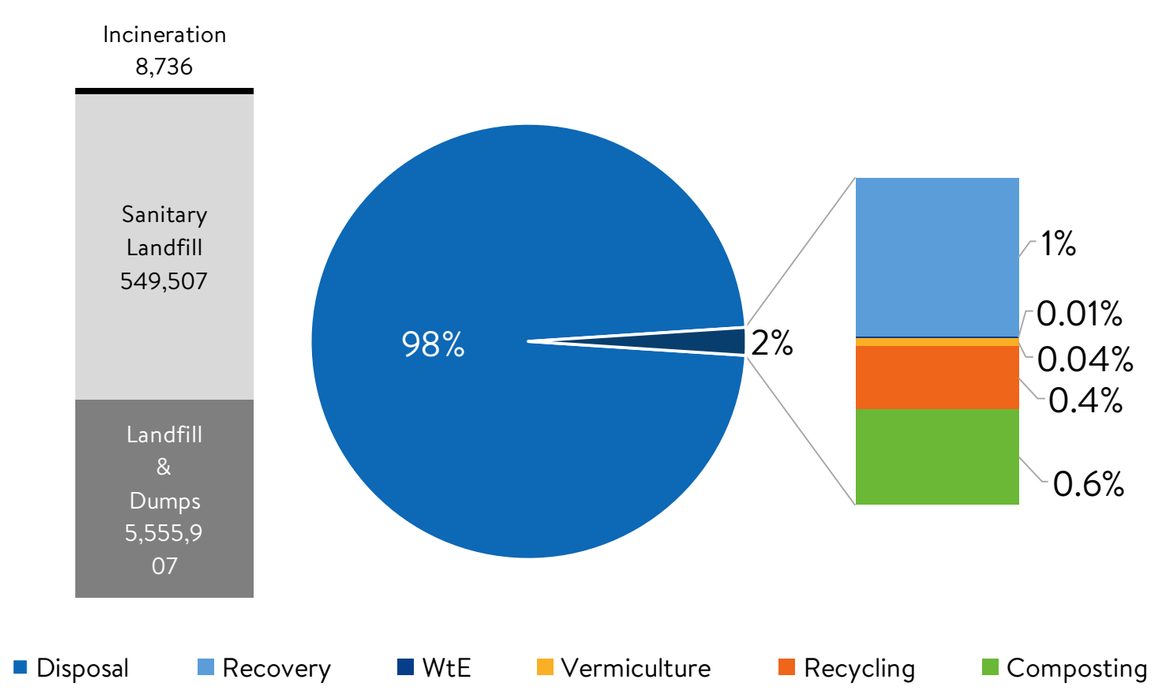


FIGURE 5:2009 WASTE AND RECOVERY IN CHILE[211]



Recycling

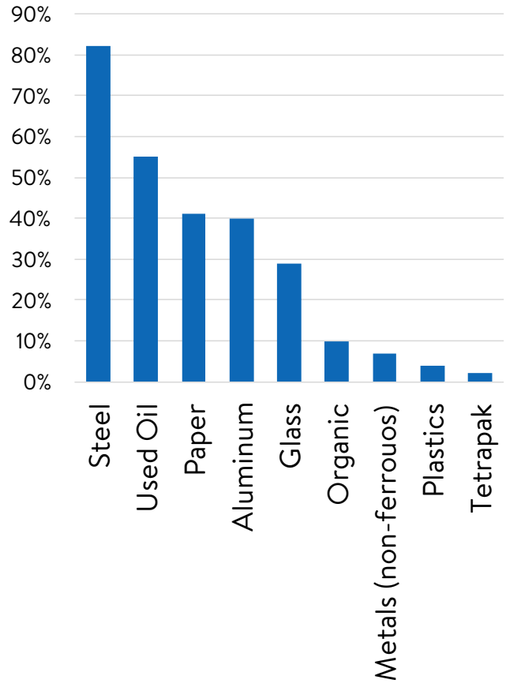
In 2009, the CONAMA estimated that only 2% of MSW was diverted from landfill.[212] In 2016, estimates were 10%.[213] Due to the growth in waste generation rates, groundwater contamination, and air pollution issues associated with landfills, the government has been working hard to create more awareness about waste prevention and recycling.

Many municipalities operate "Punto Limpio" or clean points. These are drop-off recycling centers where consumers can bring separated recyclables. The items most commonly dropped off include: steel, paper, aluminum, glass, polyethylene terephthalate (PET), and Tetra Pak cartons. Some centers will also accept electronics, batteries, expired medication, and other scrap metal.[214] Triciclos is a well-known company that operates staffed drop-off locations and has run very successful campaigns to encourage recycling. The company has expanded operations and currently operates in Chile, Argentina, Brazil and Colombia. Ironically, Vitacura which is part of Santiago metro region and is considered to be "leading" on recycling in Chile, is also one of the municipalities with the highest waste generation rates at 2.09kg/day (it is also one of the most affluent neighborhoods in Santiago).[216]

Steel, paper and aluminum are the most commonly recycled materials from MSW. Despite a relatively high level of plastics in the waste stream there is little plastics recycling currently. Only PET is attractive due to demand for the material. Of what is recycled, beverage containers are the most widely recycled. Sorting is generally a manual process. And typical of informal recycling value chains, there tend to be many middlemen.

There are not strong end markets for recycled materials inside Chile. As recycling grows, companies involved in recycling are actively seeking new markets that can use recovered materials.

FIGURE 6: MSW RECOVERY RATES 2009[215]



Commercial Recycling

Cardboard, paper, and stretch films are the most easily recycled and therefore most easily diverted materials from stores and manufacturing operations. Organics are difficult to manage, but donations to food banks are increasingly common as food waste is being banned from landfills in some areas.

Waste Pickers

There are an estimated 60,000 people who work as primary waste collectors in and around Santiago.[217] As of 2009 only about 5% of them were organized in collectives.[218] Most waste pickers focus on paper, cardboard and metals, the highest value materials. Very few focus on plastics due to the lack of processing and domestic end markets. PET is the only plastic that is collected due to high commercial demand. The average wage of a waste picker in Chile ranges from USD $120-$250.[219] Similar to other countries, waste pickers in Chile tend to be marginalized though there are selected municipalities that do recognize them.

Organics Management

There is essentially no organics management infrastructure in Chile. Small compost programs are growing in rural areas. However, no government data is available on the status or growth of organics programs. As of 2009, Only about 1% of collected organics material is composted.[220] Food donation is an important way to divert organics from landfill. Alimentos Food Bank partners with retailers and grocers. There are food waste bans and significant awareness within the population of the importance of food donation.

REGULATORY ENVIRONMENT

Chile lacks a central agency having the total responsibility for waste management. The responsibility is shared between the Health Ministry (Public Health) and the National Commission of Environment (Environmental Regulation). The Regional Governments are responsible for developing management plans and waste policies for their region. Each municipality is responsible for the collection, transport and final disposal of MSW.

Chile has some of the most robust solid waste and recovery regulations in South America. However, implementation is relatively recent, since the mid-1990's. The Chilean national waste management strategy is built around the familiar waste hierarchy: prevention, reuse, recycling, energy valorization and disposal as a last resort. The government is also creating crosscutting initiatives that improve waste management and address climate change by focusing on reducing climate forcing gases.

The financing of MSW management for all municipalities in the country is determined by national law, which sets the general conditions for waste management fees. The current legislation allows charging a quarterly fee for the service of ordinary waste management (producers of up to 60 liters per day of waste) and extraordinary services to those requesting the service (waste over-producers). These fees are set by the Law on Municipal Revenue, No. 3079/79, and Regulation No. 69 of February 14, 2006.

The following shows an overview of milestones in solid waste rules:

- In 1994, the Framework Environmental Law (Ley de Bases del Medio Ambiente) was approved and established the use of controlled landfills for the disposal of MSW.
- In 2003, hazardous waste regulations were passed that required appropriate storage, transportation, reuse, recycling and processing of hazardous materials.
- In 2013, first Extended Producer Responsibility (EPR) legislation was introduced. EPR passed for five designated products in 2016.

Extended Producer Responsibility

In 2016, Chile passed its first extended producer responsibility (EPR) law, going into effect in May 2017. The law regulates six priority products: lubricant oils: electrical and electronic appliances, car batteries, batteries, packaging, and tires.[221] Like typical EPR, producers and/or importers are required to take responsibility for products at the end of their useful lives. Consumers share in the responsibility and are called out to separate their recyclables and return products to the appropriate handler.

As part of the law, 60,000 waste pickers are recognized as part of the recycling value chain, and have the opportunity to become designated as handlers and receive National Job Skills certification. Municipalities are authorized to include them in their waste and recycling contracts. Municipalities will also be responsible for recycling education, operating collection and storage sites, and separating waste as its source. The government expanded its responsibilities under this legislation to include a registry, information platform and the authorization to fine 10,000 UTA (5.4 billion pesos) for producers and importers.[222]

KEY PLAYERS

International Organizations

- International Solid Waste Association (ISWA) www.iswa.org

National Organizations

- Fundación Chile
- Triciclos (tricicos.cl) – recycling organization
- Urbaser-Danner waste management group
- Association "Recolectores Ecológicos Independientes de La Serena (AREILS)" (Independent Ecological Collectors of La Serena), La Serena, IV Region, Chile - carries out collection, separation, processing of recyclable materials and their commercialization.
- Ministry of Health: www.minsal.cl
- Ministry of Environment: www.mma.gob.cl

Plastics

- Exma Ltda - Santiago
- Comercial Cammar Ltda – Malloco Peñaflor
- Requm – Las Condes
- Ewaste Recycling Co. - Santiago
- Cementos Polpaico – process plastics for fuel
- RINOPLAST collects in El Molle

Paper and Cardboard

- Vortex – Santiago
- SOREPA company
- RINOPLAST collects in El Molle

Metals and Glass

- Zorin Sa - Lampa
- Gerdau Aza – Steel recycling
- Requm – Las Condes
- Metalex Chile – Santiago - Metals recycling
- Cristalerías Chile – glass recycling
- Cristalerías Toro – glass recycling

Hazardous Waste

- Hidronor

KEY TRENDS AND OPPORTUNITIES

- The lack of engineered landfills and continued dependence on unlined dumps is a deficiency in a country that is experiencing such high rates of waste growth.
- Chile is being proactive in implementing solid waste management policies and structures that will support the diversion of waste from landfill.
- The recent EPR legislation is expected to rapidly increase the diversion of material for recycling. The recycling market is very incipient. There is opportunity to help create end market demand for materials and help build the circular economy for materials inside Chile and the region.
- Organics management is almost non-existent, yet organics are a large part of the waste stream. There is an opportunity to address Chile's need for renewable energy and improve waste management through better organics waste prevention strategies and the introduction of composting, anaerobic digestion or other biogas conversion technologies when organic waste is inevitable.
- End market development for recovered materials will be critical to help create the foundation and support the recycling economy develop in Chile, especially since its geography can make transport to other markets challenging.

UNIQUE MARKET CHARACTERISTICS

MATURING SOLID WASTE AND RECOVERY SYSTEM

MEXICO

Mexico has 32 States (including Mexico City) and 2,456 municipalities. The country is undergoing rapid urbanization and about 79% of the population lives in urban areas. Approximately 70% of the population is concentrated in the ten largest cities; the rest is spread throughout 200,000 towns. Mexico City is a mega city and the second most populous city in Latin America with almost 21 million people. It is also an autonomous entity comparable to a state, and is divided into 16 boroughs.

As an emerging and urbanizing economy, solid waste generation has been growing rapidly in Mexico. Solid waste generation increased by more than 61.3% between 2003 and 2015 and is correlated strongly to GDP and personal wealth. Developing adequate management systems for solid waste has been a challenge that the government is working to address, particularly in and around Mexico City where there is an ongoing landfill space crisis. Not surprisingly, waste generation is much higher in more affluent urban areas than in rural Mexico. Recycling is not embedded in the Mexican culture today, and until recently little emphasis has been given to recycling services and infrastructure development. Consumer awareness of recycling is generally low due to lack of government policies and education, but scarce landfill space is driving heightened need and awareness. When recycling does occur, separation is done by waste scavengers and intermediary scrap buyers, or through more formal systems that range from curbside collection and materials recovery facility (MRF) separation to manual separation and sale by sanitation workers. The national diversion rate is estimated at 3.6%.

SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

As shown in Figure 2, 42,103 million metric tons of municipal solid waste (MSW) was generated in Mexico.[223] Overall, 87% of MSW is generated by 30 communities of over 15,000 inhabitants, and the remaining 13% by small communities (semi-rural and rural).[224] The Central Region accounts for more than 50% of all MSW, and Mexico City accounts for an additional 12%, producing 12,500 metric tons of municipal solid waste (MSW) per day.[225] In 2011, Mexico City closed its major landfill, Bordo Poniente, and reduced the amount

FIGURE 2: 2012 MSW GENERATION BY GENERALIZED REGION[226]

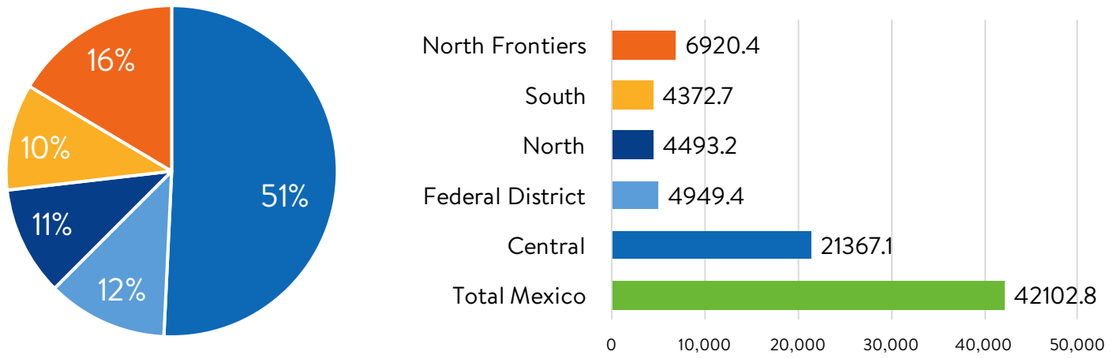


FIGURE 1: SIMPLIFIED REGIONS OF MEXICO

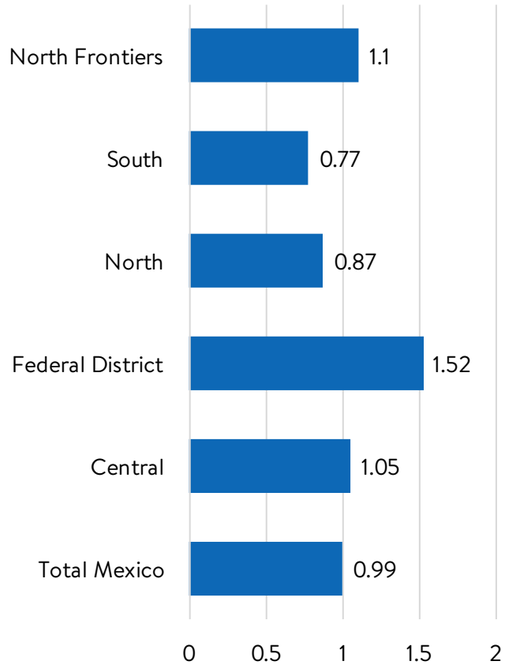
going to landfill by 5,500 metric tons through a recycling program, converted 1,023 metric tons of waste into energy, and another 507 metric tons into compost.[227]

Urban Mexicans generate a greater quantity of waste than rural Mexicans. As shown in Figure 3, Mexico City's per capita daily generation of MSW is 1.52 kg which is significantly higher than the national average of 0.99 kg.[228]

Access to Waste Management Services

Solid waste collection rates vary across Mexico, with significant differences between urban and rural areas. As of 2010, 102 or (4.1%) of Mexican municipalities had no waste service collection, disposal or treatment option and most of that is located in the state of Oaxaca. At that time, most municipalities (91%) have access to some type of waste collection and disposal service. Cities have collection rates of up to 75-85% or more, with collection typically occurring daily, and affluent urban areas having the best services. In smaller towns, the collection rate drops to 60-80%, and in rural areas collection declines further.

FIGURE 3: 2012 MSW GENERATION PER CAPITA BY GENERALIZED REGION (KG/CAPITA/DAY)[229]

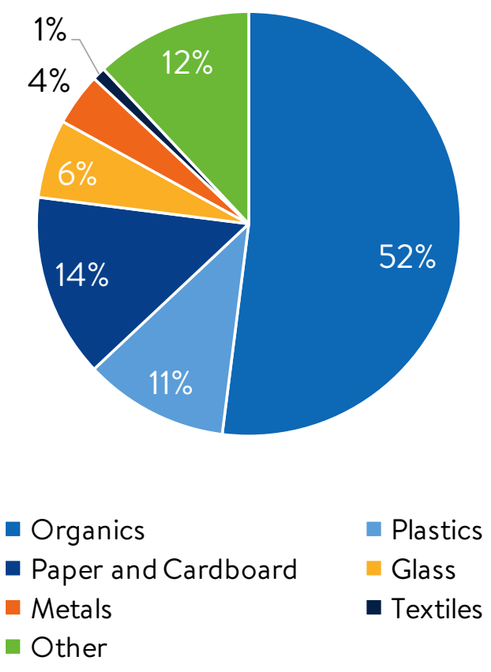


Municipalities are responsible for providing waste management service and the responsibility for financing the service. In Mexico, municipalities typically use taxes to pay for waste management services rather than charge a direct fee. As a consequence, waste management services tend to be underfunded.

Waste Management Infrastructure

In general, Mexico depends on landfills and dumps for disposal of waste, and sanitary landfills are the rule. In 2013, 96% of MSW collected was landfilled, mostly in sanitary or controlled landfills. While Mexico City closed one of the largest landfills in world (Bordo Poniente) in an effort to improve the management of its waste, challenges remain as illegal dumping within the city has become a problem. There remain high numbers of undocumented dumps in rural areas. A recent study by the Mexican NGO, Comité Técnico del Cambio Climátic, cited more than 21,000 illegal dumps in Oaxaca and of the 203 official landfills in the State, only 5 meet national waste management regulations.

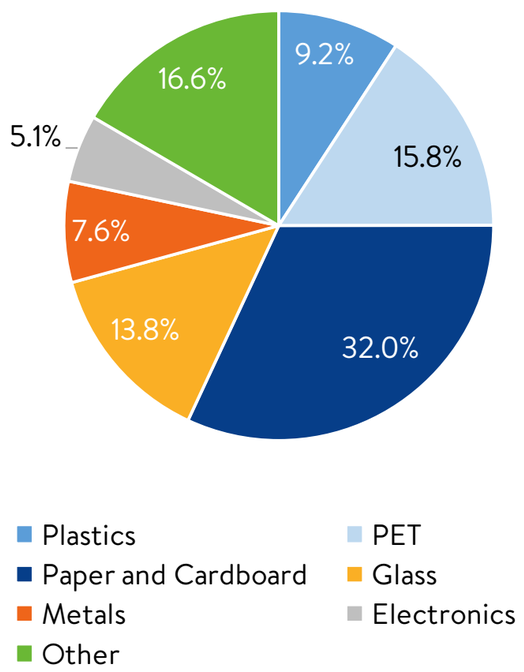
FIGURE 4: AVERAGE COMPOSITION OF MSW IN 2012[230]



The landfill challenges experienced by Mexico City has sparked investment to improve infrastructure. There has been significant effort over the past decade to address and upgrade Mexico's landfills with a shift from uncontrolled dumps towards sanitary landfills. However, recent studies suggest that out of all the landfills in Mexico, perhaps as few as 300 are properly maintained to appropriate standards. The federal government and some municipal governments are supporting initiatives to upgrade infrastructure and identify new ways to manage waste. However, improvement is slow and it is unclear if improvements are keeping up with the growth in waste volumes.

Some of these initiatives are the partnerships between Mexico City and the BMLMX Power Company on a landfill gas to energy project on the former Bordo Poniente landfill site, and with CEMEX to take 3,000 metric tons of separated and compacted solid inorganic waste to use as a fuel replacement in cement kilns.[231]

FIGURE 5: AVERAGE COMPOSITION OF RECYCLING IN 2012



While there is little to no waste-to-energy infrastructure today in Mexico, there are 43 incinerators for hazardous wastes, 85% of which are used for biologic and infectious wastes and 15% for industrial wastes.[232] Waste-to-energy is a low priority in Mexico due to cost and public perception as a health danger.

Waste Composition

A 2012 MSW waste composition study for Mexico shown in Figure 4 indicates that organics make up over half of the MSW generated (52%) and recyclable materials comprise another 34%.[233] Of recyclable material, paper and plastics are the largest fractions.

Recycling

In Mexico, few formal waste separation practices (like wet/dry separation) are encouraged by municipal authorities, even in urban areas. In 2012, Semarnat reported that just 11% of MSW was collected through selective collection, meaning wet/dry separation. Mexico City just recently implemented a requirement for source separation of organics and recyclables from trash effective July 8, 2017. Separation of recyclables is most commonly done on an informal basis by municipal collection workers and waste scavengers. Recyclable material may be collected from multiple points: door-to-door collection, separation in waste collection trucks, or at final disposal sites.

Recycling infrastructure is very underdeveloped across Mexico with the exception of Mexico City. Since the closure of its dump, the city has built three formal material recovery facilities (MRFs) and recovers about 750 metric tons per day of recyclables.[234] An additional 3,000 metric tons per day of recyclables are collected by garbage truck crews, street sweepers, and private collection companies and sorted separately.[235] Mexico City is going to going to use segregated organics for a biogas to energy plant. With wet/dry separation, these volumes should grow substantially.

The lack of recycling in Mexico is evident in the recycling rate. In 2012, only about 3.6% of the MSW in Mexico was recycled (mostly in urban areas) and the most recent Semarnat data indicates it is still below 5%.[236] The most commonly recycled materials were paper/cardboard, followed by glass and metals (see Figure 5).[237] One of the bright spot in recycling is the polyethylene terephthalate (PET) recycling rate. Mexico has one of the highest rates in the world at 50.4% in 2015 due to significant investment from the private sector. There are 14 PET reclaimers in Mexico which creates a local end market for any collected material.

Recycling is not ingrained in Mexican culture today, as little emphasis is given to services and infrastructure development. Consumer awareness is low due to a lack of government policy, voluntary industry actions, and education measures that prioritize recycling. Efforts are underway to bring investment to mechanize recycling in urban areas. Private material recovery companies have established operations in Mexico, but recovery logistics are hampered by middlemen and poor logistics. The collection of recyclables remains weak across most of the country due to the lack of collection and sorting infrastructure, comingling of organics with other materials, and poor consumer participation.

In response to its landfill crisis, Mexico City set up the Mercado del Trueque or "Barter Market," where citizens can bring their recyclables and trade them for green point vouchers that can be exchanged for food at a co-located farmer's market. In 2017, traders exchanged about 117 metric tons of recyclables.[238] The program has been expanded to include electronics and other recyclables, but the sale of recyclables does not cover the entire cost of the program.

Commercial Recycling

Commercial recycling is available throughout urban areas of Mexico, especially for corrugated, paper, metals, and selected plastics.

Waste Pickers

Poverty is a very real concern in Mexico — nearly 25 million Mexicans (11% of the population) make less than $14/day.[239] About 25% of the workforce is underemployed and over 5 million people are unemployed.[240]

Informal waste scavenging is common place in most regions of Mexico.[241] In Mexico City alone, there are approximately 25,000 to 30,000 scavengers, including many children.[242] It is estimated that informal scavengers collect up to 40% of waste generated in Mexico City.[243] Waste scavengers are typically well-organized groups, formed even by whole families, headed by a leader. However, they operate in a very competitive environment. The informal waste scavenging sector is locally important but generally marginalized in policy and municipal solid waste management discussions.

In Mexico City, a large community of several thousand waste scavengers known as "pepenadores" was associated with the Bordo Poniente dumpsite. Since its closure in 2011, these waste pickers negotiated with the Mayor to pre-pick city waste at a city-owned MRF before it is transported to distant landfills.[244] It is estimated that more than 25,000 people depend upon this informal system of recycling in Mexico City.[245]

It is typical for the recycling chain in Mexico to include as many as four intermediaries.[246] Waste pickers typically sell their pickings to a leader, who sells the material to industry at a markup. Scavenger leaders often sell recyclable material to intermediaries or the operators of collection trucks, who also separate the collected MSW, and sell it afterwards. This takes place at collection centers close to the transfer sites or at final disposition sites.

The Cooperative Society of Material Pickers (SOCOSEMA) is one of the most successful recycler cooperatives in Mexico. Formed in 1975 to counter the exploitation by middlemen, the cooperative was awarded a concession for recovery of recyclables contained in the waste at the dump.[247] The creation of SOCOSEMA saw the displacement of the middleman to some extent, and the rise in incomes of the waste pickers by nearly tenfold. Scavengers also provides collection services for municipalities that cannot afford it.

Avangard Innovative, a US-based recycling company, works with scavengers at several open dumps and controlled landfills to set up low-tech MRFs where the pickers work with basic safety gear to separate, bale, and ship recyclables to industry.[248] Sanitary conditions are much better in these facilities than at dumpsites.

Organics Management

Organics recovery is underdeveloped across the country. Most organics go to landfills and dumps.

Given the high volumes of organics in the waste stream in areas like Mexico City, substantial investments in biogas to energy are being made. A $611 million contract was awarded to the consortium of Veolia and Proactiva Medio Ambiente Mexico to design and build the El Sarape solid waste treatment plant which will include a biodigester. In the meantime, about 17% of organic waste is collected in a source-separated stream for composting and official reports from transfer stations indicate that 30% of the waste that arrives is comprised of organics that is sorted by workers at the transfer stations and sent to local composting facilities.[249] Given the high rates of poverty and hunger, food donation is an obvious option where food banks are available to both avoid waste and contribute needed food.

REGULATORY ENVIRONMENT

Waste management in Mexico is regulated by two main federal laws: The General Law for Ecological Equilibrium and Environment Protection (LGEEPA), and the Official Mexican Standards and the General Law on Waste Prevention and Integrated Management (LGPGIR).[250] LGPGIR covers MSW and hazardous waste and is based on a 3R (reduce, reuse, and recycle) strategy.

Municipal authorities fundamentally have the responsibility for planning, financing, building and operating the systems to handle MSW. The majority of the municipalities manage these services directly, while the rest do it through municipal autonomous organizations. In addition, each state and municipality typically has its own regulatory framework. There is generally a low level of commitment from state and local governments to fund, implement, and enforce existing regulations.

National laws and plans are not specific and require considerable interpretation. Funding is not allocated for achieving the goals that have been set. Infrastructure funding is inadequate for the growing solid waste profile and insufficient to enable a transition to a more integrated waste management structure. There is also a significant gap between the need to develop a recycling culture, which is recognized by policy makers and the current behavior of consumers. Long-term education and awareness-building on issues of waste, recycling, and stewardship will be required to overcome this gap.

In 2007, the National Program of Waste Prevention and Management (NPWPM) was enacted. This policy aims to update and upgrade Mexico's waste management on a number of fronts: by modernizing the legal and regulatory framework; developing new infrastructure to replace dumps as well as new financing options for waste management infrastructure; establishing management plans for targeted waste streams such as E-waste, batteries, tires, etc.; creating a national waste information system; and launching educational programs and campaigns to support the approach.[251]

Formal laws are on the books for e-waste and hazardous materials treatment, though implementation, awareness, and monitoring are generally poor.

