



Best Practices for Solid Waste Management

A Guide for Decision-Makers in Developing Countries

Recycling Markets

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United States Environmental Protection Agency
Office of Resource Conservation and Recovery

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Acronyms and Abbreviations

AD	Anaerobic Digestion
APR	Association of Plastic Recyclers
ASEAN	Association of Southeast Asian Nations
ASTM	American Society for Testing and Materials
CCAC	Climate & Clean Air Coalition
CPCIC	Cleaner Production and Climate Innovation Center
EPR	Extended Producer Responsibility
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
GGGI	Global Green Growth Institute
HDPE	High-Density Polyethylene
ISCC	International Sustainability and Carbon Certification
MRF	Material Recovery Facility
OECD	Organisation for Economic Co-operation and Development
PET	Polyethylene Terephthalate
PPE	Personal Protective Equipment
SWaCH	Solid Waste Collection and Handling
UN	United Nations
UNEP	United Nations Environment Programme
UNIDO	UN Industrial Development Organization
U.S. EPA	United States Environmental Protection Agency
USAID	United States Agency for International Development



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RECYCLING MARKETS





Key Resources

-  [Best Practices for Solid Waste Management: A Guide for Decision-Makers in Developing Countries](#) (U.S. EPA 2020)
-  [Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options](#) (OECD 2022)
-  [Improving Markets for Recycled Plastics Trends, Prospects and Policy Responses](#) (OECD 2018)

Section 1

Introduction

In many middle- and high-income countries, recycling is an important economic development opportunity contributing to job creation, cost savings, and revenue generation for cities (OECD 2018). Recycling refers to collecting, sorting, and processing materials that would otherwise be disposed of as waste into new materials that re-enter the supply chain. To be successful, recycled materials must be reincorporated into supply chains through recycling markets. Therefore, identifying and developing recycling markets is critical to the success of any recycling program. Recycling markets must be strong enough to compete with the market for raw or virgin materials in order to increase the use of secondary materials, such as recycled plastics or paper, in household and commercial products.

Recycling Markets is part of the United States Environmental Protection Agency's [Best Practices for Solid Waste Management in Developing Countries Toolkit](#). The Toolkit serves as a free resource for decision-makers implementing solid waste management programs. The Toolkit includes e-learning modules, communication materials, webinar materials, videos, and the [Best Practices Guide for Solid Waste Management in Developing Countries](#) (the Guide). The [Guide](#) describes key aspects of solid waste management and identifies best practices that can be implemented in medium and large cities in developing countries. **Recycling Markets** is a companion chapter to the [Guide](#).

In the existing [Guide](#), **Section 11 – Recycling** provides information on the benefits, challenges, and best practices for planning and implementing recycling programs. This companion chapter builds on the [Guide](#) by providing information on the benefits, challenges, and best practices for cities to identify and facilitate development of recycling markets when planning and implementing recycling programs. This chapter covers the most common types of recyclable materials and products, as listed in **Section 11 – Recycling**: paper, aluminum, steel,

plastics, batteries, glass, tires, used motor oil, and e-waste. A companion chapter on **Addressing Plastic Waste** provides a closer look at plastic waste, which may offer additional solutions to market development for recycled plastics.

This companion chapter is not intended to be a step-by-step implementation manual, but it highlights resources that local authorities and decision-makers can refer to for more detailed technical guidance. Approaches that may be successful in one city or region may not function everywhere, so the chapter presents decision-makers with the information and resources to improve equity in solid waste management within the context of their given situation.

In the solid waste management hierarchy developed by the United States Environmental Protection Agency, recycling is considered the third most preferred strategy to manage materials, behind source reduction and reuse (U.S. EPA 2017). Recycling materials reduces the demand for disposal of waste in landfills or energy recovery facilities, which are considered least preferred strategies for solid waste management (U.S. EPA 2017). **Section 3 – Approaches** of the [Guide](#) provides more information on the solid waste management hierarchy.

The best practices aim to help cities identify and facilitate development of recycling markets when planning and implementing recycling programs. Recycling around the world is limited, and current recycling programs are often unable to deal with the vast number of materials and products that are manufactured and consumed. While the focus of this chapter is on recycling markets, cities can make recycling efforts more effective by preventing and minimizing unnecessary, avoidable, and hard-to-recycle materials and products. **Section 8 – Prevention and Minimization** of the [Guide](#) provides more detail on incorporating these strategies into solid waste management plans.



Section 2

What Are Recycling Markets?

Recycling markets involve customers (e.g., paper mills, metal smelters, glass factories) which buy recyclable materials from the waste stream to make new products or handle the financial and shipping transactions necessary to move recyclables through the marketplace (U.S. EPA 1993). Exhibit 1 shows the types of secondary materials captured from products and identifies potential end-users and uses.

Waste characterization is a key first step to understand what materials a city generates. For more information, refer to **Section 7 – Waste Characterization** of the [Guide](#). With waste characterization data, cities can identify the most common materials and products in a waste stream. With this information, cities can identify if recycling markets for these materials exist.

Exhibit 1. Secondary materials that can be captured from products

Secondary Material	Example Products	Potential End-Users and Uses	Considerations
Paper	Paperboard packaging, corrugated containers (e.g., cardboard boxes), direct mail, magazines and catalogs, newspapers and inserts, office papers, paper products (e.g., books, paper towels, tissues, paper plates and paper cups), plastic- or aluminum-lined containers and cartons	Paper mills, recycled paperboard manufacturers	Moderate value material
Aluminum	Electronics; cans; appliances	Can sheet manufacture mills	High value material
Steel	Electronics; cans; appliances; building products; vehicles	Mills with electric arc furnaces and steel mills; construction industry	High value material
Plastics	Bottles and containers; durable plastics found in appliances, furniture, and sporting and recreational equipment; rigid, flexible, and expanded foam packaging; plastic bags and wraps; plastic lumber; asphalt for roads; cement blocks	Carpet fiber and fiberfill manufacturers, plastic product manufacturers, polystyrene industry, plastics industry	Volume of material in transport; Low value material; Value influences based on influence from fossil fuel pricing and other commodities
Batteries	Rechargeable batteries (e.g., lithium-ion, lead-acid, nickel-cadmium, nickel-metal hydride) and primary batteries (e.g., alkaline, lithium, silver oxide) from small consumer electronics, large vehicles, personal electric mobility devices (e.g., scooters and e-bikes), and other battery-operated household devices	Recycled at special facilities	Hazardous materials posing health risks
Glass	Containers and packaging, glass found in appliances, consumer furniture	Glass factories, fiberglass industry	Heavy weight of material; transport; lack of off-takers
Used motor oil	Motor oil	Lubricants, fuel oils, raw materials for oil-refining industry	Hazardous materials posing health risks
Tires	Tires from automobiles, motorcycles, bicycles, light-duty trucks, commercial trucks and buses	Baled for civil engineering uses, shredded and used as liners and covers at landfills	Hazardous materials posing health risks



Cities could collect and recycle nearly three quarters of their waste stream. According to the World Bank estimates, up to 56 percent of municipal waste is food and green waste that could be treated through organics recycling, and up to 16 percent of waste could be recycled, including plastic, glass, metal, paper, and cardboard (Kaza et al. 2018).

Exhibit 3 shows a regional breakdown of waste composition. Refer to the [Organics Recycling](#) section for more information on end-markets for products from composting and anaerobic digestion (AD). According to the Organisation for Economic Co-operation and Development (OECD), markets for recycled materials are growing due to policy incentives and changing commercial conditions (OECD 2018). This section includes background information on recycling markets:

- Recycling markets are separate from but linked to municipal recycling programs.** Recycling programs are municipal or private programs that collect and process materials that would otherwise be disposed as waste. Recycling markets are a critical component to the economic and social success of a city’s recycling program. Customers, often manufacturers, purchase the recycled materials and use them as inputs

into new products. Exhibit 2 shows the flow of materials through the recycling program to the end-market. For more information, refer to **Section 11 – Recycling** of the [Guide](#).

- Successful, long-term recycling markets put secondary materials back in the supply chain.** Once these recyclables, or secondary materials, enter the recycling market, the material becomes available for manufacturers to purchase and reincorporate into the supply chain and ultimately back into products that can be purchased and used. Having a long-term market is crucial to ensuring that the economics of recycling works over a prolonged period of time.
- Recycling markets consist of multiple material-specific markets.** The value of each type of recycled material is highly variable and depends on a number of factors including the material type, transportation costs, weight of material, material costs, processing costs, labor costs, and the existing market. For example, a city may not see value in collecting glass for recycling due to high transport costs as a result of its heavy weight.

