

CIRCULAR CITIES

The Six Dimensions of Circular Waste Management

FOREWORD

The ways in which cities and communities collect and dispose of their waste affect everyone. On top of struggling with poorly functioning waste management systems and mismanaged, overflowing landfills, cities across the globe are facing public health, environmental, and climate challenges due to waste. Air and water pollution from mismanagement of waste puts local communities at risk of toxin exposure or air quality concerns.¹ Landfills and informal burning contribute to climate change.^{2,3} 11 million tons of plastic enter the ocean annually⁴.

Yet, this picture could look very different. By keeping waste streams separate, properly processing organics like food and garden waste, and sorting and selling dry recyclables like plastic, paper and metals, cities could be putting much of their waste back into productive supply chains and reducing the need for energy intensive virgin materials. But most cities don't know where to start. This is the challenge that we designed Delterra's Rethinking Recycling program to tackle.

This report is the synthesis from four years of Delterra's extensive learning and on-the-ground experimentation in Asia and Latin America. We have codified these learnings in our Six Dimensions of Integrated Waste Management Framework, which we are excited to provide as open-source knowledge for all who are working around the globe to create circular waste management and recycling systems.

This journey began before the founding of Delterra with the launch of Rethinking Recycling in 2019 – then housed in McKinsey.org, the private foundation of McKinsey & Company – as an investigation into how to help cities in the Global South to rapidly increase the amount of their waste recycled back into productive use. After extensive research and field studies, our insight was that many wonderful organizations are working along different points of the waste value-chain, but no one is orchestrating a holistic, system-change approach. Rethinking Recycling was conceived with this goal in mind – to build a replicable model that ensures both a reliable, ethical supply of clean, high quality recycled material, and consistent demand for that material at a fair price.

Work like this cannot be delivered by any one organization. This is the result of a great deal of passion and hard work over the years by Delterra employees, community leaders, residents and waste workers, as well as our government, non-profit and private sector partners. We are grateful to them all for joining us on this journey and we look forward to continuing to learn together in the coming years as we further refine our thinking and scale to new cities and countries.

Please let us know what you think. This should not be treated as a static model – we will continue to refine it as we learn with and from others. If you think we have missed something – let us know!

On behalf of the entire Delterra team,



Shannon Bouton

President & CEO





TODAY, THE WORLD'S CITIES ARE DROWNING IN WASTE...

Overflowing landfills and unmanaged waste are causing public health problems and contaminating our land, air, and water – yet we continue to produce more waste than ever.⁵

On land, disposal of waste in landfills contributes to contamination of soil, exposing community members to toxic chemicals and heavy metals.⁶ In the air, burning of waste releases chemicals like mercury and contributes to a growing number of premature deaths globally from air pollution.⁷ In waterways such as canals and rivers, dumping of waste contributes to urban flooding, putting community members' lives and property at risk.⁸ These challenges represent only a subset of the consequences of our waste crisis experienced by communities across the world, yet shed light on what the future holds if swift action is not taken. As concerns grow for the health and safety of the environment and local communities, cities are looking for solutions.

In response to increasing public awareness of the waste challenge, companies and policymakers are making commitments to support the transition to a circular economy. In the corporate environment, businesses are making efforts to redesign packaging and increase recycled content in their products.⁹ From a policy perspective, regulators across the world are taking action to minimize plastic pollution and ensure minimum thresholds for usage of recycled materials.¹⁰ While these changes are beginning to generate unprecedented demand for recycled material, the global recycling and waste management system is not fully prepared to meet this demand.¹¹

However, cities around the world are rising to the challenge and prioritizing their transition from a linear to a circular economy.

Instead of moving in a straight line from production to consumption to disposal, a circular economy involves a loop where, in addition to reducing overall consumption, production materials come from what would otherwise be waste. Ideally, once materials enter this loop, they stay within the ecosystem for as long as possible, rather than adding to the dual problems of extracting more resources and managing waste. Although moving towards a circular economy requires coordinated action from stakeholders across society, cities have a unique opportunity to make strides towards circularity through their waste management systems.

But what specifically can cities do to improve waste management performance so they can close the loop and move towards a more circular economy?

To better understand how communities handle waste today and what it takes to holistically transform these systems, Delterra drew on creative solutions from around the world and partnered with local communities in Argentina and Indonesia to test system-level solutions. Together with our partners, we have tested and refined the core dimensions of successful integrated waste management. In this report, you will find deep dives on each of the Six Dimensions of Integrated Waste Management, supported by case studies from Delterra's work and other relevant work globally.