KEY PLAYERS

International Organizations

- World Bank's International Finance Corporation (IFC)
- International Solid Waste Association (ISWA)
- UNEP - Global Partnership on Waste Management
- Fondo de Cooperacion Mexico-Mexico (Cooperation fund between Mexico and Mexico)
- Pan American Network for Sanitary Waste Management (REPAMAR)

National Organizations

- Ecology and Corporate Commitment (ECOCE)
- Fundación Mundo Sustentable, a Mexican NGO
- Mexico City's Environment Department
- Secretariat of Environment and Natural Resources (SEMARNAT)
- Green Point Foundation
- Recycle Electronics Mexico
- The Sociedad Cooperative de Seleccionadores de Materiales (SOCOSEMA)

Plastics

- Avangard Innovative (all materials)
- Promotora Ambiental S.A. de CV (PASA)
- RECD

Paper and Cardboard

- Paper Waste Recycling Mexico S.A

Metals and Glass

- SESMAN Recycling
- Recycladora Omega

KEY TRENDS AND FINDINGS

- Mexico is a maturing market for solid waste handling and recycling, though it still faces substantial hurdles.
- Mexico City is leading the way on diversion of solid waste away from landfills and dumps. It is making substantial investment in new local infrastructure.
- Urban areas are better able to manage solid waste materials toward recycling, while rural areas primarily lag.
- Waste pickers have become a major and important part of solid waste management in Mexico, but are not viewed favorably by the larger culture.
- Diversion options like recycling and composting are not well-integrated into Mexican culture
- Wet/Dry separation of recyclable or recoverable material from trash is an emerging best practice.
- Mexico has one of the highest PET recycling rates in the world and has a robust reclamation infrastructure.

Unique Market Characteristics: Developed Solid Waste and Recovery Systems

UNIQUE MARKET CHARACTERISTICS

DEVELOPED SOLID WASTE AND RECOVERY SYSTEM

CANADA

Canada is a very large country with 10 provincial jurisdictions, 3 territorial governments and 3,643 municipalities (Figure 1).[252] The majority of the population of 36 million is concentrated along the border with the United States so there are vast areas in Canada that are sparsely populated. Ontario is the most populated province, representing about 39% of the country with just under 14 million people.[253] It is home to Toronto, Canada's largest city, with 5.6 million people or about 15% of the population.[254]

Waste and recycling infrastructure is well-developed across most of the country. Fast growth has caused landfill capacity to become limited near urban centers like Toronto, Vancouver, and Halifax. As a consequence, there has been interest in organics diversion in select urban areas. Waste to Energy (WTE) is not common in Canada today. Organics recovery infrastructure is developing with more than 180 established composting sites and anaerobic digestion (AD) facilities expected to be built in the next decade, especially around key urban centers like Toronto and in Québec.

The national diversion rate is 34%.[255] Of the 25 million metric tons of waste generated in 2012, 38% was residential waste and 62% was non-residential.[256] Diversion is and will remain challenging in rural and sparsely populated areas. Hub and spoke systems are developing to address these challenges. Waste generation rates are expected to increase by approximately 40% by 2025 (from 2001 levels).[257]

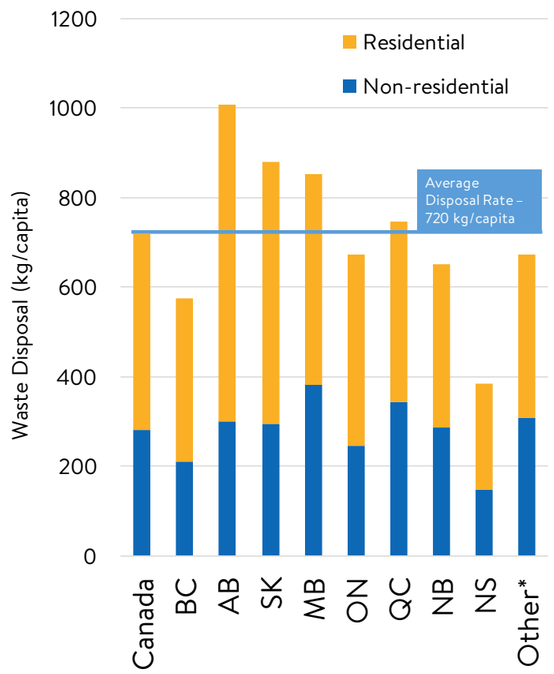
SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

Nationally, Canada generates about 25 million metric tons of residential and commercial non-hazardous waste each year. Of the 25 million metric tons, 9.6 million metric tons (38%) comes from the residential sector and 15.4 million metric tons (62%) from non-residential sectors.[258]

The provinces of Ontario and Québec are responsible for more than half (15.1 million metric tons) of the municipal solid waste generated in Canada.[259] Due to their large populations, Ontario, Québec, and British Columbia are responsible for much of the waste generation, nationally. The average Canadian generates 720 kg of waste (Figure 2).[260] Nova Scotia has lowest per capita generation rate (386 kg/capita).[261] British Columbia has the second lowest

FIGURE 2: NON-HAZARDOUS WASTE DISPOSED IN CANADA BY PROVINCE AND SOURCE[262]



* Includes PEI, NL, YT,NT,NU < 3% of Canada pop.

FIGURE 1: CANADIAN PROVINCIAL AND TERRITORIES MAP

generation rate (573 kg/capita).[263] Low landfill fees in bordering US states (Washington, Michigan, New York) attract waste from Canada, particularly from industrial, commercial and institutional (ICI) generators in Ontario and British Columbia, which causes a cross-border flow of waste to low-cost disposal rather than diversion.

Access to Waste Management Services

Responsibility for solid waste management in Canada is shared among federal, provincial/territorial and municipal governments, but it is primarily regulated at the provincial level. The federal government has responsibility for toxic substances, international and interprovincial movement of waste, waste management on federal lands and operations, and air emissions. It is also engaged in waste management through federal funding programs. Provincial & Territorial governments are responsible for approvals, licensing and monitoring of operations within their jurisdictions. Municipal governments are responsible for collection, diversion and disposal operations within their jurisdictions. Municipal solid waste is managed either by the local or regional authorities or by the private sector waste management industry under contract to the local or regional authorities.

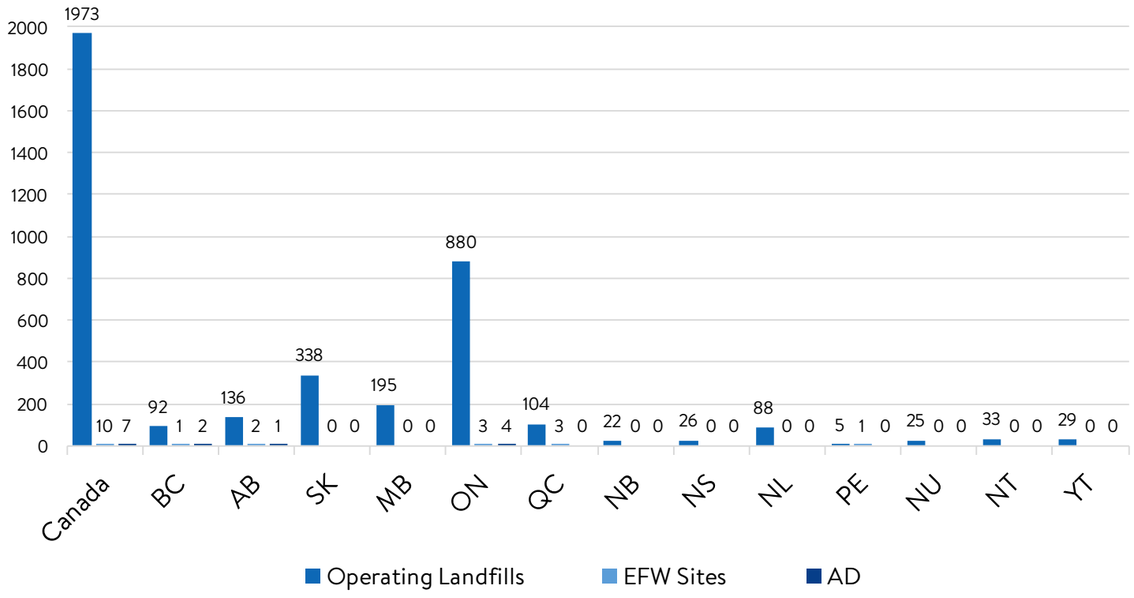
In most urban areas, recycling is part of daily life and part of consumer expectations for waste management systems. Canada diverts about 34% of its waste through a mix of commercial business-to-business recycling and municipally-run curbside recycling programs.[264] Industrial, commercial, and institutional (ICI) establishments have access to recycling in most areas.

Waste Management Infrastructure

Infrastructure for solid waste management is well-developed and improving throughout the country, although some outdated infrastructure remains in remote regions. Government policy has turned to focus on upgrading the infrastructure in these areas.

The majority of municipal solid waste (MSW) in Canada is disposed in engineered landfills. There are 1,973 landfills in Canada, with the vast majority in Ontario (880), Saskatchewan (338), and Manitoba (195) (Figure 3).[265] Most landfills are well-engineered, though flaring and landfill gas are not common. There are 70 landfills with landfill gas recovery systems, in Ontario (28), Québec (16), and Vancouver (8). In Nunavut, landfills are above ground and unmanned.[266]

FIGURE 3: CANADIAN SOLID WASTE INFRASTRUCTURE BY PROVINCE[267]



Tipping fees in Canada vary widely, encompassing a high of CAD $100/metric ton in Prince Edward Island and a mid-range of CAD $45-$70 in Ontario, while at the low end, fees in Saskatchewan ranged from CAD $20-$44/metric ton to CAD $0/metric ton in some cases.[268] One barrier to increasing landfill diversion in Canada is the low tipping fees for landfilling in US border states. Approximately four million tons of waste were exported by Ontario alone in 2016 to US landfills, mostly in Washington, Michigan & New York — primarily Industrial, Commercial and Institutional (ICI) and Commercial, Renovation, and Demolition (CRD) waste managed by the private sector.[269]

Overall, WTE does not currently represent a significant disposition method. There are only 10 thermal treatment facilities treating MSW in Canada and they range from mass burn incinerators to gasification plants, plasma arc and pyrolysis units.[270] Both Metro Vancouver, BC and the Peel Region of Ontario (ON) have recently opted not to pursue thermal energy from waste facilities. Infrastructure for hazardous or universal waste reprocessing, treatment, or appropriate disposal is available throughout Canada. These wastes must be transported by a licensed hauler to a certified facility and a manifest system must be maintained.

Materials Recovery Facility Infrastructure

The Materials Recovery Facility (MRF) infrastructure in Canada is well-developed, with municipally-owned and "merchant" facilities providing capacity, especially in urban areas. The evolution of hub and spoke systems to collect recyclables from more rural areas and bring them into more central MRFs is also developing. Rural/suburban MRFs often operate below capacity. Recent research has identified these underperforming assets.

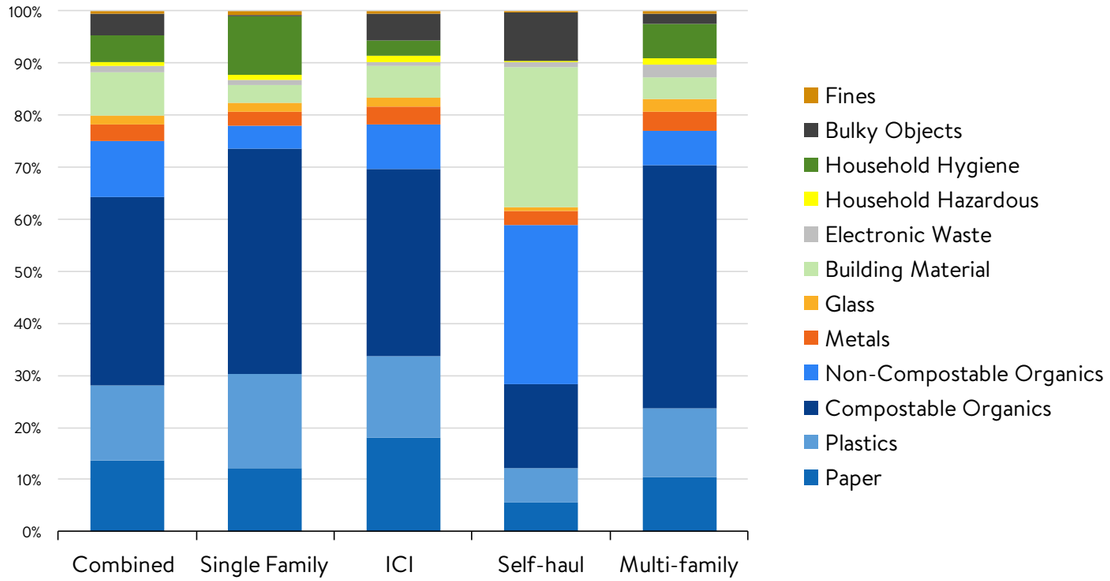
Toronto and its sprawling suburbs have been the focal point of recycling infrastructure development in the past 5 years, a trend that will likely continue over the next decade with population growth.

Organics Management Infrastructure

There was a 125% increase in food and yard waste diversion between 2000-2012.[271] Access to organics recovery facilities varies across the country, with some areas having significant access to centralized collection of household organics and processing of ICI organics.

Composting is seen as the diversion opportunity that yields the greatest benefits relative to cost. Currently

FIGURE 4: COMPOSITION OF SOLID WASTE IN METRO VANCOUVER (2013), EXCL. CONSTRUCTION & DEMOLITION WASTE[272]



more than 180 composting sites treat primarily green waste. Interest is growing in food waste diversion, especially as only 3.5% of Canadian landfills control for methane emissions through flaring or landfill-gas-to-energy systems.

There are total of seven anaerobic digestion units in Canada, including four sites around Toronto and two around Vancouver, and some are associated with waste-to-energy (WTE) sites.[273] This number is dynamic due to the intense interest in this sector. Edmonton has invested in a large mixed waste processing site with an AD plant that produces biofuels. Québec is planning to invest in significant expansion of organics management technologies over the next decade. Overall, there is increasing focus on development of organics processing infrastructure, especially in areas with landfill capacity constraints.

Lack of organics processing capacity is an ongoing barrier to increased diversion for several reasons:

- Lack of clarity on standards for processing different waste streams and for product use,
- Lack of economic incentive programs, such as feed-in tariffs for energy generated from organics.
- Complexity of approval requirements in some jurisdictions
- Relatively low cost for disposal, including disposal in US landfills

Waste Composition

Composition of waste disposed in Canada varies regionally depending on socio-economic factors and waste policies and local infrastructure. Urban centers that have a focus on landfill diversion are likely to be quite different from rural areas. In general, organics constitute about 47% and are the largest component of the waste stream in most jurisdictions in Canada, despite the growth of residential organics collection programs. Paper and plastics are also major components of the waste stream for each sector, representing about 14% each or 28% overall. The composition of the non-hazardous waste stream in Canada is comparable to many developed countries without aggressive post-use segregation programs.