Exhibit 2. Boundaries and Connections of a Recycling Program within the Recycling Market

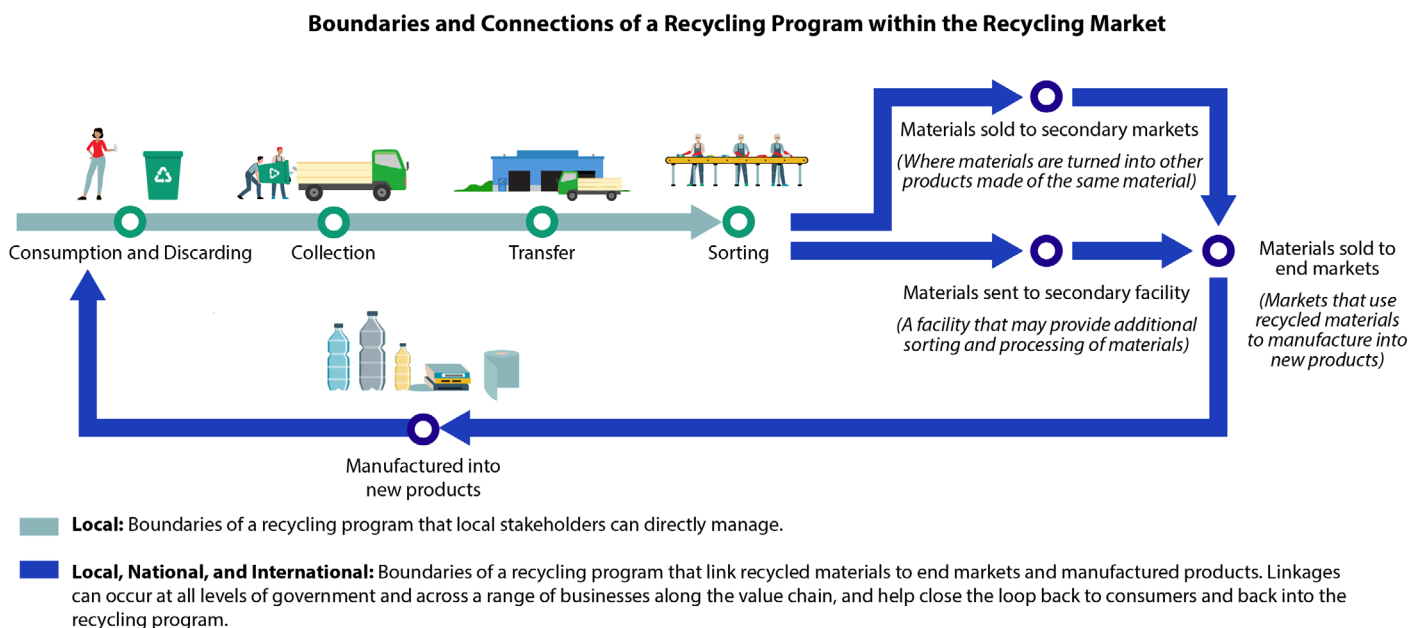
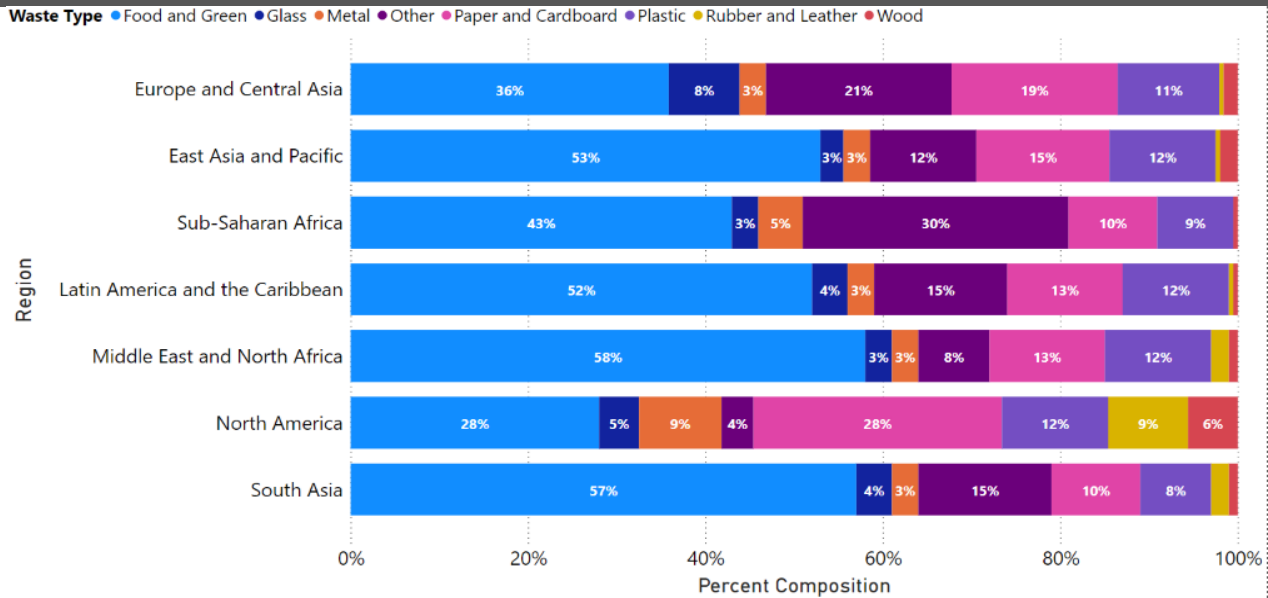


Exhibit 3. Global Waste Composition by Geographic Region (Kaza et al. 2018).



- Recycling markets can be local, regional, national, or international.** Recycling markets are classified into multiple geographic boundaries including domestic and international.

 - Local markets.** Communities within a city in which recyclables are collected, including formal and informal sector workers. Cities can help drive local markets by enacting policies or schemes to increase collection and decrease contamination of recyclables.
 - Regional markets.** Communities within a couple hundred miles or kilometers from the community (U.S. EPA 1993). Cities can enable regional markets by engaging in partnerships with other communities. Facilitating transportation to achieve markets at a more regional level, especially in rural areas, is an important step in developing regional markets. Partnering and connecting with neighboring communities and linking generators and cities with the online and offline marketplaces can increase capacity to recycle additional materials and can help identify new potential markets for materials.
 - National markets.** All communities within a country (U.S. EPA 1993). Cities can enable a national recycling market to foster a circular economy. A national recycling market creates jobs in the recycling and manufacturing industry and offers cities the opportunity to tap into domestic sources of material.
 - International markets.** All other countries in which recyclables are imported from or exported to. Changing international policies have limited the export of materials to certain countries (U.S. EPA 2021a). Policies to restrict imports such as the China National Sword, which was enacted to stop receiving dirty, unprocessed “recycled bales” from around the world, have caused local recycling facilities to limit the materials accepted for recycling or stop accepting recyclables altogether.





KEY POINT 

International Influences on Recycling Exports

China National Sword Policy. In 2017, China prohibited the import of all but the highest quality recyclable materials, including post-consumer plastics. This policy shifted the plastics market to other countries, where infrastructure to properly handle recyclables could not keep up with the increase of incoming materials. Recycling programs around the world were affected, causing some materials, such as plastics, to be mismanaged (e.g., improperly disposed of or littered) or sent to landfills or incinerators.

Basel Convention Plastic Waste Amendments. The fourteenth meeting of the Conference of the Parties to the Basel Convention adopted amendments to Annexes II, VIII, and IX to the Convention with the objectives of enhancing the control of the transboundary movements of plastic waste and clarifying the scope of the Convention as it applies to such waste. These amendments have impacts on recycling markets. National-level policies are also impacting these markets; for example, Thailand is planning a ban of imports of plastics by 2025 (Plastic Free World 2023).

Global Commitment 2022. The Ellen MacArthur Foundation, in collaboration with the UNEP, launched the Global Commitment to reduce virgin plastic use and start building a circular economy. More than 500 international organizations are signatories of this commitment, including Nestlé, PepsiCo, and Unilever [Ellen MacArthur Foundation Undated (b)].

2.1. Why Focus on Recycling Markets?

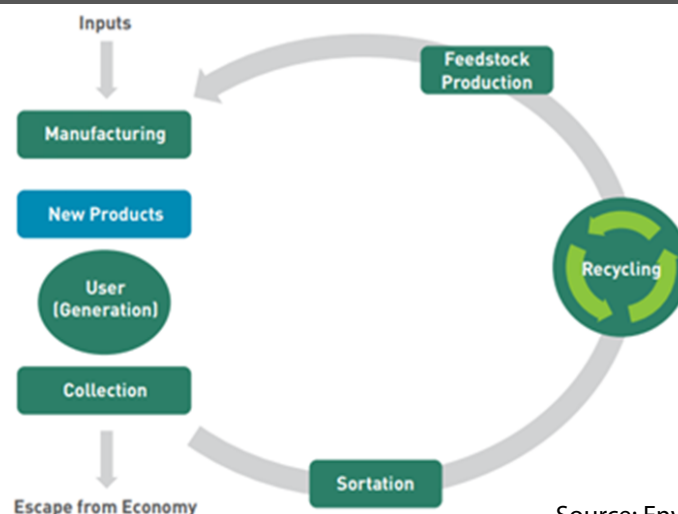
Focusing on recycling markets offers various benefits, including:

- **Promoting a circular economy.** Exhibit 4 shows the basic concept of how materials flow through the recycling system in a *circular economy*, which keeps materials, products, and services in circulation for as long as possible. Recycling markets benefit from a circular system because materials are contained within the system and are constantly used and sold to end-markets. While

the quality of some materials is reduced during the recycling process, recycling is a more circular strategy than discarding materials before their end of useful life. Cities can directly contribute to circularity by recovering valuable materials in their waste streams and connecting those secondary materials with recycling markets.