FIGURE 5: NON-HAZARDOUS WASTE DIVERTED IN CANADA BY PROVINCE AND SOURCE[274]

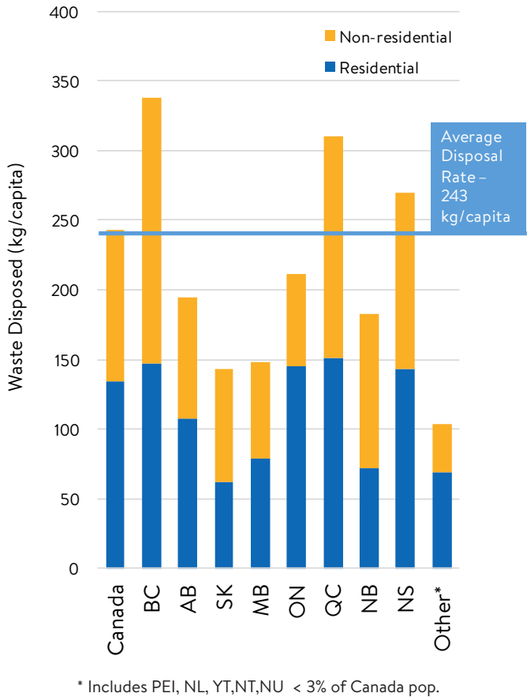
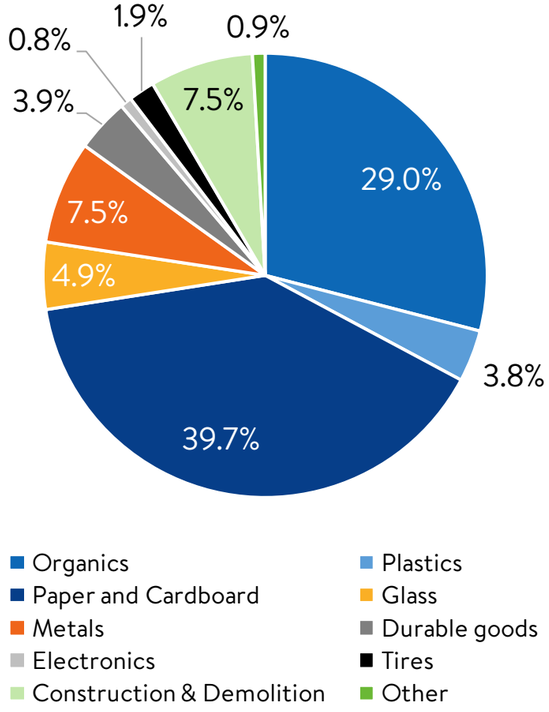


FIGURE 6: COMPOSITION OF DIVERTED MATERIAL IN CANADA, 2012[275]



Recycling

Residential and commercial recycling is very well developed across most of Canada. Some of the very remote regions are notable exceptions. The average Canadian diverts 243 kg of waste from landfills with a total 4.7 million metric tons (55%) coming from the residential sector and a total of 3.8 million metric tons (45%) from non-residential sectors (Figure 5).

British Columbia (BC) has the highest rate of waste diversion at 338 kg/capita[276], mainly due to its extensive diversion and extended producer responsibility (EPR) programs. Québec (QC) also has extensive diversion programs and diverts 210 kg/capita.[277] Québec also has an ambitious 60% waste diversion target for organics. Nova Scotia (NS) has had disposal bans for organics for over a decade and has recently updated its diversion strategy, resulting in an average diversion of 270 kg/capita.[278]

The largest constituent of diverted material in Canada is paper, including corrugated cardboard, newsprint, carton board and office paper, comprising about 39.7% overall. Organic material, including both food and leaf & yard waste, is also a major component of diverted waste, at about 29% (Figure 6). Construction & demolition waste and metals are the next highest at 7.5% each.

REGULATORY ENVIRONMENT

The Canada-wide Action Plan for extended producer responsibility (EPR) is the federal framework established by the Canadian Council of Ministers of the Environment (CCME) to encourage provincial action to implement EPR. It has been a driving force since 2009. Provinces & territories committed to working toward the development of framework legislation and/or regulations for priority materials. It has motivated provinces and localities to develop infrastructure and to work on increasing awareness of waste and recycling. Waste diversion is fostered by other types of supporting legislation like landfill bans and levies, as well as carbon taxes. In addition to legislation, increasing difficulty siting new landfills in populated areas is expected to drive waste diversion in Canada over the next decade.

Packaging is one of several target products. EPR for Printed Paper and Packaging (PPP) is well-established in Ontario, Québec, British Columbia, and Manitoba, and was rolled out in Saskatchewan in 2016, and the Atlantic Provinces and Alberta are considering adoption of a similar program. EPR for a wide range of products is also evolving rapidly in more populated provinces. Toronto typically leads with new legislation and enabling legislation for Individual Producer responsibility (IPR) was adopted by the Ontario province in 2012.[279] The tire program will be the first program to transition to IPR. Other programs are likely to follow pending successful transition of the tire program. Industrial, Commercial and Institutional (ICI) wastes are likely to be targeted by several provinces in next few years.

FIGURE 7: CANADA-WIDE ACTION PLAN EPR PRIORITY MATERIALS LIST[280]

Phase 1 – within 6 years (by 2015)	Phase 2 – within 8 years (by 2017)
Packaging	Construction materials
Printed materials	Demolition materials
Mercury containing lamps	Furniture
Other mercury-containing products	Textiles and carpet
Electronics and electrical products	Appliances, including ozone depleting substances (ODS)
Household hazardous and special wastes	

Stewardship EPR programs for many materials have been in place in some jurisdictions in Canada for many years, predating the federal framework. Product types commonly covered by these programs include: several categories of electronics and appliances, batteries, packaging and printed paper, beverage containers, pharmaceuticals, used paint, oil, tires, sharps, automobiles, and mercury-containing equipment. EPR programs are likely to grow in number and scope in the coming years. Several provinces have issued policy documents incorporating EPR (ON, QC) and some provinces (e.g. ON, NS) are currently drafting new or revised EPR legislation and/or regulations. Issues influencing the evolution of EPR in Canada include:

- Capacity of smaller governments to develop and implement programs is limited
- Acknowledgement that EPR is not necessarily the best or only policy tool for promoting waste prevention and diversion
- Increasing focus on the ICI sector – to date programs for some materials have focused primarily on the municipal sector
- Producers continue to call for greater harmonization across provincial programs

QUÉBEC'S WASTE POLICY AND ACTION PLAN 2011–2015

Québec has set a 60% recovery goal for organics, with a phased implementation of organics landfill ban by 2020 – impacting paper & cardboard (2013), wood (2014), and household organics (2020).281 The province has committed to an investment of CAD $650 million in composting & Anaerobic Digestion (AD) facilities – both public & private with 21 projects: 13 AD; 11 composting & 2 mixed-biological and thermal (MSW & organics).282 The plan foresees using various technology & performance funding programs including CAD 10 million targeted at the ICI sector waste, an emerging target for composting and AD.

Extended Producer Responsibility and the Circular Economy

Clear scientific linkage of materials management, landfill management, and greenhouse gas emissions to climate change has brought about greater awareness of waste and environmental issues. Canada's response has been to implement a regulatory structure comparable to Europe and to build out infrastructure that has evolved the Canada-wide action plan into one oriented to support a circular economy. Regulation has sped its development and the next decade should bring it to full maturity.

The following elements are being considered and implemented in strategies and policies of some jurisdictions across Canada:

- Waste disposal levies
- Landfill bans at provincial and municipal level
- Direct engagement with ICI Sector
- Waste-to-energy
- Increasing organics processing capacity
- Collaborative initiatives among multiple stakeholders, such as public-private partnerships
- Reporting of data on which to base waste management policy, planning & evaluation

KEY PLAYERS

International Organizations

- International Solid Waste Association (ISWA) www.iswa.org

National Organizations

- Federal government departments – broad policy development & funding programs
  - Zero Waste Council
- Industry associations – advocacy & project support
  - Retail Council of Canada (RCC)
  - Waste management, particularly OWMA
  - PAC, Packaging Consortium
  - Canadian Plastics Industry Association (CPIA)
  - Composting Council of Canada

Local Governments

- Provincial waste regulators – policy development & regulation & funding programs
- Provincial recycling councils, particularly RCBC, RCA, RCO: advocacy & project support
- Stewardship Organizations – implementation of EPR/stewardship programs on behalf of obligated companies.
  - Stewardship Ontario
  - Éco Entreprises Québec
  - Recycle BC

KEY TRENDS AND OPPORTUNITIES

- Canada has advanced waste and recovery systems and policies, including comprehensive EPR programs.
- Nationally, Canada generates about 25 million metric tons of residential and commercial non-hazardous waste each year and diverts about 34% of it through a mix of commercial business-to-business recycling and municipally-run curbside recycling programs.
- There will likely continue to be an increase in provincial requirements across Canada for waste diversion and producer responsibility, including:
  - New EPR/IPR regulations and programs with increased performance outcomes
  - Efforts to harmonize EPR across provinces
  - Increased ICI generator requirements and policies supporting diversion such as landfill bans, disposal levies, diversion standards and waste diversion planning & reporting
  - Increased focus on the circular economy
- With new obligations come opportunities for additional diversion of waste streams as infrastructure, new partners, new funding programs and economies are realized.
- However, significant challenges remain:
  - Regulations and policies supporting diversion and the development of infrastructure will take time and remain very slow in some provinces.
  - Diversion of harder-to-manage materials such as complex composite plastics and fiber materials will remain problematic
  - Transport distances from remote rural areas and challenging economics for facilities in those areas will mean lags and greater cost
  - Investment in diversion infrastructure for some materials will continue to be constrained in jurisdictions where cheap disposal (landfill) is available, such as across the US border from Ontario and BC

UNIQUE MARKET CHARACTERISTICS

DEVELOPED SOLID WASTE AND RECOVERY SYSTEM

JAPAN

Japan is an island nation with 47 prefectures, 8 regions and 1,719 municipalities (Figure 1). Japan has two of the largest mega cities in the world, Tokyo and Osaka, which account for roughly 25% of all waste generated in the country.[283] With a population of about 127 million, Japan is known for having some of the highest density living of any developed country. The country is heavily urbanized and employs a comprehensive system of waste management and selective recovery with very high levels of citizen compliance.

Solid waste collection is complex in Japan compared to other countries, with separation into burnable, non-burnable and recyclable fractions. Organics and food waste are also collected in some regions, depending on the availability of infrastructure. Consumers are expected to separate recyclable materials into eight or more categories and are provided detailed instructions on how to manage their waste materials (see Figure *4*). The nationwide policy strongly encourages the recovery of products and materials wherever possible. Extended producer responsibility (EPR) is used to collect fees

for FIGURE 2: 2011 TOTAL WASTE DISPOSED BY REGION OF JAPAN[284]

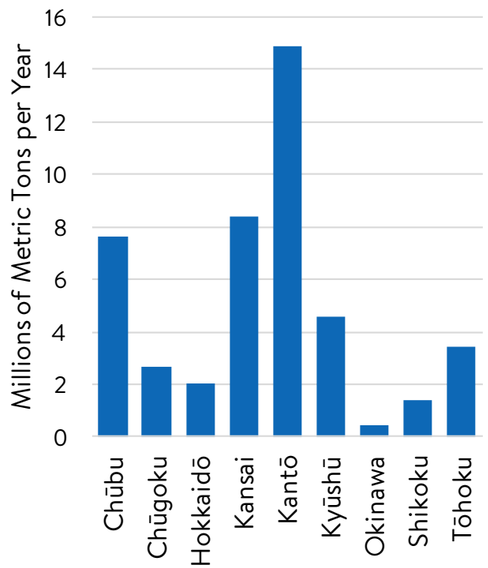


FIGURE 3: 2014 JAPANESE MANAGED DOMESTIC WASTE[285]

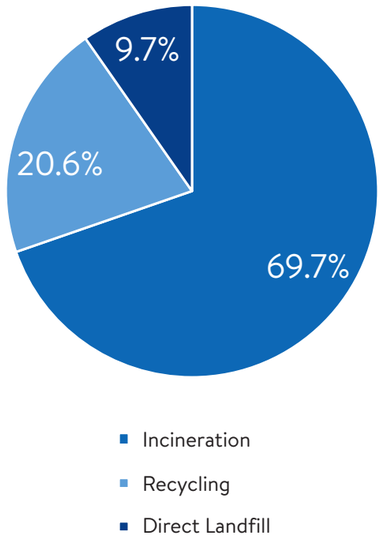
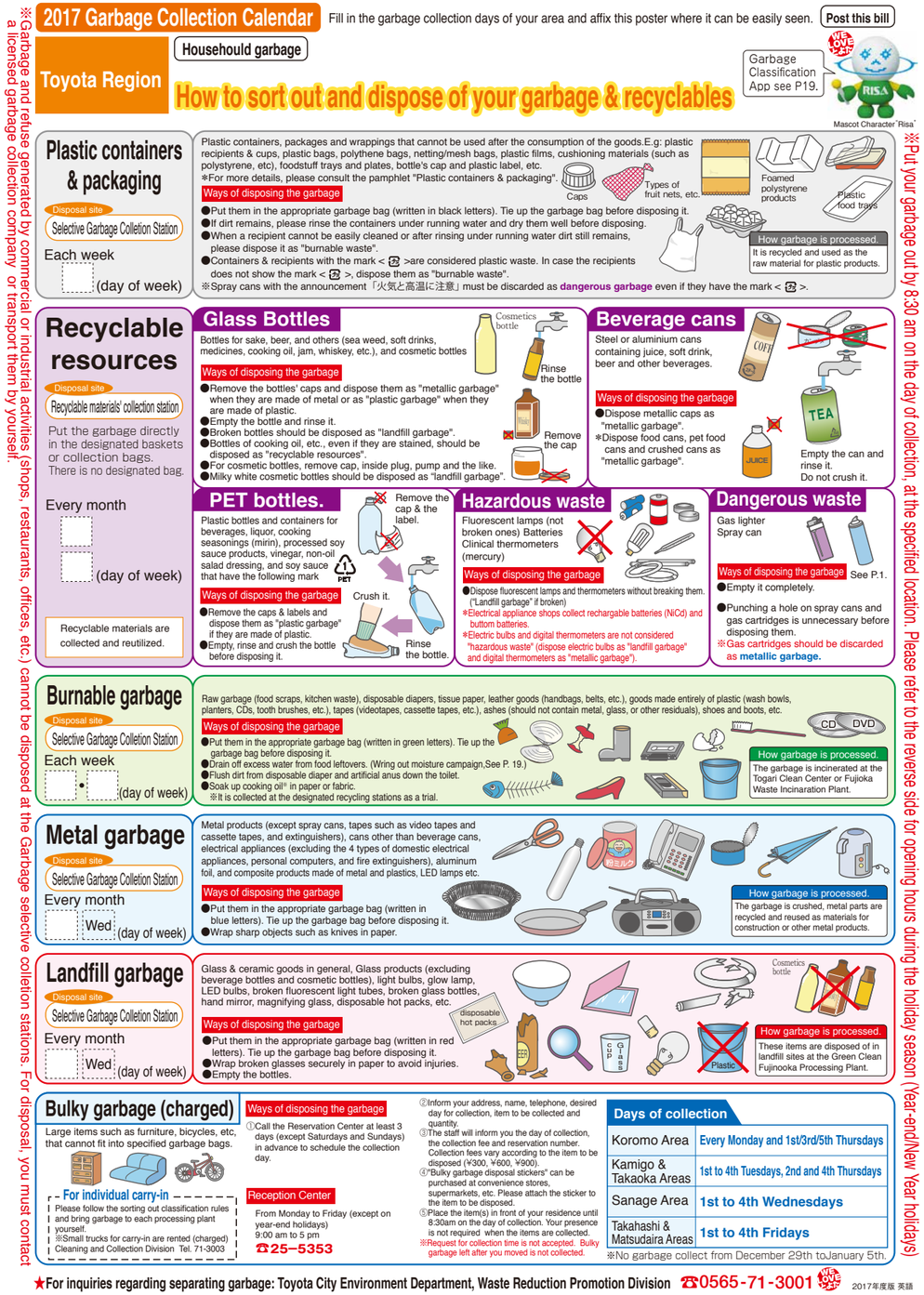


FIGURE 1: REGIONS OF JAPAN

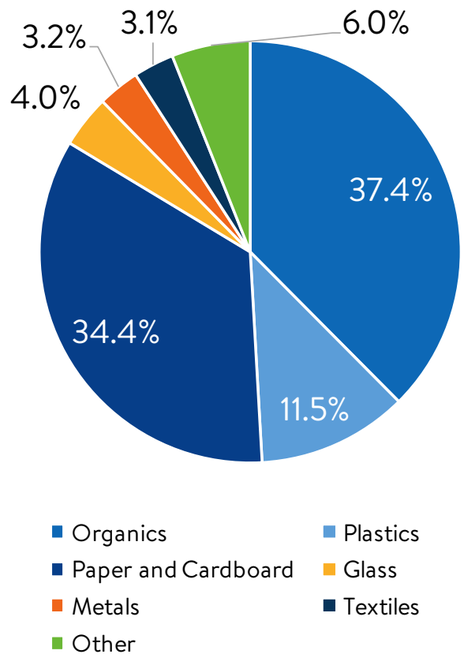
FIGURE 4: TOYOTA CITY WASTE AND RECYCLING GUIDELINES – PAGE 1 OF 22[286]



selected packaging types like polyethylene terephthalate (PET), glass, mixed plastics and paper.

Waste is managed at the city and prefecture level. The large urban areas have the widest range of waste and recovery options. As an island nation, Japan has extremely limited landfill space. As a consequence, incineration has become the primary waste disposition method and has been used extensively for decades for materials that are not recycled. There is a high concentration of incinerators in urban areas. Though actively improved by measures taken by the government since 2001, the association of incineration with dioxin pollution in the 1980s and 1990s cultivated a strong 'Not in My Backyard' (NIMBY) movement within Japan. Eco-Towns have become test grounds for zero waste and other environmental programs, and the town of Kamikatsu is notable for having 44 categories of sorting.[287]

FIGURE 5: AVERAGE COMPOSITION OF JAPANESE MSW[291]



SOLID WASTE & RECOVERY STATISTICS

Waste Generation Overview

Japan generates about half the waste per capita of the U.S. despite having roughly the same GDP per capita according to the Organization for Economic Co-operation and Development (OECD) Factbook. This is in part due to cultural norms and a higher density of living.[288] In Japan, the Ministry of Environment thoroughly tracks the generation of both industrial waste and domestic waste which is the Japanese equivalent of municipal solid waste (MSW). In 2014, Japan generated 385 million metric tons of industrial waste, of which just over half was recycled, and 44.32 million metric tons of domestic waste of which about 20.6% (9.13 million metric tons) was recycled (Figure 3).[289] This is equivalent to a per capita generation rate of 947g of domestic waste/person/day and represents about a 20% drop in overall per capita generation since 2000.[290] This drop is due in part to a declining population combined with a focus on waste education and management. According to World Bank projections, the rate of Japanese waste generation is

FIGURE 6: RECYCLING RATES FOR INDIVIDUAL MATERIALS

Material	Recycling Rate	Extended Producer Responsibility	Source
Paper & Paperboard	80.8% (2014)	No EPR	292
Steel Cans	92.0% (2014)	No EPR	293
Aluminum Cans	87.4% (2014)	No EPR	294
PET	93.5% (2014)	EPR	295
Glass	94.3% (2014)	EPR (There is also a returnable bottle to bottle system in Japan)	296
Plastic	74.4% (2014)	EPR	297
Paper Containers & Packaging	38.0% (2014)	EPR	298

expected to increase to 53.6 million metric tons/year by 2025.[299] This would be about a 20% increase from 2014 levels. Given current trends, this seems like an overly aggressive growth rate.

Access to Waste Management Services

Managing domestic waste and recycling is an obligation of municipalities. Consumer access to solid waste management services in Japan is excellent. Nearly all Japanese residents have access to solid waste collection and recycling services. Despite the complexity of waste separation protocols, compliance by citizens is high. The use of clear plastic bags for source separated waste is used so it is easy to detect non-compliance.

Waste Management Infrastructure

Incineration is the primary waste disposition method. Figure 3 shows the breakdown of how domestic waste was managed in Japan in 2014. Only about 4.3 million metric tons (9.7%) of waste were landfilled.[300] Almost all domestic waste is treated by incineration prior to landfilling. There are thousands of landfills in Japan and managing materials to prolong the life of these landfills is a waste management priority. According to the 2014 Ministry of Environment report, the Kanto and Chubu provinces have landfill deficiencies that requires waste to be hauled to other areas.

Waste Composition

As shown in Figure 5, a 2014 waste composition study of diverse residential waste conducted in eight cities by the Ministry of the Environment found that slightly more than 32.2% of organics waste in domestic waste is food waste and another 34.4% is paper and paper products.[301] Plastics make up the next largest fraction at 11.5%.[302]

Recycling

The 2014 national recycling rate of 20.6% shown in Figure 3 for domestic waste[303] is relatively low compared to many developed markets. However, the recycling rates for individual materials (steel, aluminum, and PET) as shown in Figure 6 is high compared to other developed markets like the U.S or Canada. Japan has an extended producer responsibility system for some materials and no regulation for materials that have strong market demand. Following the adoption of policies in 2000 that focused on a Circular Materials Society, the growth of paper and packaging recycling increased rapidly and plateaued in 2010.[307] A combination of curbside recycling and drop-off depots are common throughout Japan to collect recyclables. Access to recycling is best in cities and larger towns.[308]

Consumers are asked to separate municipal solid waste into burnable, non-burnable and recyclable fractions. Depending upon the community, residents may be asked to source separate up to eight or more recyclable fractions. Glass is typically separated into clear, amber and other colors. Many techniques are used to ensure correct separation, including detailed instructions as those shown in Figure 4, attaching names to bags, using clear bags, issuing fines, and even employing local, neighborhood voluntary enforcement groups.

Commercial Recycling

Small businesses are exempt from some of the recycling obligations that impact larger businesses in Japan. Materials like paper and metals enjoy strong markets. Demand for paper fiber has recently increased in Japan and in the surrounding Asian markets, creating strong economic demand for all grades of recovered fiber-based packaging, provided it meets quality standards. This presents a strong opportunity for commercial generators of corrugated or other high-volume fiber streams. Municipalities provide businesses with detailed instructions on how to bundle their newspaper, corrugated and other paper for recycling. Similarly, ensuring packaging is properly labeled for its appropriate disposition helps consumers.

Organics Management

The Food Recycling Law of 2000 governs the management of commercially generated food waste by food manufacturers and processors, food wholesalers

FIGURE 6: DISPOSITION OF JAPANESE FOOD WASTE BY GENERATOR, 2011[304]

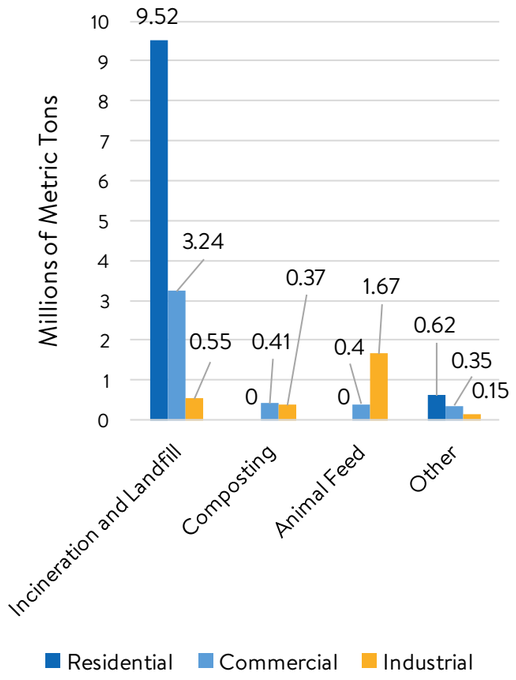


FIGURE 7: DISPOSITION OF FOOD WASTE IN JAPAN, 2011[305]

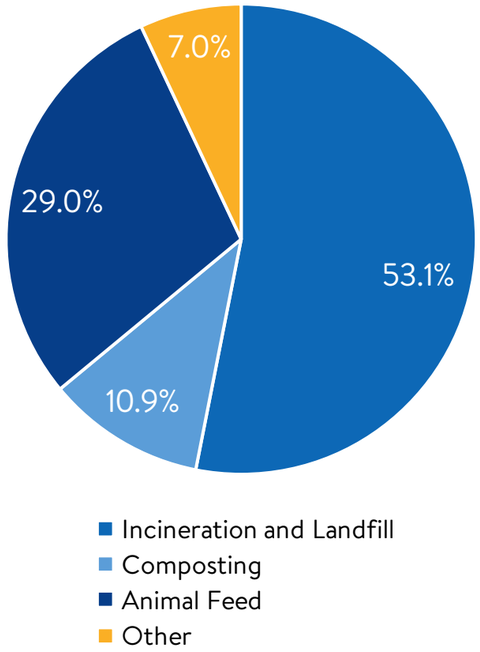
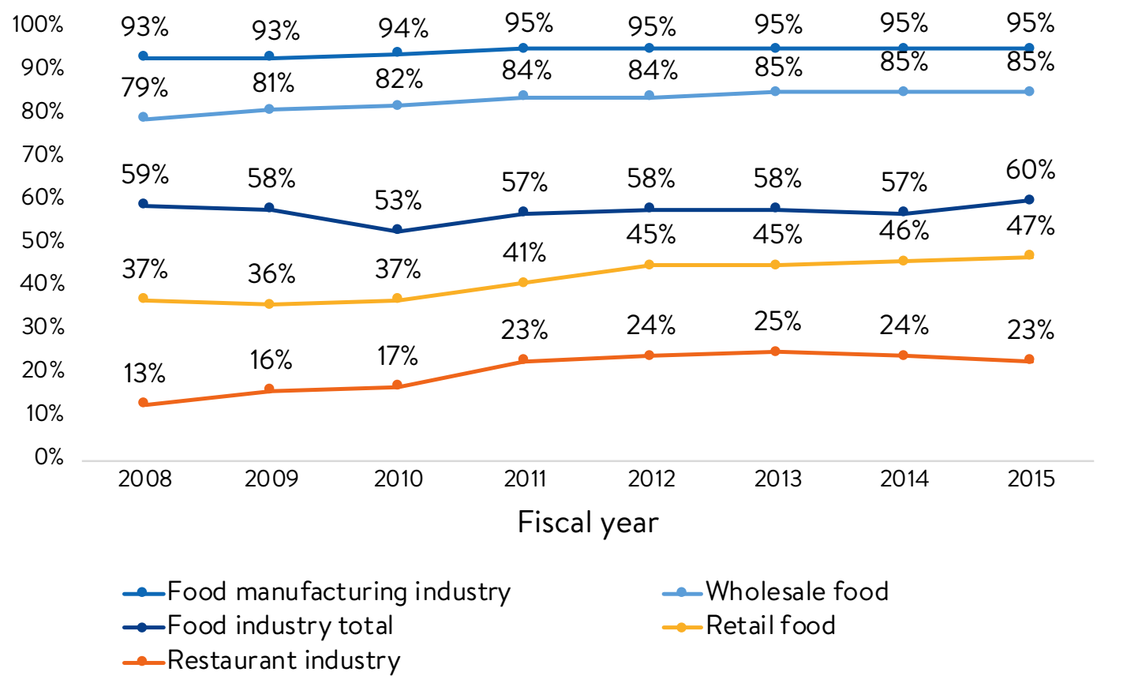


FIGURE 8: RECOVERY RATES FOR RECYCLABLE FOOD RESOURCES[306]



and retailers, restaurants and caterers.[309] It had not been aggressively implemented beyond industrial sources until 2012, when targets for reducing food wastage from across the supply chain, including food retail, were introduced.