- **Supporting economic development and partnerships between the public and private sectors.** Linking informal waste collectors with formal collection systems can address gaps in waste collection. Forming partnerships between the formal and informal collection system will

Exhibit 4. Flow of Materials Through A Recycling System



Source: Environmental Protection Agency National Recycling Strategy



strengthen existing recycling markets and may lead to the development of new end-markets. Additionally, the growth of the recycling industry contributes to jobs, wages, and tax revenue for cities (U.S. EPA 2020b).

- **Reducing resources to process virgin material.** Recycle and reuse of materials such as plastic, aluminum, paper, glass, or others can save production and energy costs required to process more virgin material in order to meet market demand [Stanford Undated]. The United Nations Environment Programme (UNEP) suggests that a shift to a circular economy can reduce virgin plastic production by approximately 55 percent and help governments reduce emissions by 25 percent (UNEP 2022).
- **Reducing the environmental impact of rapidly growing and urbanizing areas.** Recycling recovers materials that hold economic value. More end-markets result in more materials recovered. As more materials are recovered, fewer materials leak into the environment, limiting the negative impacts from solid waste pollution. For more material-specific information

on environmental impacts, refer to **Section 11 – Recycling** of the [Guide](#). Recovering more materials also reduces the reliance on extracting raw materials for new products and supports resource efficiency. Raw material extraction and processing is responsible for half of all global greenhouse gas emissions and up to 90 percent of biodiversity loss and water usage (UNEP 2019).

- **Advancing social issues.** Vulnerable populations benefit from recycling markets because markets can create new and better jobs. New opportunities for women, the informal sector, and youth may result from improving recycling markets that shift toward a more circular economy.

New skills such as transportation and storage logistics, delivery, re-processing, reuse, and repair are necessary to support recycling and material recovery in emerging economies. Entry-level jobs may attract more youth and low-literacy workers because they require more basic skillsets. A growing recycling sector can offer a wide range of employment opportunities, from those that require only basic skill sets to more technical jobs suitable for the highly skilled.



KEY POINT

Informal Waste Sector Role in Recycling Market Development

The private sector, including the informal sector, is responsible for most recycling services. The informal sector consists of individuals, groups, and small businesses that collect, sort, and sell recyclable materials. In many low-income countries, informal workers play a key role in a city's overall waste management system by starting and sustaining recycling services, filling in gaps where collection and sorting efforts may be lacking in the formal system. Informal sector workers achieve high recovery rates because collection is vital for their livelihoods. Incorporating the informal waste sector with the formal collection system offers key benefits including:

- **Environmental advantages.** Increased recovery rates keep waste out of waterbodies and other critical habitats, as well as reducing dependence on open burning.
- **Economic advantages.** The informal sector converts waste into tradeable commodities, forms new trading networks and businesses, and generates employment.
- **Social advantages.** Informal waste collectors' exposure to hazards is ideally lessened when these workers are integrated into the formal system. In some places, informal sector workers receive personal protective equipment (PPE), health insurance and safety checks, and education and training benefits as part of their integration into the formal recycling system.
- **Technological advantages.** Informal sector workers often introduce new and innovative technologies, such as phone applications for on-demand recyclables pickup.

For more information about the informal waste sector, see the [flyer on Informal Sector Recycling](#) as part of the Best Practices for Solid Waste Management Toolkit.



Section 3

Challenges

Market failures and barriers can undermine the effectiveness of city recycling programs and collection of recycled materials. Cities face several challenges in identifying and developing recycling markets, including:

- **Geographic boundaries and lack of collection.** One study estimates that about two billion people do not have access to waste collection services, limiting the number of materials collected for recycling (UNEP 2015). For those who do have adequate waste collection services, materials and products may not always align with the recycling technology available in each region.
- **Lack of data.** Data on the generation of and final management pathways of plastics and other recyclable materials is limited and inconsistent (OECD 2018). Having available data on material supply and demand will help suppliers and end-users better understand the recycling market, identify gaps in the market, and connect end-markets.
- **Volatile supply and demand.** It is especially important for cities to identify local and regional markets for recyclables, and tailor segregation plans accordingly. In instances where markets for certain products do not currently exist, cities can work with the private sector to encourage market demand and lower risks to the city. The demand for recyclables can shift unpredictably, resulting in price fluctuations. Situations such as a global pandemic and other global economic factors have an impact on the recycling sector. For example, during the COVID-19 pandemic, oil prices decreased, resulting in the cost of virgin plastics being much lower than the price of recycled ones (University of Colorado Boulder 2022). In some instances, sudden drops in material prices can make operating recycling

facilities financially unsustainable. In such cases, recyclables may end up being disposed of in landfills (U.S. EPA 1993). Low supply of recycled materials may discourage the development of a market for that material. High supply or low demand for a material may overwhelm the market, decreasing the value of the material.

- **Price considerations.** Cities have found it useful to collect and analyze data on the size of the local market for recyclable materials. Key considerations include:
 - **Distance to the nearest recycler or remanufacturing facility.** It may not be economically and logistically feasible to recycle certain materials if the nearest recycler or remanufacturing facility is located far away. For example, Polyethylene Terephthalate (PET) bottle-to-bottle recycling facilities are not commonly located near every city. As a result, the price paid for PET bottles is very low, and many of them are recycled into lower-value products such as polyester for clothing manufacturers. Cities looking to develop recycling programs for specific materials can learn from the challenges of other cities or communities with similar conditions.
 - **Handling and transportation costs for recyclables.** It may be less expensive to use raw or virgin materials if it is too costly to handle and transport recycled materials. If recyclables are transported, the buyer and seller will need to determine and agree upon who bears the cost of transportation of the recyclables.



- **Volatility of market prices for different materials.** For many raw materials, volatile prices cause markets to fluctuate (UN Industrial Development Organization 2019). The manufacturing process is then left with limited material availability, which influences recycling programs and virgin material markets (UN Industrial Development Organization 2019). Price swings contribute to the vulnerability of low-income and informal workers, many of whom already face extreme poverty and may not receive compensation for their time and labor.
- **Quality and contamination of the recyclable materials.** The quality of a recyclable material impacts the sale price. Higher-quality recycled materials are more effective substitutes for raw or virgin materials. However, mixing of waste leads to contamination of materials during streamlined recycling collection. This is a common phenomenon in developing countries where the tipping fee model for collection is followed. In some cases, buyers will demand some pre-processing such as baling, washing, or chipping, meaning investments in equipment are required to achieve the highest possible price.

Challenges posed by single-use plastics, and variable quality and types of plastic in items such as cutlery, plates, straws, cups, balloons, and plastic bags, present special challenges for recycling and often are not seen as worth the time required to process.
- **Historical and future trends.** Commodity prices for recycled materials fluctuate over time. For example, the U.S. EPA has compiled historical commodity prices for recycled materials, which show that in the United States, there was a general downward trend in the values of all commodities between 2010 and 2018, except for high-density polyethylene (HDPE) and glass (U.S. EPA 2020a). Cities can use historical data to prioritize which materials to focus on recovering. If these data are not available, decisions could be informed by either (1) a large presence of recyclable material in the residual waste stream, or (2) local manufacturing sector and corresponding material demand.
- **Consumer perception.** Consumer perceptions provide one of the largest challenges for recycling markets. Key considerations include:
 - **Perception that recycling is expensive.** In many places, waste collection services are private, requiring households to pay (McKinsey & Company 2022). In some cities with private waste collection, residents may avoid paying fees by dumping or burning waste, contributing to negative public health outcomes and increased land and marine pollution.
 - **Limited information about proper separation, recycling schemes, drop-off points, and recycling partners.** Consumers may not fully understand which materials can be recycled, causing low recycling rates and high contamination. This may lead consumers to assume that non-recyclable waste is recyclable ("wishcycle") (iDSA 2021). Materials are not often sorted correctly at the source, causing materials to be contaminated by "wet" organic materials when they arrive at material recovery facilities (MRFs; McKinsey 2022). Contamination limits the quality, value, and availability of materials entering the recycling market (McKinsey 2022).
 - **Reduced quality of recycled products.** A recycled product is not as high quality as a product made from virgin materials. For example, recycled fibers from all materials lose some of their virgin qualities and durability. This may lead consumers to choose a product that is made from virgin materials over recycled.