As shown in Figure 6, animal feed was the primary disposition for industrial food waste. In 2011, approximately 95% of industrial food waste was recycled as shown on Figure 8.[310] Since targets were established, diversion from restaurants remains at less than 25%, while diversion from wholesalers and food retailer has improved to 60% and 47%, respectively.

Because of challenges enforcing the food waste recycling law, the difficulty of diverting food waste in the highly congested cities of Japan, food retailers and restaurants have experienced lower diversion rates than food wholesalers. However, since 2011, food retailers have experienced the greatest diversion improvement for commercial generators at 6%.[311]

In 2011, households recycled only 6% of food waste. Incinerators and landfills are the predominant destination, and consumers are asked to extract moisture and dispose of food waste as part of their burnable waste.

Since the 2011 Great East Japan Earthquake, alternatives to incineration for food waste and biomass have emerged through biomass energy which is viewed as a source of alternative energy.

REGULATORY ENVIRONMENT

Given its resource and landfill constraints, Japan has aggressively cultivated a culture of stewardship.[312] It has extensive policies built on the "Sound Materials-Cycle Society" (SMC) framework and a well-developed waste and recycling infrastructure that reflect these policy priorities. Japan has some of the most extensive solid waste policies of any developed country, with regulations on the following product types:

- Containers and packaging
- Home appliances
- Small home appliances
- Food waste
- Construction materials
- End-of-life vehicles

Japan is advancing the SMC program through policy, recovery infrastructure, state-promoted and voluntary industry initiatives, measurement and reporting systems, and systematic education. Most recently, the government has begun to employ life cycle assessment to inform environmental priorities. The federal government tracks many SMC programs to support waste reduction and recovery efforts.

Extended Producer Responsibility

Extended Producer Responsibility plays an important role in Japanese materials management. The Container and Packaging Recycling Law, for instance, requires that manufacturers, retailers and wholesalers are responsible for recycling PET bottles, glass and plastic packaging in proportion to the volume that they manufacture or sell. Of the nine-plus million metric tons of materials recycled in Japan, 1.43 million metric tons are handled by the government-designated producer responsibility organization known as the Japan Containers and Packaging Recycling Association (JCPRA).[313] The JCPRA collects fees, certifies recyclers and works with communities on collecting materials. Fees are calculated annually.

KEY PLAYERS

International Organizations

- International Solid Waste Association (ISWA) www.iswa.org

National Organizations

- Ministry of the Environment
  - Waste Management and Recycling Department
  - Policy Planning Division
  - Office of Sound Material-Cycle Society
- Ministry of Economy, Trade and Industry
- Japan Containers and Packaging Association http://www.jcpra.or.jp/english/tabid/613/index.php#Tab613
- Japan Waste Management Association (JWMA)

Prefectural and Local Governments

- Prefectures
- Local governments
- Wards/districts

Plastics

- Plastic Waste Management Institute https://www.pwmi.or.jp
- The Japan Plastics Industry Federation http://www.jpif.gr.jp
- The Council for PET Bottle Recycling http://www.petbottle-rec.gr.jp/english/
- Plastics Packaging Recycling Council

Paper and Cardboard

- Japan Paper Association https://www.jpa.gr.jp/en/
- Japan Recycling Council for Beverage Cartons
- Paper Packaging Recycling Council
- Corrugated Packaging Recycling Council

Metals and Glass

- Japan Steel Can Recycling Association http://www.steelcan.jp/english/
- Japan Aluminum Can Recycling Association
- Japan Soft Drink Association http://www.j-sda.or.jp/about-jsda/english.php
- Glass Bottle Recycling Promotion Association

KEY TRENDS AND OPPORTUNITIES

- Incineration is the primary method of waste management. Landfill space is a critical issue in Japan, especially for incinerator ash. The diversion of domestic waste is only 20.6% and has been flat since 2010. The constraint of landfill space is a critical situation for Japan.
- Policies to promote waste reduction and recycling are in place, and heavily enforced.
- Consumer recycling instructions are detailed, yet Japan has one of the lowest national recycling rates of any developed country in large part due to its dependence on incineration.
- Since the 2011 Great East Japan Earthquake, there is a commitment to look for new sources of alternative energy. There is an opportunity to take advantage of the growing interest in biomass energy in parts of Japan for food waste diversion.[314]
- Flexible packaging and plastic wrap are commonly used in consumer packaging in Japan. These materials are not typically recycled and are used as fuel in combustion systems.
- Corrugated, aluminum and selected rigid plastics and glass are readily recycled at most locations.

RESOURCES

PROLOGUE

- Hoornweg, D. & Bhada-Tata, P., "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- Food and Agricultural Organization of the United Nations, "SAVE FOOD: Global Initiative on food Loss and Waste Reduction".

BUSINESS CASE

- Medina, Martin., The Worlds Scavengers – Salvaging for Sustainable Consumption and Production. AltaMira Press, May 2007

CAM

- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- El Salvador Census, "Censo de Poblacion de Vivienda 2007: Hogares por Municipios y Departmentos Segun la Forma de Eliminacios de la Basura".
- El Salvador Ministry of Public Health and Social Assistance, Directorate of Regulation, General Directorate of Health, "Guide for the management of solid waste with final disposal in cells of continuity" Aug. 2007.
- El Salvador National Program for Integrated Waste Management, "Plan for the Improvement of Solid Waste Management in El Salvador", May 2010.
- Government of the Republic of Nicaragua, Ministry of the Environment and Natural Resources (MARENA), "National Policy on integral management of solid waste 2004-2023", June 2004.
- Government of Reconciliation and National Unity of Nicaragua, "Nicaragua Garbage Management 2012".
- International Solid Waste Association, Waste Atlas.
- National institute of Statistics INE Honduras, CENSO DE XVII POBLACIÓN Y VI VIVIENDA 2013.
- The Economist, "The World's Most Dangerous Cities", March 31, 2017.
- United Nations Human Settlement Programme, "Solid Waste Management in the World's Cities: Water and Sanitation in the World's Cities 2010".

COSTA RICA

- Arias, L., "Two more companies close operations in Costa Rica, lay off 110 employees", *The Tico Times*, June 4, 2014.
- Costa Rica Ministry of Health, "Política Nacional Para la Gestión Integral de Residuos 2010-2021", 2011.
- Dhia Ben-Haddej et al., "Managing Costa Rica's Waste: Recommendations for a Municipal Solid Waste Management Plan 2010-2011", Worcester Polytechnic Institute, December 13, 2010.
- Fendt, Lindsay, "Facing closures of makeshift garbage dumps, Costa Rican municipalities scramble to manage trash", *The Tico Times*, August 20, 2014.
- Government of Costa Rica, National Institute of Statistics and Census.
- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- Instituto CostaRicense De Turismo, "Guía Nacional de Manejo de Residuos, Diay Jacincto!?" 2014.
- Municipalidad de San Jose, Departmento de Gestion Ambiental, "Diagnostico sobre la Gestion de los Residuos Solidos en el Canton de San Jose",Febrero 2011.
- Programa Competitividad y Medio Ambiente (CYMA) 2008: Plan de Residuos Sólidos (PRESOL), Plan de Acción. San José. Costa Rica. May, 2008.
- Ruiz Vega, Carolina, "I Encuentro Costarricense de Recicladores será este sábado", *La Nacion*, September 9, 2013.

CHINA

- Duggan, Jennifer, "Why China's waste pickers are a better alternative to incineration", *The Guardian*, May 26, 2015.
- Government of China, Ministry of Environmental Protection, "Waste Management Policies and Waste Management Policies and Practices in China" July 2010.
- Government of China, National Bureau of Statistics, "China Statistical Yearbook 2014", 2014.
- Government of China, The State Council, "China to promote extended responsibility for environment", January 3, 2017.
- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- Hoornweg, D., Philip Lam and Manisha Chaudhry, "Waste Management in China: Issues and Recommendations", May 2005.
- "Law Report: China" Global Alliance of Waste Pickers.
- Themelis, Nickolas and Zhixiao Zhang, "WTE in China", *Waste Management World*, January 8, 2010.
- Yuanyuan, Liu, "Chinese Waste-to-energy Market Experiences Rapid Growth During Last Five Years" *Renewable Energy World*, April 28, 2015.

INDIA

- Annepu, Ranjith Kharvel, Sustainable Solid Waste Management in India, Columbia University Earth Engineering Center, January 10, 2012.
- Brown, Will, "Mumbai's slumdog recycling works surprisingly well – unless you're one of its workers", *City Metric*, June 12, 2017.
- Census Organisation of India. Government of India (2001). Census of India.
- Government of India Ministry of Environment and Forests "Municipal Solid Waste (Management and Handling) Rules", 2000.
- Government of India Ministry of Environment and Forests "Plastic Waste Management Rules", 2016.
- Government of India Ministry of Environment and Forests "E-Waste Management and Handling Rules", 2011.
- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- "India fifth biggest generator of e-waste in 2014: U.N. report", *The Hindu*.
- Kaushal, Rajendra Kumar, Varghese, George K., Chabukdhara, Mayuri. 2012. Municipal Solid Waste Management in India-Current State and Future Challenges: A Review. International Journal of Engineering Science and Technology 04/2012; 04(04):1173-1189.
- Kumar, Sunil, et al., "Challenges and opportunities associated with waste management in India", Royal Society Open Science, 22 March 2017.DOI: 10.1098/rsos.160764.
- Global Alliance of Waste Pickers, "Law Report: India".
- National Solid Waste Association of India (NSWAI) infographic.
- National Solid Waste Association of India (NSWAI), "Waste in India: The Statistics".

SOUTH AFRICA

- Collect-a-Can "January 2015 - 2015: The Year of Sustainable Corporate Social Investment" July 8, 2015.
- E-Waste collection points: www.ewaste.org.za/ewaste/collectionpoints (or phone Ewasa on 031 575 8119).
- "E-Waste: South Africa's Next Gold Rush?", *Waste Management World* 14.08.2013.
- Government of the Republic of South Africa, Department of Environmental Affairs (DEA), "National Waste Information Baseline Report", 2012.
- Government of the Republic of South Africa, Department of Environmental Affairs (DEA), "Report on the determination of the extent and role of waste picking in South Africa", 2014.
- Government of the Republic of South Africa, Department of Environmental Affairs and Tourism (DEAT), "Assessment of the status of waste serviced delivery and capacity at the local government level", 2007.
- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- International Solid Waste Association, "The World's 50 Biggest Dumpsites 2014 Report", Waste Atlas.
- Johannessen, Lars Mikkel; Boyer, Gabriela. 1999. Observations of solid waste landfills in developing countries: Africa, Asia, and Latin America. Urban and Local Government working paper series; no. UWP 3. Washington, D.C: The World Bank. http://documents.worldbank.org/curated/en/393531468741627673/Observations-of-solid-waste-landfills-in-developing-countries-Africa-Asia-and-Latin-America
- OECD "Territorial Reviews: The Gauteng City-Region, South Africa, 2011", OECD Publishing.
- Oyekale, Abayomi Samuel "Factors Explaining Households' Cash Payment for Solid Waste Disposal and Recycling Behaviors in South Africa" *Sustainability* 2015, 7, 15882-15889; doi:10.3390/su71215795, September 28, 2015.
- Paper Recycling Association of South Africa (PRASA), "Paper Recycling in South Africa - Facts and Statistics", July 8, 2015.
- PET Plastic Recycling South Africa, "Review of PETCO Activities 2016" PET Recycling Company.
- Plastics|SA "Survey of the South African Recycling Industry in 2014", May 2015.
- PlasticsSA, "SOUTH AFRICA'S PLASTIC RECYCLING STATISTICS FOR 2014" UrbanEarth, June

17, 2015.
- Statistics South Africa, "General Household Survey, 2015", Statistical release P0318, May 2017.
- Statistics South Africa, "Quarterly Labour Force Survey – QLFS Q1:2017, June 1, 2017.
- Statistics South Africa, "Unemployment increases in the third quarter of 2015", October 27, 2015.
- The Glass Recycling Company "Glass Recycling Data" July 8, 2015.

ARGENTINA

- Allen, Cecilia and Maeva Morin, "Buenos Aires City, Argentina, Including Grassroots Recyclers", *Gaia*.
- Balde, C.P., et al., "The Global Waste Monitor 2017: Quantities, Flows, and Resources", United Nations University, UNE-VIE SCYCLE, and International Solid Waste Association.
- CEAMSE, "Study on the Quality of Urban Solid Waste, 2009", February 2010.
- City of Buenos Aires website, "Urban Solid Waste".
- Goldstein, Nora, "Zero Waste In Buenos Aires (Argentina)", BioCycle, June 2008, Vol, 49, No. 6, p. 53.
- Goldstein, Nora and Sam Savage, "Composting Company Forges Ahead with Organics Diversion", July 3, 2008.
- Government of Argentina, Ministry of Health and Sustainable Development, "National strategy for the integral management of RSU", 08-09-2016.
- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- Ijjasz- Vásquez, Dr. Ede, "Integrated Management of Urban Solid Waste in Latin America and the Caribbean", World Bank.
- International Solid Waste Association, "The World's 50 Biggest Dumpsites 2014 Report", Waste Atlas.
- INTI Cordoba, Central Region of Cordobo, Ministry of Industry, "Home Composting".
- Inter-American Development Bank (IDB), "Regional Evaluation on Urban Solid Waste Management in Latin America and the Caribbean – 2010 Report (IDBMG-115)", 2010.
- Inter-American Development Bank (IDB), "Emerging Issues in Solid Waste Management in Argentina" (IDB-DP-372), June 2014.
- Inter-American Development Bank (IDB), "Sectorial Analysis Urban Solid Waste Management".
- National Institute of Statistics and Census (INDEC), 2010 Census.
- Global Alliance for Incinerator Alternatives (GAIA), "On the Road to Zero Waste".
- Robinson, Kristie, "Buenos Aires embraces "cartoneros" in push for zero waste" October 16, 2014.
- The World Factbook, US Central Intelligence Agency, January 03, 2018.

BRAZIL

- Abramovay, R.; Esperanza J. S., Petitgand, C., Lixo zero; gestão de residuos sólidos para uma sociedade mais próspera. São Paulo: Planeta sustentável: Instituto Ethos, 2013.
- Abrelpe, Panorama Dor Residuos Solidos No Brazil, 2014.
- Allianz, "A countdown of the 20 largest urban areas on the planet, according to the 2015 edition of Demographia's World Urban Areas index."
- Ambiente & Sociedade, "Selective waste collection in the São Paulo Metropolitan Region: impacts of the National Solid Waste Policy", Ambient. Soc. Vol.17 no.3 São Paulo July/Sept. 2014.
- Cempre, Ciclosoft 2014.
- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- IBGE (Instituto Brasileiro de Geografia E Estatística) (2013) "Produto interno bruto a preços correntes e produto interno bruto per capita segundo as grandes regiões, as unidades da federação e os municipios – 2010-2013".
- IBGE (Instituto Brasileiro de Geografia E Estatística), Indicadores De Desenvolvimento Sustentavel, Brazil 2012.
- IPEA, Megatendencias Mundiais 2030.
- ISWA, CCAC City Waste Management Profile – São Paulo February 2015.
- MDIC
- Plastivida
- Polzer VR, Pisani MAJ. The challenge of solid waste collection in precarious settlements in São Paulo, Brazil. Edorium J Waste Manag 2015;1:1–9.
- The World Bank, Brazil.
- US Central Intelligence Agency (CIA), World Fact Book: Brazil. January 3, 2018.

CHILE

- Association for Progressive Communications (APC) and Humanist Institute for Cooperation with Developing Countries (Hivos), "Global Information Society Watch 2010, Focus on ICTs and Environmental Sustainability", 2010.
- Global Alliance of Waste Pickers "Law Report: Chile, Waste Pickers in Chile".
- González Martínez, Tahnee María, "Analysis of different municipal solid waste management systems in Santiago de Chile", 2011.
- Government of Chile, Ministry of the Environment, "State of the Environment Executive Summary", 2010.
- Government of Chile, National Commission of the Environment, "First Management Report of Solid Waste in Chile", 2010.
- Government of Chile News, "President Bachelet enacts the Recycling and Extended Producer Liability Law", May 26, 2016.
- The World Bank, "Chile At-A-Glance".
- U.S. Central Intelligence Agency, "The World Factbook, Chile".

MEXICO

- Alonso, María Gaviota Velasco Pérez, "Generation and Disposition of MSW in Mexico and Potential for Improving Waste Management in Toluca Municipality." Columbia University, January 2011.
- Baker, James A., "Challenges to Sustainable E-Waste Recycling", Baker Institute for Public Policy, October 28, 2014.
- Chen, Martha, et al., "Membership-Based Organizations of the Poor", Routeledge Studies in Development Economics, 2007.
- Cortinas de Nava, Cristina. Mexican Legislation on Waste Management Plans and Consumer Products that become Waste when Discarded. Lecture at the Workshop for the Development of a Proposal at the Technical Level of "Central American Policy on Solid Waste and Disposal and a Regional Proposal on Deposits and Returns". 2004.
- Duran Moreno, Alfonso; et al., "Mexico City's Municipal Solid Waste Characteristics and Composition Analysis", National Autonomous University of Mexico, September 2011.
- Gasca-Alvarez, Sergio, "Waste Prevention and Management Program, 2009-2012, Mexico", Ministry of the Environment and Natural Resources, 2013.
- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- Mercado del Trueque, Annual Results.
- Michell, Nick, "How Mexico City has turned garbage into fuel", *Cities Today*, January 18, 2013.
- "Poverties in Mexico: Economic Crises & 21st Century Welfare", January 5, 2012.
- Secretariat of the Environment and Natural Resources (SEMARNAT), "Compendium of Environmental Statistics 2013 Edition, "Estimated generation of urban solid waste by geographical area".
- Secretariat of the Environment of the Federal District (SMA), "Inventory of Solid Waste of the Federal District 2012".
- Council on Foreign Relations, "Criminal Violence in Mexico".
- World Bank Data – Mexico Urban Percentage
- SEMARNAT Waste generation data – 2013 MSW generation in Mexico by State.
- Mexico News Daily, "Separating garbage will be obligatory", June 20, 2017.
- INEGI. *National census of Municipal and Delegational 2012 (CNGMD) Governments.* Module 6: Municipal Solid Waste. Aguascalientes. Mexico. 2013.

CANADA

- Canadian Council of Ministers of the Environment, "Canada-wide Action Plan for Extended Producer Responsibility", October 2009, PN 1499.
- Canadian Council of Ministers of Environment, "State of Waste Management in Canada", 2014.
- Government of Canada, "Get to know Canada – Provinces and Territories".
- Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.
- Metro Vancouver, "2013 Waste Composition Monitoring Program" February 2014.
- Nicholson, John, "The USA, Executive Orders, and Canadian Waste Management", *Solid Waste & Recycling*, February 21, 2017.
- Scott, Michael, "Extended Producer Responsibility: Who Cares?", *Newswire Canada*, May 27, 2013.
- Statistics Canada, Tables 051-0005 and Table 153-0041.
- Statistics Canada, Table 051-0005 and Table 153-0042.
- Statistics Canada, Table 153-0043.

JAPAN

- Government of Japan, Ministry of the Environment, "Annual Report on Environmental Statistics, 2014".
- Government of Japan, Ministry of the Environment, "FY2010 Results of Sorted Collection and Recycling of Waste by Municipalities Based on the Containers and Packaging Recycling Act".
- Government of Japan, Ministry of the Environment, "History and Current State of Waste Management in Japan", February 2014.

- Government of Japan, Ministry of the Environment, “Municipal solid waste emissions and disposal in FY2014” February 22, 2016.
- Government of Japan, Ministry of the Environment, “Municipal solid waste emissions and disposal in FY2015” March 28, 2017.
- Government of Japan, Statistics Bureau, Ministry of Internal Affairs and Communications, “Statistical Handbook of Japan 2017”.
- Hoornweg, D. & Bhada-Tata, P. “What a Waste: A Global Review of Solid Waste Management”, World Bank, 2012.
- Hoornweg, D. et al., “Environment : Waste production must peak this century”, Nature, 10/30/2013.
- Japan Steel Can Recycling Association, “Annual Report on Steel Can Recycling 2014”.
- OECD Factbook 2015-2016: Economic, Environmental and Social Statistics, OECD Publishing, Paris.
- Onishi, Norimitsu, “How Do Japanese Dump Trash? Let Us Count the Myriad Ways”, *The New York Times*, 5/12/2005
- Paper Recycling Promotion Center, “Paper Recycling in Japan” August, 2017.
- The Council for PET Bottle Recycling, “Recycling Rate of PET Bottles”.
- The Japan Containers and Packaging Recycling Association, December 2015.

ENDNOTES

1 Hoornweg, D. & Bhada-Tata, P., “What a Waste: A Global Review of Solid Waste Management”, World Bank, 2012.

2 Food and Agricultural Organization of the United Nations, “SAVE FOOD: Global Initiative on food Loss and Waste Reduction”.

3 Medina, Martin., The Worlds Scavengers – Salvaging for Sustainable Consumption and Production. AltaMira Press, May 2007

4 Hoornweg, D. & Bhada-Tata, P. “What a Waste: A Global Review of Solid Waste Management”, World Bank, 2012.

5 Hoornweg, D. & Bhada-Tata, P., 2012.

6 Hoornweg, D. & Bhada-Tata, P., 2012.

7 Government of Reconciliation and National Unity of Nicaragua

8 International Solid Waste Association, Waste Atlas.

9 El Salvador National Program for Integrated Waste Management, “Plan for the Improvement of Solid Waste Management in El Salvador”, May 2010.

10 El Salvador National Program for Integrated Waste Management

11 United Nations Human Settlement Programme, “Solid Waste Management in the World’s Cities: Water and Sanitation in the World’s Cities 2010”.

12 Hoornweg, D. & Bhada-Tata, P.

13 Hoornweg, D. & Bhada-Tata, P.

14 El Salvador Census

15 National institute of statistics INE Honduras

16 Government of the Republic of Nicaragua, Ministry of the Environment and Natural Resources (MARENA), “National Policy on integral management of solid waste 2004-2023”, June 2004.

17 El Salvador Ministry of Public Health and Social Assistance, Directorate of Regulation, General Directorate of Health, “Guide for the management of solid waste with final disposal in cells of continuity” Aug. 2007.

18 Government of Costa Rica, National Institute of Statistics and Census.

19 Costa Rica Ministry of Health, “Política Nacional Para la Gestión Integral de Residuos 2010-2021”, 2011.

20 Programa Competitividad y Medio Ambiente (CYMA) 2008: Plan de Residuos Sólidos (PRESOL), Plan de Acción. San José. Costa Rica. May, 2008.

21 Ibid.

22 Ibid.

23 Hoornweg, D. & Bhada-Tata, P. “What a Waste: A Global Review of Solid Waste Management”, World Bank, 2012.

24 CYMA, 2008

25 Ibid.

26 Costa Rica Ministry of Health

27 Ibid.

28 CYMA, 2008

29 Fendt, Lindsay, “Facing closures of makeshift garbage dumps, Costa Rican municipalities scramble to manage trash”, The Tico Times, August 20, 2014.

30 CYMA, 2008

31 Ibid.

32 Municipalidad de San Jose, Departmento de Gestion Ambiental, “Diagnostico sobre la Gestion de los Residuos Solidos en el Canton de San Jose”,Febrero 2011.

33 Arias, L., “Two more companies close operations in Costa Rica, lay off 110 employees”, The Tico Times, June 4, 2014.

34 Dhia Ben-Haddej et al., “Managing Costa Rica’s Waste: Recommendations for a Municipal Solid Waste Management Plan 2010-2011”, Worcester Polytechnic Institute, December 13, 2010.

35 Ibid.

36 Ibid.

37 Ruiz Vega, Carolina, “I Encuentro Costarricense de Recicladores será este sábado”, La Nacion, September 9, 2013.

38 Dhia Ben-Haddej et al., 2010

39 Government of China, National Bureau of Statistics, “China Statistical Yearbook 2014”.

40 Ibid.

41 Yuanyuan, Liu, “Chinese Waste-to-energy Market Experiences Rapid Growth During Last Five Years” Renewable Energy World, April 28, 2015.

42 Government of China, National Bureau of Statistics, “China Statistical Yearbook 2014”.

43 Ibid.

44 Ibid.

45 Ibid.

46 Ibid.

47 Themelis, Nickolas and Zhixiao Zhang, 2010

48 Yuanyuan, 2015

49 National Bureau of Statistics, “China Statistical Yearbook 2014”

50 Duggan, Jennifer, “Why China’s waste pickers are a better alternative to incineration”, The Guardian, May 26, 2015.

51 Hoornweg, D., Philip Lam and Manisha Chaudhry, 2005

52 “Law Report: China” Global Alliance of Waste Pickers.

53 Hoornweg, D., Philip Lam and Manisha Chaudhry, “Waste Management in China: Issues and Recommendations”, May 2005.

54 Government of China, Ministry of Environmental Protection, “Waste Management Policies and Waste Management Policies and Practices in China” July 2010.

55 Hoornweg, D. & Bhada-Tata, P., 2012

56 MEP, 2010

57 Government of China, The State Council, “China to promote extended responsibility for environment”, January 3, 2017.

58 YMA, 2008

59 Ibid.

60 Ibid.

61 Hoornweg, D. & Bhada-Tata, P. “What a Waste: A Global Review of Solid Waste Management”, World Bank, 2012.

62 Annepu, Ranjith Kharvel, Sustainable Solid Waste Management in India, Columbia University Earth Engineering Center, January 10, 2012.

63 Hoornweg, D. & Bhada-Tata, P., 2012.

64 Annepu, 2012.

65 Ibid.

66 Ibid.

67 ibid.

68 Kumar, Sunil, et al., “Challenges and opportunities associated with waste management in India”, Royal Society Open Science, 22 March 2017.DOI: 10.1098/rsos.160764.

69 Census Organisation of India. Government of India (2001). Census of India.

70 National Solid Waste Association of India (NSWAI) infographic.

71 Annepu, 2012.

72 Ibid.

73 Ibid.

74 Ibid.

75 Ibid.

76 Kaushal, Rajendra Kumar, Varghese, George K., Chabukdhara, Mayuri. 2012. Municipal Solid Waste Management in India-Current State and Future Challenges: A Review. International Journal of Engineering Science and Technology 04/2012; 04(04):1173-1189.

77 Ibid.

78 Ibid.

79 Annepu, 2012.

80 Ibid.

81 Ibid.

82 Global Alliance of Waste Pickers, “Law Report: India”.

83 Ibid.

84 Annepu, 2012.

85 Ibid.

86 Brown, Will, “Mumbai’s slumdog recycling works surprisingly well – unless you’re one of its workers”, City Metric, June 12, 2017. Available online: https://www.citymetric.com/fabric/mumbai-s-slumdog-recycling-works-surprisingly-well-unless-you-re-one-its-workers-3096

87 Government of India Ministry of Environment and Forests “Municipal Solid Waste (Management and Handling) Rules”, 2000.

88 Government of India Ministry of Environment and Forests “Plastic Waste Management Rules”, 2016.

89 Government of India Ministry of Environment and Forests “E-Waste Management and Handling Rules”, 2011.

90 “India fifth biggest generator of e-waste in 2014:

U.N. report", The Hindu.

91 Statistics South Africa, "Quarterly Labour Force Survey – QLFS Q1:2017, June 1, 2017.

92 Statistics South Africa, "General Household Survey, 2015", Statistical release P0318, May 2017.

93 Government of the Republic of South Africa, Department of Environmental Affairs (DEA), "National Waste Information Baseline Report", 2012.

94 DEA, "National Waste Information Baseline Report"

95 International Solid Waste Association, "The World's 50 Biggest Dumpsites 2014 Report", Waste Atlas.

96 DEA, "National Waste Information Baseline Report"

97 Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.

98 DEA, "National Waste Information Baseline Report"

99 Oyekale, Abayomi Samuel "Factors Explaining Households' Cash Payment for Solid Waste Disposal and Recycling Behaviors in South Africa" Sustainability 2015, 7, 15882-15889; doi:10.3390/su71215795, September 28, 2015.