Furthermore, people may think that a recycled product should be cheaper than one made from virgin materials even if it is of equal quality. The use of additives in manufacturing processes can also hinder the suitability of materials for recycling. For plastics, the use of composite plastics, a wide range of polymers, special additives, various colors, and end-uses—food grade vs. non-food grade plastic—presents a challenge for developing a recycling market for plastics (OECD 2006; OECD 2018).



Section 4

Best Practices

This section describes best practices for improving markets for recycled materials. Many cities find that a combination of strategies and partnerships is most beneficial to enable recycling markets, including:

- **Local and regional stakeholders.** Cities can identify stakeholders for each part of the recycling system and create partnerships that can help overcome barriers and create a more resilient recycling system.
- **Frameworks and incentives.** Existing waste management rules and systems, economic incentives and disincentives, accessing and investing in technologies, strengthening domestic policies and market development, and strengthening international cooperation are all effective ways cities can enable a successful recycling market.
- **Quality and quantity of recycled materials.** Improving the quality and increasing the quantity of materials provides market confidence and can result in increased demand for recycled materials.
- **Investments.** Attracting investments can help cities increase the volume of recycled materials collected, and the quality of materials recycled and sold to end-markets.

4.1. Identifying Local and Regional Stakeholders ✓

It is important to engage with all stakeholders in the solid waste management system to address information barriers that can inhibit the connection of recycling collectors, processors, and end-market purchases (UNIDO 2019). Exhibit 6 identifies local and regional stakeholders that cities may engage when improving recycling markets. Cities can form partnerships with stakeholders to identify and overcome common barriers, working together to find solutions (Exhibit 5 and 7). The condition of the road network may determine whether certain partnerships are financially practical. Transfer stations and reverse logistics can help to facilitate capture of materials from a broader area.

Stakeholder-led actions can create a stronger, more resilient, and cost-effective solid waste system (U.S. EPA 2021a). Conducting consumer outreach and education campaigns on the value of secondary materials and importance of the consumer role in purchasing and waste management can enhance the volume and quality of recyclables collected. For more information, refer to see **Section 4 – Stakeholder Engagement** of the [Guide](#).



EXHIBIT 5 CASE STUDY



Multi-Stakeholder Circular Economy E-Portal in Rwanda

The Global Green Growth Institute (GGGI), in collaboration with Rwanda Environment Management Authority, the United Kingdom's Foreign, Commonwealth & Development Office, and Save The Environment Initiative, worked together to develop the Circular Economy Marketplace E-portal. The portal was developed due to the lack of data available about the quantities and types of plastic waste found in Rwanda. The Cleaner Production and Climate Innovation Center (CPCIC) maintains this interactive portal. The portal is designed to help stakeholders identify gaps, opportunities, and challenges within the plastic waste value chain. Producers of plastic waste can connect with recycling companies to increase the volume of recycled plastics for new products. Policymakers can use the tool to identify effective actions needed to incentivize the reuse of plastic to increase circularity in the plastic waste value chain.

For more information, visit the [GGGI](#) and [CPCIC](#) websites.



Exhibit 6. Recycling Services Stakeholders

Stakeholder	Role
Public health and sanitation departments	Inspection and enforcement of solid waste management system
Public works departments	Operational functions of waste collection
Natural resource management agencies	Management of solid waste, such as recovery or composting
National or state/provincial environmental ministries	Development and implementation of policies and plans
Municipal governments	Oversight of solid waste management operations such as trucks, workers, and equipment
Land use or town/physical planning agencies	Planning for new infrastructure locations
Regional governments	Oversight of solid waste management operations, such as landfills, incinerators, and composting facilities
Private sector companies	Collection, street sweeping, material recovery, and building and operating facilities; off-take of materials
Households/residential waste generators	Residents who are underserved can organize community-based organizations (CBOs) to advocate for enhancing the solid waste management system, including increased service, funding, and participation
Business waste generators	Waste from businesses; may have to pay for waste service directly
Informal sector workers, enterprises, and MRF operators or contractors	Recovery of resources from waste streams throughout the city; scavenging for waste at dumpsites to recover recyclable materials
Non-governmental organizations	Improvement of environment and quality of life for people by organizing and advocating for informal sector workers, and communicating between CBOs and government authorities
Community-based organizations	Raising awareness of and increasing participation in solid waste management activities; some CBOs deliver waste collection and recycling services
Low-income residents and peri-urban communities	Greatest need for enhanced solid waste management system to reduce environmental health risks
Women	Often responsible for domestic waste management and segregation of recyclables; more vulnerable to negative health impacts from mismanaged waste; may be restricted to low-value roles and lacking influence and opportunity within the value chain
Independent collectors	Move across waste dump sites to recover recyclable materials
Cart pushers, bicycle, and tricycle riders	Collection by individuals or organized groups of recyclable materials from dumpsites, streets or homes, sometimes with a handcart or something similar
External funding agencies	Provision of technical assistance for projects they fund

Source: Gana et al. (2022)





EXHIBIT 7 CASE STUDY



Partnerships with Local Self-Help Groups for Improving Collection and Segregation

The Solid Waste Collection and Handling (SWaCH) cooperative autonomous enterprise that provides front-end waste management services which includes collection, segregation, transportation and management to the citizens of Pune. SwACH is a workers' cooperative run by informal workers that receives policy and infrastructure support from Pune Municipal Corporation (Centre for Public Impact 2021). The formation of SWaCH dates back to the early 1990s when waste pickers and itinerant waste buyers in Pune and Pimpri Chinchwad came together to form a membership-based trade union. The trade union's efforts were recognized by Pune Municipal Corporation, which signed an agreement with the union for collection and handling of waste. The initiative today works with nearly 3,000 informal sector workers by protecting their right to dignity and providing a safe livelihood [ESCAP Undated].

The SWaCH workers are associated with the door-to-door collection at the ward level. The waste collected is brought to sorting stations or sheds. The waste is then manually segregated into different recyclable fractions. The workers receive their income from the monthly user fee that households pay for the service and the sale of recyclables from the sorted waste.

For more information, see the [Centre for Public Impact's website](#).

4.2. Enabling Incentives/ Instruments ✓

Cities can use economic and policy instruments to enable and advance markets for recycled materials (Exhibit 8). Common solutions include:

- **Economic incentives.** Stakeholders can collaborate to create regulatory policy instruments that offer incentives and capacity building to collect, sort, and recycle solid waste. Further incentivizing sorting of solid waste can increase the value of recycled materials because contamination of other materials is limited, and additional recycled materials can be recovered through sorting efforts [OECD Undated(a)].

Extended producer responsibility (EPR) is “an environmental policy approach that gives producers financial or physical responsibility for a product’s entire lifecycle, including the treatment or disposal of post-consumer products” (Exhibit 12) (OECD 2022). In practice, this means that companies pay a fee according to the quantity of material they are putting into the market. Fees collected through EPR schemes are dedicated to funding waste collection services. EPR schemes have been applied to plastic packaging, e-waste, vehicles, and batteries. Sometimes, EPR plays a crucial role in meeting the minimum price

for sustaining collection and transportation of materials from cities. Successful implementation of EPR can incentivize recyclability at the design stage while increasing the quantity recovered through collection and recycling systems.

- **Taxes.** Cities can set taxes on manufacturers to disincentivize use of single-use materials or offer subsidies or credits for manufacturers that meet specific criteria to reduce pollution (OECD 2022). Tax incentives or credits for using recycled materials can advance recycling markets by driving up the demand for recycled materials (OECD 2018). Taxes are most effective when they are high enough to discourage consumption.
- **Deposit-refund schemes.** Deposit-refund schemes offer incentives, such as payments or credits, to encourage the recovery of products such as glass or plastic bottles (OECD 2022). Consumers pay the additional deposit when purchasing a product (e.g., US\$0.05 for a glass bottle, in addition to the normal price of the purchase) and have the deposit refunded when returned for recycling at a designated collection point. Deposit-refund schemes can help to improve the quantity and quality of recovered materials (Exhibit 9 and 10).



- Recycled content standards.** Recycled content standards require producers to ensure that a certain percentage of their products or packaging are made from recycled content (OECD 2022). For example, a government may set a target requiring manufacturers to use at least 50 percent recycled plastic when making plastic products. Cities can also align their own public procurement policies with recycled content requirements. Recycled content standards can help increase the demand for recycled materials and give confidence to the market. Standards are most effective when accompanying enforcement mechanisms are in place.
- Encourage participation in certification schemes and product standards.** Cities can increase the demand for secondary materials by participating in certification schemes and product standards. Such schemes and standards offer cities an opportunity to increase the volume of materials recycled as well as the quality of recycled materials.



CASE IN POINT 

Incentivizing Recycling for Free Transportation in Indonesia

In 2017, Indonesia joined the United Nations Clean Seas campaign and committed to reducing marine litter by 70 percent by 2025. To increase plastics collection, the city of Surabaya developed a program that allowed the city’s bus riders to receive a free, hour-long trip in exchange for three large bottles, five medium bottles, or 10 plastic cups. In a city of 2.9 million, approximately 16,000 residents trade plastic bottles for free travel weekly.

For more information, visit [Trash for Tickets on Indonesia’s ‘Plastic Bus’](#) and the [Clean Seas website](#).



CASE IN POINT 

Setting Recycled Content Standards Around the World

Below is an overview of some recycled content regulations:

- The European Union has mandated that industry include 25 percent recycled content in PET bottles by 2025 and 30 percent in all plastic bottles by 2030 under the Single-Use Plastics Directive.
- Likewise, in the U.S. state of California, manufacturers are required to include an annual average of 15 percent post-consumer recycled content in beverage containers starting in 2022. By 2025, the mandate is set to increase to 25 percent and by 2030 to 50 percent.
- Washington state has also recently announced a schedule for post-consumer recycled content requirements for different product categories, starting with beverage containers and trash bags in 2023, adding certain household cleaning and personal care products in 2025, and expanding to dairy milk containers in 2028.

For more information, visit the [Holland Colours website](#).



Exhibit 8. Potential certification schemes and product standards.

Scheme/Standard	Objective
Association of Plastic Recyclers (APR) Design Guide for Plastics Recyclability ¹	Guide plastic package designers by outlining industry-accepted criteria to ensure products are compatible for recycling
Global Recycled Standard (GRS) and the Recycled Claim Standard (RCS) ²	International standards that set requirements for recycled materials in products across the entire supply chain
International Sustainability and Carbon Certification (ISCC) Plus ³	Certifies waste and residue raw materials across the supply chain
QA-CER Recycled Content Certification System ⁴	A global certification system for plastic, textiles, or composite materials based on ISO 9001 principles
SCS Recycled Content Standard V7.0 ⁵	Requirements for recycled content found in final products
UL 2809 Environmental Claim Validation Procedure (ECVP) for Recycled Content ⁶	Validates the recycled content for any materials in pre- and post-consumer products
Resources:	
1. The Association of Plastics [Undated]	4. Belgian Quality Association (2017)
2. Textile Exchange [Undated]	5. SCS Global Services (2017)
3. ISCC (2019)	6. UL Standards (2020)



KEY POINT

Addressing Textile Waste

The international clothing industry has doubled in sales between 2000 and 2015. Textile waste from clothing continues to increase as clothing utilization—the average number of times a garment is worn before it ceases to be used—decreases due to lower priced clothing and new, seasonal trends. This phenomenon is known as “fast fashion” [Ellen MacArthur Undated (a)]. Cities can work towards creating a textile circular economy by incentivizing the private sector to develop take-back programs for consumers to recycle old or no longer functional clothes and household textiles. Import bans or landfill bans can also prevent textiles from entering a country or a landfill, and can encourage additional recycling of textiles. For example, East African countries Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda enacted an import ban on second-hand clothing in 2016 to decrease the volume of textiles in the countries (Changing Markets Foundation 2021).





EXHIBIT 9 CASE STUDY



Increasing Recycling Efforts Through Incentive Programs in Sri Lanka

It is estimated that about 20 percent of households in Sri Lanka have access to public waste collection services. This results in large amounts of waste being burned or improperly disposed of in their communities or the environment. In 2018, USAID's Clean Cities, Blue Ocean program partnered with the Sri Lankan government to create solutions for advancing recycling efforts throughout the country. These efforts involve heavily engaging the private sector, as the government believes the private sector to be a key player in combatting ocean pollution.

One such effort is in partnership with the Idea Factory, which has developed a reverse vending machine that instantly pays users for recycling qualified waste. These vending machines have been placed throughout the Jaffna District to see if rewards or other incentives will increase participation in recycling efforts. This effort will also provide the national government with useful data and feedback to incorporate in future larger scale efforts.

The program and Sri Lankan local governments have also partnered with Janathakshan to design and launch new plastic recovery centers throughout the Kaduwela Municipal Council area of Colombo. Informal collectors will be able to sell recyclable waste at fair market prices to the centers, where they will then be sorted, cleaned, and resold to commercial recyclers to be made into new products. This effort seeks to close the gap between end-users discarding recyclable waste and the market demands for clean, recyclable materials.

For more information, visit the [Urban Links website](#).

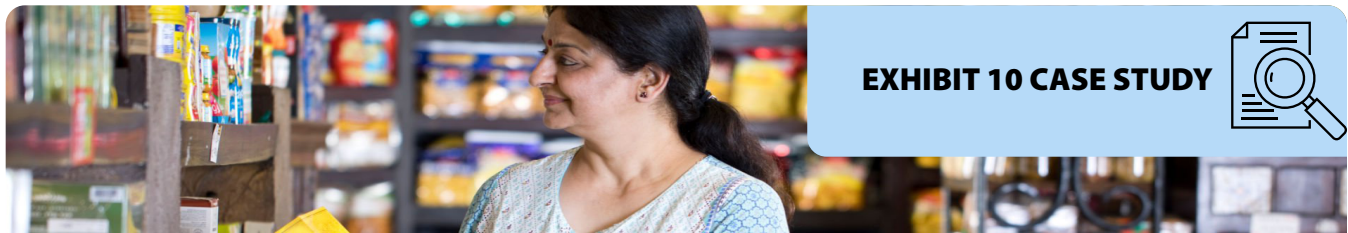


EXHIBIT 10 CASE STUDY



Zero Baht or Shop with Your Waste

Zero Baht is a concept in Thailand for setting up shops that allow citizens to barter recyclable goods for other goods without transacting in currency [OECD Undated(b)]. A similar concept has also been implemented in the city of Panjim, Goa, in partnership with the local municipal authority. The initiative acts as an intermediary between citizens and MRFs and provides incentives in the form of daily use products such as soap or shampoo in exchange for recyclables at pre-decided rates. The rates at which recyclables are exchanged are adjusted every two weeks on the basis of the current market value and are decided by the local municipal authority. The initiative offers a win-win opportunity to all stakeholders involved including the shopkeeper.

For more information, visit [Marine Plastics Pollution Thailand](#)



4.3. Innovation and Technology

Innovation of new technologies to collect, sort, and recycle solid waste is necessary to improve markets for recycled materials. Cities can support research and development of technologies and products that will expand market opportunities. Research and development can result in:

- **Increased volume of recycled materials.** By investing in innovative systems and technologies, cities can capture additional and better-quality materials from the solid waste stream and reduce contamination and leakage of materials into the environment [OECD Undated (a)].
- **Decreased contamination.** Sorting technologies can help cities properly sort recycled materials and limit contamination of non-recyclable materials. For more information about increasing the value of recycled materials, refer to the [Identifying opportunities to improve the quality and quantity of recycled materials](#) section.
- **New markets.** Cities can create new markets for materials by developing new strategies to use secondary materials as feedstocks and developing technology to allow the recycling of difficult-to-recycle materials (U.S. EPA 2021a).
- **New partnerships.** Cities can form new partnerships with stakeholders to implement new projects that can fund secondary materials use and expand markets for materials and products (U.S. EPA 2021a) (Exhibit 11).
- **Addressing risks.** Cities can use research to address certain risks that materials pose such as risk that materials will be used to fuel energy generation or risks that recyclable materials may not prove as resilient as virgin materials (e.g., recycled materials used in eco-bricks).



EXHIBIT 11 CASE STUDY



Innovative Partnership Across Argentina and Latin America Expands Recycling System

In 2019, Deltterra, a nonprofit organization, partnered with the Barrio Mugica community and 13 labor cooperatives to establish a recycling and composting program called A Todo Reciclaje (ATR). Under ATR, collection workers use QR code technology to track data on recyclable, compostable, and mixed waste. Data are used to compare performance on a weekly basis and to identify solutions for any challenges that arise. Since the program's inception, Barrio Mugica has achieved the highest recycling rates in the city.

The program then expanded its efforts to the city of Olavarría, where the formal recycling rate was less than 1 percent. Here, Deltterra established the Gestión Integral de Residuos de Olavarría program to create a replicable, economically sustainable and inclusive model for solid waste management in Argentina. Deltterra has collaborated with supply-chain partners to address the challenges of recycling along the entire value chain.

After achieving success in Barrio Mugica and Olavarría, Deltterra is expanding its partnership with Red Innovación Local, a network of more than 280 Argentine cities. Deltterra's partnerships with Barrio Mugica, Olavarría, and this network are helping to lay the groundwork for a reliable and ethical supply chain for companies seeking to source recycled material. These efforts are helping Argentina transition to a circular economy.