100 Statistics South Africa, "General Household Survey, 2015"

101 DEA, "National Waste Information Baseline Report"

102 Ibid.

103 Oyekale, 2015.

104 Statistics South Africa, "General Household Survey, 2015"

105 Government of the Republic of South Africa, Department of Environmental Affairs and Tourism (DEAT), "Assessment of the status of waste serviced delivery and capacity at the local government level", 2007.

106 Ibid.

107 DEAT, "Addressing Challenges with Waste Service Provision in South Africa: Municipal Waste Sector Plan"

108 DEA, "National Waste Information Baseline Report"

109 Ibid.

110 Ibid.

111 The Glass Recycling Company "Glass Recycling Data" July 8, 2015.

112 PET Plastic Recycling South Africa, "Review of PETCO Activities 2016" PET Recycling Company.

113 Plastics|SA "Survey of the South African Recycling Industry in 2014", May 2015.

114 Collect-a-Can "January 2015 - 2015: The Year of Sustainable Corporate Social Investment" July 8, 2015.

115 Paper Recycling Association of South Africa (PRASA), "Paper Recycling in South Africa - Facts and Statistics", July 8, 2015.

116 OECD "Territorial Reviews: The Gauteng City-Region, South Africa, 2011", OECD Publishing.

117 DEA, "National Waste Information Baseline Report"

118 Government of the Republic of South Africa, Department of Environmental Affairs (DEA), "Report on the determination of the extent and role of waste picking in South Africa", 2014.

119 Johannessen, Lars Mikkel; Boyer, Gabriela. 1999. Observations of solid waste landfills in developing countries: Africa, Asia, and Latin America. Urban and Local Government working paper series; no. UWP 3. Washington, D.C: The World Bank. http://documents.worldbank.org/curated/en/393531468741627673/Observations-of-solid-waste-landfills-in-developing-countries-Africa-Asia-and-Latin-America

120 PlasticsSA, "SOUTH AFRICA'S PLASTIC RECYCLING STATISTICS FOR 2014" UrbanEarth, June 17, 2015.

121 DEA, "National Waste Information Baseline Report"

122 "E-Waste: South Africa's Next Gold Rush?", Waste Management World 14.08.2013.

123 The World Factbook, US Central Intelligence Agency, January 03, 2018.

124 Ibid.

125 Ibid.

126 Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.

127 Inter-American Development Bank (IDB), "Regional Evaluation on Urban Solid Waste Management in Latin America and the Caribbean – 2010 Report (IDBMG-115)", 2010.

128 IDB, 2010.

129 Hoornweg, D. & Bhada-Tata, P., 2012.

130 Balde, C.P., et al., "The Global Waste Monitor 2017: Quantities, Flows, and Resources", United Nations University, UNE-VIE SCYCLE, and International Solid Waste Association.

131 Ijjasz- Vásquez, Dr. Ede, "Integrated Management of Urban Solid Waste in Latin America and the Caribbean", World Bank.

132 Inter-American Development Bank (IDB), "Emerging Issues in Solid Waste Management in Argentina" (IDB-DP-372), June 2014.

133 Ibid.

134 Inter-American Development Bank (IDB), "Sectorial Analysis Urban Solid Waste Management".

135 International Solid Waste Association, "The World's 50 Biggest Dumpsites 2014 Report", Waste Atlas.

136 Global Alliance for Incinerator Alternatives (GAIA), "On the Road to Zero Waste".

137 CEAMSE, "Study on the Quality of Urban Solid Waste, 2009", February 2010.

138 National Institute of Statistics and Census (INDEC), 2010 Census.

139 Hoornweg, D. & Bhada-Tata, P., 2012.

140 City of Buenos Aires website, "Urban Solid Waste".

141 IDB, 2014.

142 Robinson, Kristie, "Buenos Aires embraces "cartoneros" in push for zero waste" October 16, 2014.

143 Ibid.

144 Ibid.

145 Goldstein, Nora and Sam Savage, "Composting Company Forges Ahead with Organics Diversion", July 3, 2008.

146 INTI Cordoba, Central Region of Cordobo, Ministry of Industry, "Home Composting".

147 Allen, Cecilia and Maeva Morin, "Buenos Aires City, Argentina, Including Grassroots Recyclers", Gaia.

148 Goldstein, Nora, "Zero Waste In Buenos Aires (Argentina)", BioCycle, June 2008, Vol, 49, No. 6, p. 53.

149 Government of Argentina, Ministry of Health and Sustainable Development, "National strategy for the integral management of RSU", 08-09-2016.

150 Balde, C.P., et al.

151 IDB, "Sectorial Analysis Urban Solid Waste Management".

152 IBGE (Instituto Brasileiro de Geografia E Estatística), Indicadores De Desenvolvimento Sustentavel, Brazil 2012.

153 The World Bank, Brazil.

154 US Central Intelligence Agency (CIA), World Fact Book: Brazil. January 3, 2018.

155 IBGE (Instituto Brasileiro de Geografia E Estatística) (2013) "Produto interno bruto a preços correntes e produto interno bruto per capita segundo as grandes regiões, as unidades da federação e os municípios – 2010–2013".

156 Hoornweg, D. & Bhada-Tata, P. "What a Waste: A Global Review of Solid Waste Management", World Bank, 2012.

157 Ibid.

158 Allianz, "A countdown of the 20 largest urban areas on the planet, according to the 2015 edition of Demographia's World Urban Areas index." March 16, 2015.

159 IBGE, 2012.

160 Ibid.

161 Ambiente & Sociedade, "Selective waste collection in the São Paulo Metropolitan Region: impacts of the National Solid Waste Policy", Ambient. soc. vol.17 no.3 São Paulo July/Sept. 2014.

162 IBGE, 2012.

163 Ibid.

164 IBGE, 2012.

165 Hoornweg, D. & Bhada-Tata, P., 2012.

166 Ibid.

167 Abrelpe, 2014.

168 Ibid.

169 Abrelpe, Panorama Dor Residuos Solidos No Brazil, 2014.

170 Cempre, Ciclosoft 2014.

171 IBGE, 2012.

172 Plastivida

173 ISWA, CCAC City Waste Management Profile- São Paulo, February 2015.

174 IPEA, Megatendencias Mundiais 2030.

175 Ibid.

176 Ibid.

177 Ibid.

178 Ibid.

179 Ambiente & Sociedade, 2014.

180 Ibid.

181 ISWA, 2015.

Plastivida

182 Abramovay, R.; Esperanza J. S.; Petitgand, C., Lixo zero: gestão de resíduos sólidos para uma sociedade mais próspera. São Paulo: Planeta sustentável: Instituto Ethos, 2013.

183 MDIC

184 Ibid.

185 Ibid.

186 The World Bank, “Chile At-A-Glance”.

187 Government of Chile, Ministry of the Environment, “State of the Environment Executive Summary”, 2010.

188 The World Bank

189 Government of Chile, National Commission of the Environment, “First Management Report of Solid Waste in Chile”, 2010.

190 The World Bank

191 State of the Environment Executive Summary, 2010

192 First Management Report of Solid Waste in Chile, 2010

193 Ibid.

194 Ibid.

195 Ibid.

196 Ibid.

197 Ibid.

198 Ibid.

199 Ibid.

200 Ibid.

201 González Martínez, Tahnee María, “Analysis of different municipal solid waste management systems in Santiago de Chile”, 2011.

202 Ibid.

203 AmCham Chile

204 First Management Report of Solid Waste in Chile, 2010

205 First Management Report of Solid Waste in Chile, 2010

206 Ibid.

207 Ibid.

208 AmCham Chile

209 Association for Progressive Communications (APC) and Humanist Institute for Cooperation with Developing Countries (Hivos), “Global Information Society Watch 2010, Focus on ICTs and Environmental Sustainability”, 2010.

210 AmCham Chile

211 First Management Report of Solid Waste in Chile, 2010

212 Ibid.

213 Government of Chile News, “President Bachelet enacts the Recycling and Extended Producer Liability Law”, May 26, 2016.

214 AmCham Chile

215 First Management Report of Solid Waste in Chile, 2010

216 Ibid.

217 Global Alliance of Waste Pickers “Law Report: Chile, Waste Pickers in Chile”.

218 Ibid.

219 Ibid.

220 First Management Report of Solid Waste in Chile, 2010

221 Government of Chile News, 2016.

222 Ibid.

223 Secretariat of the Environment and Natural Resources (SEMARNAT), “Compendium of Environmental Statistics 2013 Edition, “Estimated generation of urban solid waste by geographical area”.

224 Alonso, María Gaviota Velasco Pérez, “Generation and Disposition of MSW in Mexico and Potential for Improving Waste Management in Toluca Municipality.” Columbia University, January 2011.

225 Duran Moreno, Alfonso; et al., “Mexico City’s Municipal Solid Waste Characteristics and Composition Analysis”, National Autonomous University of Mexico, September 2011.

226 SEMARNAT, Compendium of Environmental Statistics 2013

227 Michell, Nick, “How Mexico City has turned garbage into fuel”, Cities Today, January 18, 2013.

228 Duran Moreno, 2011.

229 Ibid.

230 Ibid.

231 Michell, 2013.

232 Alonso, 2011.

233 SEMARNAT, Compendium of Environmental Statistics 2013

234 Michell, 2013.

235 Ibid.

236 Alonso, 2011.

237 SEMARNAT, Compendium of Environmental Statistics 2013

238 Mercado del Trueque, Annual Results.

239 “Poverties in Mexico: Economic Crises & 21st Century Welfare”, January 5, 2012.

240 “Ibid.

241 Alonso, 2011.

242 Ibid.

243 Secretariat of the Environment of the Federal District (SMA), “Inventory of Solid Waste of the Federal District 2012”.

244 Michell, 2013.

245 Alonso, 2011.

246 Ibid.

247 Chen, Martha, et al., “Membership-Based Organizations of the Poor”, Routeledge Studies in Development Economics, 2007.

248 Alonso, 2011.

249 SMA

250 Cortinas de Nava, Cristina. Mexican Legislation on Waste Management Plans and Consumer Products that become Waste when Discarded. Lecture at the Workshop for the Development of a Proposal at the Technical Level of “Central American Policy on Solid Waste and Disposal and a Regional Proposal on Deposits and Returns”. 2004.

251 Gasca-Alvarez, Sergio, “Waste Prevention and Management Program, 2009-2012, Mexico”, Ministry of the Environment and Natural Resources, 2013.

252 Government of Canada, “Get to know Canada – Provinces and Territories”.

253 Statistics Canada

254 Ibid.

255 Canadian Council of Ministers of Environment (CCME), “State of Waste Management in Canada”, 2014.

256 CCME, 2014.

257 Hoornweg, D. & Bhada-Tata, P. “What a Waste: A Global Review of Solid Waste Management”, World Bank, 2012.

258 CCME, 2014.

259 Ibid.

260 Ibid.

261 Ibid.

262 Statistics Canada, Tables 051-0005 and Table 153-0041

263 Ibid.

264 CCME, 2014.

265 CCME, 2014.

266 Ibid.

267 Ibid.

268 Ibid.

269 Nicholson, John, “The USA, Executive Orders, and Canadian Waste Management”, Solid Waste & Recycling, February 21, 2017.

270 CCME, 2014.

271 Ibid.

272 Metro Vancouver, “2013 Waste Composition Monitoring Program” February 2014.

273 Ibid.

274 Ibid.

275 Statistics Canada, Table 153-0043

276 Statistics Canada, Table 051-0005 and Table 153-0042

277 Ibid.

278 Ibid.

279 Scott, Michael, “Extended Producer Responsibility: Who Cares?”, Newswire Canada, May 27, 2013.

280 CCME, “Canada-wide Action Plan for Extended Producer Responsibility”, October 2009, PN 1499.

281 CCME, “State of Waste Management in Canada”

282 CCME, “State of Waste Management in Canada”

283 Government of Japan, Ministry of the Environment (MOE), “Annual Report on Environmental Statistics, 2014”.

284 Government of Japan, Ministry of Environment MOE),”Annual Report on Environmental Statistics, 2015

285 Ibid.

286 Full version available online: http://www.city.toyota.aichi.jp/_res/projects/default_project/_page_/001/008/609/h29/e.pdf

287 Onishi, Norimitsu, “How Do Japanese Dump Trash? Let Us Count the Myriad Ways”, The New York Times, 5/12/2005

288 Hoornweg, D. et al., “Environment : Waste production must peak this century”, Nature, 10/30/2013.

289 Government of Japan, Statistics Bureau, Ministry of Internal Affairs and Communications, “Statistical Handbook of Japan 2017”.

290 Statistical Handbook of Japan, 2017.

291 Government of Japan, Ministry of the Environment, “Annual Report on Environmental Statistics, 2014”.

292 Paper Recycling Promotion Center, “Paper Recycling in Japan” August, 2017.

293 Japan Steel Can Recycling Association, “Annual Report on Steel Can Recycling 2014”.

294 MOE, “Annual Report on Environmental Statistics, 2017”.

295 MOE, “Annual Report on Environmental Statistics, 2017”.

296 Ibid.

297 Ibid.

298 Ibid.

299 Hoornweg, D. & Bhada-Tata, P. “What a Waste: A Global Review of Solid Waste Management”, World Bank, 2012.

300 MOE, “Annual Report on Environmental Statistics, 2014”

301 Ibid.

302 Ibid.

303 Government of Japan, Ministry of the Environment, “Annual Report on Environmental Statistics, 2014”.

304 Ibid.

305 Ibid.

306 Ministry of Agriculture, Forestry and Fisheries Statistics Department

307 MOE, “Annual Report on Environmental Statistics, 2014”

308 Ibid.

309 Government of Japan, Ministry of the Environment, “History and Current State of Waste Management in Japan”, February 2014.

310 MOE, “Annual Report on Environmental Statistics, 2014”

311 Food industrial Policy Office, Biomass Policy Division, Food Industry Affairs Bureau, Aug. 2017.

312 Statistics Japan, Statistical Handbook of Japan 2017

313 The Japan Containers and Packaging Recycling Association

314 Government of Japan, Ministry of the Environment, “History and Current State of Waste Management in Japan”, February 2014.