For more information, visit [Deltterra's website](#) and [Transforming recycling in communities in Latin America with Deltterra](#).





CASE IN POINT



Using Artificial Intelligence to Improve Job Quality and Recycling Markets

In India, *Kabadiwalla Connect* uses AI to connect waste collectors with recycling facilities. By using data and mapping, clear market information is provided to informal sector workers to help track and plan where to collect materials. This reduces the need for waste pickers to forage through dumpsites and results in higher-quality materials that are sold to end-markets.

For more information, visit [Solutions for Youth](#).

4.4. Strengthening Domestic Policies and Market Development ✓

National and sub-national governments can help drive the demand side of recycling markets through sustainable public procurement policies. Key factors to consider when designing domestic policies include:

- Targeting the closure of leakage pathways of materials into the environment;
- Incentivizing recycling and sorting at the source; and
- Restraining demand and designing for circularity of a material [OECD Undated (a)].

These factors can help increase the volume and quality of materials that can be recycled and sold to end-markets.

Cities can strengthen and promote domestic market development by:

- **Conducting market development workshops.** Cities can bring stakeholders together by coordinating market development workshops to discuss current markets for recycled materials, understand ways these markets can be strengthened, and to identify other potential markets for recycled materials. Initially, cities can start identifying and mapping recyclers in their local market, recognize them through a registration mechanism, and thereafter bring them together for support. This support should be reciprocal, and recyclers should also be shown the advantage of linkages. Market development workshops can also provide an opportunity

for cities to educate stakeholders on the value of secondary materials. Market development workshops can be effective at the local, national, and regional levels (U.S. EPA 2021a).

- **Education and outreach.** Cities can provide educational materials to community members that inform communities about and provide basic market development materials, explain the importance of recycling and the economic benefits associated with recycled materials, and identify local market development challenges. An effective way to promote these materials is through a market development toolkit, where all necessary resources are compiled into one reference or source (U.S. EPA 2021a).
- **Increasing awareness of recycled materials.** Cities can increase awareness of available recycled materials among industries throughout the region through compounder or raw material sellers. Manufacturers may only look to local markets for recycled material feedstock and may not be aware of available recycled material feedstock throughout the broader region. Cities may issue certificates to traders or recyclers that purchase recycled dry waste from their regions. By increasing awareness of available recycled material feedstock, manufacturers can take advantage of the available supply and develop infrastructure in areas with a consistent supply of feedstock (U.S. EPA 2021a). Cities can also intervene by developing and promoting awareness about recycling parks or industrial clusters that are only for recyclers and by offering financial benefits or access to the city waste stream for its users.



- **Expanding to smaller or more remote jurisdictions.** Cities can build recycling market opportunities by expanding to smaller jurisdictions that may not currently have access to the same recycling markets in cities. This is an effective way to stimulate local job growth, form regional partnerships, and enable new markets for recycled materials to form and become more attractive to private sector investors (U.S. EPA 2021a).

4.5. Encouraging International Cooperation ✓

Cities can work together with nearby cities or neighboring countries to develop regional partnerships and action plans that promote a circular economy [OECD Undated (a)]. For example, the Association of Southeast Asian Nations (ASEAN) launched the ASEAN Regional Action Plan for Combating Marine Debris in the ASEAN Member States (2021 – 2025) supported by member national governments and donor partners such as GIZ and USAID. The Regional Action Plan is focused on reducing plastic usage, enhancing collection, and minimizing leakage, as well as creating value from waste. The Regional Action Plan provides guidelines for countries to help reduce or phase out certain single-use plastics, harmonize regional policies on recycling and plastics packaging standards, and strengthen regional measurement and monitoring of marine litter (The World Bank 2021).



EXHIBIT 12 CASE STUDY



National Policies that Promote Recycling in India: Extended Producer Responsibility

India’s EPR framework seeks to promote the concept of circularity. Plastics were recently included through the amended Plastic Waste Management Rules of 2022, introduced in February 2022. Under the rules, producers, importers of plastic packaging, and brand owners are made accountable (termed “obligated entities”) for managing the end packaging waste. The EPR framework mandates annual targets for collection, reuse, and recycling of plastic packaging for each obligated entity. The rules clearly classify eligible plastics as rigid, flexible (single or multi-layer of plastic), MLP (at least one layer of plastic and one layer other than plastic), or plastic sheet or similar used for packaging. A similar framework has been introduced for waste streams including tires, batteries, and electronic waste.

For more information, visit [India's EPR Guidelines](#).



CASE IN POINT



Setting a Global Recycling Initiative in Africa

An estimated US\$8 billion is lost in Africa due to unrecovered recyclable materials. One estimate projects this value to increase to up to US\$60 billion by 2050. To help address this lost revenue, Egypt announced a global initiative, called “50 by 2050,” at the Conference of the Parties 27 (CoP27). The initiative aims to improve the recycling rate in Africa from 10 percent to 50 percent by 2050. This initiative is the first holistic approach for the African continent to address all waste types and offers a collaborative platform for all stakeholders involved in waste management to contribute. Egypt’s announcement was the first time in CoP history that waste was put on the map as a global climate strategy.

For more information, visit the [Global Waste Initiative 50 by 2050](#).



4.6. Improving the quality and quantity of recycled materials ✓

Improving the quality and quantity of recycled materials is key to a successful recycling market. Higher-quality materials have a higher economic value. Increasing the quantity of recycled materials allows for more materials to be sold to end-markets. Common strategies to improve the quality and quantity of recycled materials include:

- **Collecting general data.** Collecting as much data as possible is a critical step to understanding the waste stream and informing key decision making about where to focus or prioritize investment and policies. Key data points to collect include:
 - Estimated tonnages of generated materials
 - Estimated tonnages of recycled materials
 - Estimated tonnages of recycled materials received at MRFs and other recycling facilities
 - Estimated tonnages or proportions of source-separated weight, ensuring quality and quantity of recyclables
- **Conducting a baseline assessment.** A baseline assessment to understand the types and applications of materials in the waste stream and monitor the flow of waste is a critical first step in creating recycling markets. It is important to understand and identify areas of concern, including products, businesses, sectors, and each step of the recycling system, before deciding to create a recycling market. For more information, refer to **Section 7 – Waste Characterization** of the [Guide](#).
- **Identifying products in the waste stream and analyzing the end-markets for those materials.** Cities can conduct analyses to understand the composition and volume of waste streams. Waste streams can vary by generation source (e.g., residential, commercial, institutional, and industrial). For example, the commercial sector may have a higher percentage of paper materials than the residential sector. Understanding the composition and volume of waste can establish a baseline to understand the types of materials in each waste stream and evaluate contamination of the waste stream. By establishing a baseline, cities can understand if the waste stream is comprised of primarily recyclable or non-recyclable materials.

Analyzing contamination of the waste stream can help authorities tailor solutions for expanded sorting infrastructure and technology or enhanced educational campaigns. It can also help authorities make educated assumptions about future recycling and waste management needs, and plan appropriately for those needs (Climate & Clean Air Coalition [CCAC] 2018). It is important to assess current end-market trends for a material, as well as the immediate past trends and near future projections (U.S. EPA 1993).
- **Implementing educational campaigns.** Cities can offer educational campaigns, instructional literature, and other communications such as TV and radio announcements about proper recycling practices or economic incentive opportunities. These may lead to lower contamination of recycled materials, thus increasing their value (OECD 2018).
- **Investing in infrastructure and technology.** Cities can increase participation and the volume of recycled materials by increasing the availability of suitable recycling infrastructure. Infrastructure can also lead to a less-contaminated recycling system with the right sorting technology (OECD 2018).
- **Manually sorting recycled materials.** Labor-intensive options such as manual sorting offer a low-cost, labor-effective way to increase the quality and quantity of recycled materials (McKinsey & Company 2022). In places where there is high unemployment, such labor-intensive activities can provide a wide range of jobs. In many places this will be more appropriate than expensive sorting technology.



4.7. Attracting investments for the recycling industry ✓

Successful recycling markets require investments into all parts of the recycling system including collection, sorting, and processing of solid waste. Investing in all parts of the recycling system can increase the volume of recycled materials collected, and the quality of materials recycled and sold to end-markets. Common best practices for attracting investments include:

- **Conducting a baseline assessment.** Cities can conduct a baseline assessment to better understand current investments in the recycling system and to identify potential areas that require investment. For example, during a baseline assessment, a city may notice that collection efforts are well funded, but funding for sorting efforts after materials are collected may be lacking. A city could then focus on attracting investments for sorting efforts to enhance the quality of recycled materials.
- **Identifying sources of funding.** Cities can consider various sources of funding, both internal and external. Common sources for funding include:
 - **One-time funding mechanisms**, such as:
 - **Local revenue sources**, including taxes, tariffs, and services charges.
 - **Local and national operating budgets**, including budget funds and subsidies.
 - **Long-term funding mechanisms**, such as:
 - **Grants**, including from national governments, financial institutions, and foundations.
 - **Results-based financing**, including linkages of payment for services to the achievement and verification of pre-agreed outcomes or targets.
 - **Public-private partnerships**, including cooperative agreements between the public and private sector.
 - **Bonds**, including bonds that cities can sell to institutions or individuals with a promise to pay back the bonds' value and interest at specified intervals. These are less common in some developing countries with high levels of debt.
 - **Loans**, including from financial institutions or banks that have fixed repayment rates over a set period.
- For more information, refer to **Section 6 – Economic Considerations** in the [Guide](#).



MR. GREEN AFRICA

CASE IN POINT



Empowering the Informal Sector Leads to Investment in Africa

Mr. Green Africa was the first recycling company to be a Certified B Corporation on the African continent. The company collects and recycles plastics by integrating informal waste workers, micro-entrepreneurs, and consumers into a formal value chain. This approach helps increase the volume of post-consumer plastic waste collected and offers stakeholders an opportunity to earn a fair and transparent income. Clients of Mr. Green Africa have been able to achieve their targets for using recycled materials in manufacturing due to the high-quality feedstock collected by the company. Due to the company's approach to achieve high-quality feedstock while contributing to a just and equitable supply chain, Mr. Green Africa has been successful in attracting investors (USAID 2022). For example, the Global Innovation Fund has invested US\$1 million in equity and debt due to Mr. Green Africa's efforts to integrate the informal waste sector into their model [Global Innovation Fund Undated].

For more information, see [Investing in Waste Management and Recycling with a Gender Lens and the Global Innovation Fund](#).



- **Creating a common marketplace for feedstock and products.** Cities can offer more supply and demand security for recyclers by creating a common marketplace for both raw materials and recycled materials (McKinsey & Company 2020). For example, the Circular Plastics Alliance is comprised of more than 300 organizations across the plastics value chain committed to boosting the European Union market for recycled plastics to more than 11 million tons [European Commission Undated].
- **Creating an investment-friendly environment.** Cities can create an investment-friendly environment by increasing collection and separation efforts that reduce contamination. Educating and empowering consumers to properly separate and dispose of their waste can help reduce contamination of recyclable materials and provide recyclers with higher-value materials. Technology such as artificial intelligence (AI) and higher-quality washing systems can help increase the value of recycled materials (McKinsey & Company 2020). Refer to Case in Point: Using AI to Improve Job Quality and Recycling Markets for an example of how AI can be used.
- **Integrating gender and the informal waste sector.** Gender and informal sector workers are important considerations as they are key to increasing volumes of recycled materials. Cities can integrate gender and informal sector workers in the recycling system to attract investors that share a common mission to improve the livelihoods of these groups (USAID 2022). Cities can help support self-help groups, spaces for informal sector workers to be integrated, and social security and insurance schemes. Public sector bodies can also influence private sector inclusion of informal waste collectors through procurement specifications.

A strong and effective legal, policy, and institutional framework, as well as political and economic stability, offer an investment-friendly environment. By creating an investment-friendly environment, cities allow for increased business development opportunities (UNIDO 2019).



Section 5

Organics Recycling

Section 10 – Organic Waste of the [Guide](#) provides an overview of the benefits of organic diversion and best practices for organic waste management options, including organics recycling through composting, anaerobic digestion (AD), and animal or livestock feed. The United States Environmental Protection Agency’s Food Recovery Hierarchy ranks the prioritized actions to prevent and divert waste food. This hierarchy includes the following management practices, ranking from most preferred to least preferred: source reduction, feeding hungry people, feeding animals, industrial uses, composting, and landfill or incineration (U.S. EPA 2022). For more information, refer to **Section 10 – Organic Waste Management** of the [Guide](#).

- **Composting** is the controlled decomposition of organic materials in the presence of oxygen. The use of compost enriches soil, helps retain moisture, suppresses plant diseases and pests, and reduces the need for chemical fertilizers (U.S. EPA 2020c). Composting requires three general steps:
 - Combining organic waste types, such as wasted food, yard trimmings, and manure
 - Adding wood chips, shredded paper, or other bulking agents to accelerate the breakdown of organic waste
 - Allowing the compost to stabilize and mature through a curing process (U.S. EPA 2015)

- **AD** is a process through which bacteria break down organic matter—such as animal manure, wastewater biosolids, and food wastes—in the absence of oxygen [U.S. EPA Undated(a)]. The products of the AD process include biogas, an energy source that contains mostly methane and carbon dioxide, and digestate. Digestate is the material that is leftover after organic materials are anaerobically digested. Digestate is rich in nutrients and can be used as fertilizer for crops (U.S. EPA 2020c). AD minimizes odor, reduces pathogens and solid waste, and produces gas and digested materials (both wet and dry) that can be used for various applications (U.S. EPA 2020c).

When deciding which management practice or practices to use for organic waste, it is important to understand the tradeoffs of each management practice and inputs. For example, composting is a more financially feasible system than AD, and agricultural waste or market waste is often a less contaminated feedstock input than household or restaurant food waste (CCAC 2016).



KEY POINT

Defining Types of Recyclable Waste Around the World

Wastes such as food waste, green waste, and yard waste are defined using terms such as organic waste, biowaste, or wet waste, whereas recyclables such as plastics, metals, and papers are commonly referred to as dry waste in the international waste community.



5.1. Challenges

Cities face many challenges when developing markets for organics, including:

- **Low feedstock quality.** The types of organic waste that are used for biogas production through AD can have a drastic impact on the quality of the product. Foods that are easily digestible convert into volatile fatty acids, which can introduce bigger challenges down the line in the biogas production process (Xu et al. 2017). This causes recyclers to use waste that has low organic loading rates to ensure there are no contaminants in the mix.
- **Limited supply of feedstock.** The stock of waste available to organics recyclers is often limited. With the current market, AD may have reached a tipping point at which the demand for feedstock has surpassed the supply (Baddeley 2014).
- **High costs of contamination.** To meet legislative standards and regulation levels, organic waste goes through a treatment process, such as removing plastic packaging, which can be costly to the processors or recycler and increase daily operating costs, both of which could outweigh the profits. This treatment is necessary to ensure no dry waste is present in the wet waste (CCAC 2016).
- **High costs of technology and infrastructure.** Investing in technologies for AD for biogas production can come at a high cost. Certain organic wastes such as pre-consumer food wastes that are composed of inorganic compounds might not be compatible with other wastes for AD processes, which could require a recycler to invest in separate machinery to digest the other materials (Xu et al. 2017).
- **Operational challenges.** These challenges include long-term contracts; slurry, which can cause damage to the environment if not managed properly; climate factors; space constraints; and transport requirements.
- **Limited off-take markets for end-products.** The limited off-take markets for end-products present a challenge because the amount of end-products produced may exceed the demand, leaving organic waste recyclers with excess product.



KEY POINT

International Agreements - Global Methane Pledge

In 2021, the United States and European Union launched the Global Methane Pledge (GMP), inviting countries to collectively reduce global methane emissions by at least 30 percent from 2020 levels by 2030. Over 150 countries have committed to the pledge [Global Methane Pledge Undated].

Waste is responsible for approximately 20 percent of global methane emissions from human activities. Under the GMP, the GMP Waste Pathway was launched to focus on reducing emissions across the solid waste value chain. As a result, a Food Waste Management Accelerator is helping to develop methane mitigation projects in 10 countries, the Global Food Banking Network is launching a new effort to quantify and track food banking methane mitigation, the Inter-American Development Bank project #SinDesperdicio is creating projects to reduce food loss, and a new USAID Food Loss and Waste Partnerships Facility will scale efforts in six countries (U.S. Department of State 2022).



5.2. Best Practices

This section describes best practices for improving markets for organic materials, including animal or livestock feed, compost, biogas, and digestate. Common strategies to consider include:

Animal or Livestock Feed

- **Turning food scraps and waste into proper feed for agricultural operations.** Food scraps and waste can be diverted to feed animals. This can be a beneficial way for farmers to save money on purchasing food for livestock (Leib et al. 2016).
- **Forming partnerships with food waste generators and livestock growers.** Developing partnerships between food waste generators and livestock growers can create a mutually beneficial system where food waste generators can supply livestock growers with feedstock that would otherwise be disposed of at landfills or through incineration. This can also decrease disposal costs because fewer food scraps are sent to landfills (Leib et al. 2016).
- **Promote the environmental benefits of using food scraps as animal or livestock feed.** Using food scraps as animal feed offers environmental benefits such as decreasing the amount of energy, water, and other resources typically required to grow crops to feed animals or livestock, and decreases the amount of land necessary to grow such food. By diverting food scraps from the landfill, less methane will be emitted from the decomposition of food (Leib et al. 2016).
- **Understand any laws about feeding animals or livestock.** Cities or countries may have different laws surrounding feeding animals or livestock. Learning about potential food bans or required licenses is a critical step to take before deciding to implement an animal or livestock feed program.
- **Utilizing Black Soldier Fly larvae.** Black Soldier Fly larvae are fed on food waste and then used for animal feed and in aquaculture (CCAC 2022).

Compost and Digestate

- **Identifying customers and perception.** Consider all potential customers and their needs and willingness to pay for compost and digestate. Common customers of compost include conventional farmers, organic farmers, residents, landscapers and developers, public entities, and plant nurseries (CCAC 2016). By understanding the potential customers, cities can plan for customers' end-product requirements such as compost grade, nutritional requirements, and purchasing patterns (e.g., timing, frequency). The demand of customers may also be influenced by seasonal patterns (CCAC 2016).

To address customer perception, it is important to consider the quality of compost. If the quality of the compost is low, there will not be a market for it. Consider following international guidelines or standards to ensure quality compost. For example, American Society for Testing and Materials (ASTM) D5975-17: Standard Test Method For Determining The Stability Of Compost By Measuring Oxygen Consumption is an international standard that can help composters understand if the organic material can be used for its intended purpose (ASTM 2017).

- **Promoting and incentivizing high quality end-products.** Consider customer perceptions when strategizing on the market for end-products like compost and digestate. Compost and digestate offers various benefits compared to alternative products such chemical fertilizers, animal waste, mulch, and peat moss. Benefits include:
 - **Nutrient restoration**, including nitrogen, potassium, and phosphorus (CCAC 2016).
 - **Land conditioning**, including replenishing depleted soil; supporting root growth, soil aeration, and microorganism growth; and balancing soil acidity (CCAC 2016).
 - **Moisture management**, including improved land drainage and water retention (CCAC 2016).





CASE IN POINT



GOBAR-Dhan Scheme

The Galvanizing Organic Bio-Agro Resources (GOBAR-Dhan) scheme in India is an initiative by the Department of Drinking Water and Sanitation, Government of India launched in 2018 and aims to support the rural areas and villages in managing their biodegradable, agricultural, and cattle waste. The department supports every district in India by providing both technical and financial support of 50 Indian Rupees to achieve effective management of cattle/biodegradable waste and convert it into biogas and organic manure. This financial support is used to create infrastructure that the community itself will use, own, operate, and manage.

A total of 583 plants are presently working in about 151 districts in India under this scheme. There are close to another 175 plants under construction [GOBAR-Dhan Undated].

For more information, see the [case study on Safe Management of Cattle and Other Biodegradable Waste](#).

- **Erosion control and re-vegetation**, including replacing lost soil due to erosion and preventing further erosion by absorbing water (CCAC 2016).
- **Filtration**, including improving water quality by filtering out heavy metals, grease, and fuel when applied as a lining (CCAC 2016).
- **Public health benefits**, because compost does not pose any physical illness if processed properly, unlike chemical fertilizers (CCAC 2016).
- **Waste reduction and environmental benefits**, including reduced reliance on chemical fertilizers and decreased methane emissions by diverting organic waste from landfills (CCAC 2016).
- **Identifying distribution methods**. Cities have various ways to distribute compost, including on-site usage or sales, or through secondary channels such as local retailers and bulk wholesalers. Customers may have different distribution needs. For example, local farmers who purchase compost on-site reduce transportation costs. Identifying the most effective distribution method for customers can increase demand for compost (CCAC 2016).
- **Economic considerations**, such as collection and transportation costs and markets. Cities can consider the various costs associated with composting including sourcing feedstock (collection and transport); operations and maintenance; and end-product storage, marketing, and transportation. Understanding where organic waste is generated can help cities strategize how to collect and transport in cost-effective ways. For example, if there is a centralized marketplace that produces a high volume of organic waste, it would be financially beneficial to have a communal collection point for organic waste located nearby to reduce collection and transportation costs. To help protect against variations in demand, cities can engage with customers to understand purchasing patterns and conduct financial forecasts. This can be an effective way to protect against the volatility of compost markets (CCAC 2016). For more information, refer to **Section 9 – Separation, Collection, and Transportation** of the [Guide](#).

Cities can emphasize the benefits of using compost and incentivize customers to buy compost to increase the demand for high-quality compost.

- **Establishing quality standards**. Cities can establish quality standards to ensure that the compost does not contain any contaminants, such as plastics, heavy metals, or disease vectors and is viable for plant growth conditions. This can help consumers feel comfortable that they are buying quality compost (CCAC 2016).



Biogas and Digestate

- **Identifying end uses.** Cities can tailor marketing efforts based on the current or potential demand for biogas and digestate. Biogas can be used for a variety of end-uses including for cooking, electricity, heating, conversion into biomethane (after purification) for injection into the gas distribution grid, or use as renewable transport fuel. Digestate can be used on agricultural land or used as bedding material for urban landscaping projects, for home gardens, or in horticulture or forestry (World Biogas Association 2018).
- **Promote the benefits of using biogas or digestate.** Cities can promote the benefits of using biogas and digestate as a means of increasing demand for the products (Exhibit 13). Biogas offers a wide range of end uses, such as thermal applications, power generation, industrial applications, biomethane injection, or for vehicle fuels (U.S. EPA 2014). Digestate offers rich micro-organisms, carbon, micronutrients, and other nutrients including nitrogen, phosphate, potash, calcium, magnesium and sulfur. Digestate also can increase crop yield and reduce the use of chemical fertilizers (World Biogas Association 2018).
- **Understanding the varying market value.** The market value of digestate varies based on the type of feedstock and digestion processed used to produce it. The dry matter percentage, pH level, and nutrient contents vary based on how the digestate was produced. Cities can market various types of digestate to attract a variety of end-users (World Biogas Association 2018).
- **Participating in certification schemes.** Cities can leverage certification schemes to enhance marketability and promote quality end-products. Certification schemes can reduce contamination, providing cities with higher-quality end-products (World Biogas Association 2018).
- **Incentivizing renewable energy.** Cities can incentivize the use of biogas to increase supply and demand. Common incentives include:
 - **Structured payments**, including payments that require energy companies to invest in biogas technology, which can create additional supply of biogas.
 - **Minimum renewable energy standards**, including mechanisms that require energy generators to source a minimum percentage of energy from biogas (World Biogas Association 2018).
 - **Renewable Energy Certificates**, including mechanisms that offer credits for renewable energy generation (U.S. EPA 2014).

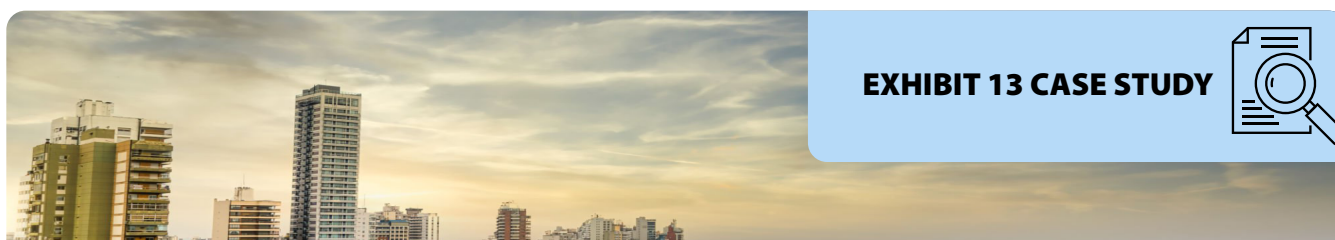


EXHIBIT 13 CASE STUDY



Biowaste Recycling and End-market Development in Chile

The *Reciclo Orgánicos* program is implemented by the Ministry of the Environment and Climate Change of Canada and Environment Ministry of Chile and executed by Arcadis Canada with support from Arcadis Chile and ImplementaSur. Approximately 58 percent of municipal solid waste in Chile is organic and heavily contributes to greenhouse gas emissions upon decomposing in landfills. The program seeks to reduce greenhouse gas emissions from organic waste by diverting it from disposal and into composting or AD, and by capturing and utilizing landfill gas at existing disposal sites. The program is estimated to reduce greenhouse gas emissions from the waste sector by 70 percent.

For more information, visit the [Arcadis website](#).



Questions for Decision-Makers

- What materials are currently collected in the city? Are there additional materials that could be collected for recycling?
- How can the contamination of materials be minimized?
- What educational or outreach campaigns has the city conducted to increase awareness that recycled materials hold economic value if managed properly?
- Has the city considered both domestic and international markets when developing the recycling system?
- How has the city worked with the private sector? How can the city work in public-private partnerships for enabling effective recycling markets?
- What role does the informal sector play in the delivery of recycling services?
- How might the formalizing of recycling services impact the livelihood of the informal sector?
- Does the city have data as to how much recycled material is available to supply end-users? If yes, are there any gaps in the demand for certain materials?



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