THE SIX DIMENSIONS OF INTEGRATED WASTE MANAGEMENT



GENERATION & SOURCE SEPARATION

- **Provision of information** to encourage recycling, educate and drive behavior change, and communicate impact
- Effectiveness of **citizen participation campaigns**
- Targeted efforts to promote **large generator** source separation



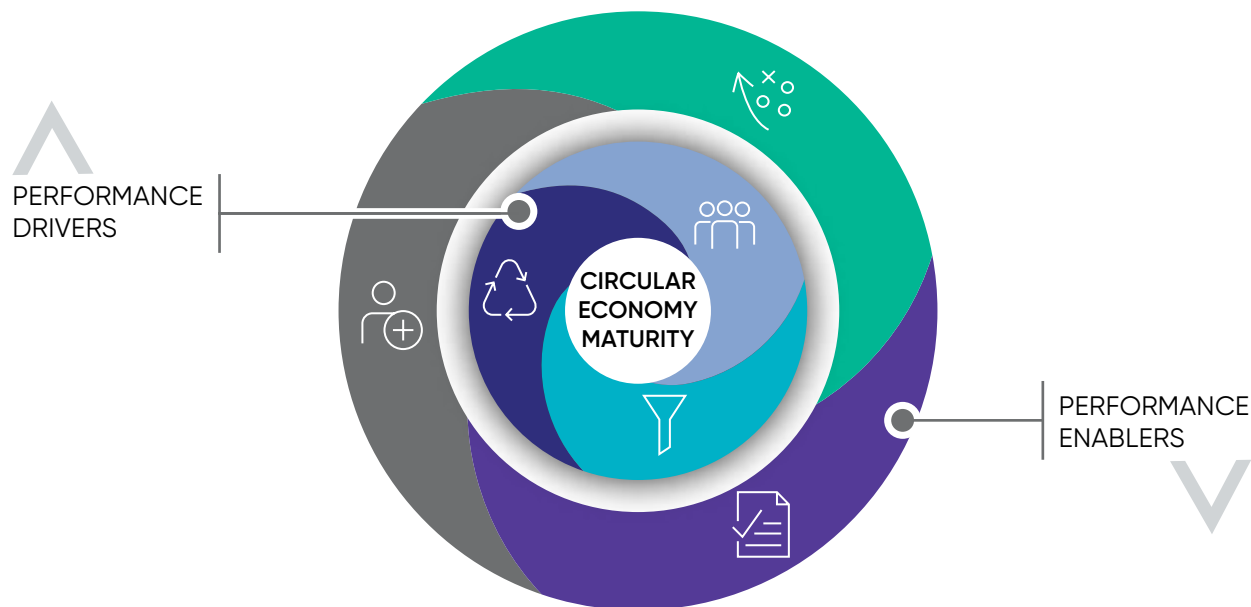
COLLECTION, SORTING & TREATMENT

- Waste **collection** coverage of citizens & large generators
- Efficiency of **collection routing**
- **Sorting** infrastructure capacity and productivity
- Facilities that allow for **safe and environmentally sound disposal** of waste (including landfilling)
- **Tracking and monitoring** of waste flows



OFFTAKE & MARKET DEMAND

- **Offtake** of compostable and recyclable materials and/or partnerships to benefit from them
- **Public-Private Partnerships** to strengthen and stabilize the demand for materials
- Adoption of **emission standards**



STRATEGY & BUDGET

- **Vision & strategy** to boost circular economy
- Granular insight in **waste management cost and revenue** drivers and opportunities
- **Financial means** to achieve targets
- Adoption of **technological solutions**
- Regular **waste characterization studies**



POLICIES & REGULATIONS

- Adoption of **emission standards**
- Orchestration of policies & regulations to **incentivize** the circular economy
- **Formalized collaboration** between municipality and waste workers



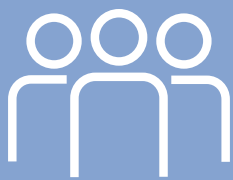
CAPABILITIES & PARTNERSHIPS

- **Dedicated circular economy KPIs** embedded in departments
- Capabilities and development of **stakeholder talent**
- Waste workers **incentivized and empowered** to improve recycling
- **Effective partnerships** with waste management company and (informal) waste workers
- **Impact tracking** and communication of results
- **Digital capabilities** to measure waste management performance and inform decision making

The inner ring of dimensions comprises **PERFORMANCE DRIVERS**, which typically involve more visible and tangible waste management practices. The outer ring of our Six Dimensions comprises **PERFORMANCE ENABLERS**, which are less tangible but form the basis for successful implementation.

To move towards a more circular model, cities must work across all dimensions concurrently and in an integrated manner. For example, it is not sufficient to work on implementing segregated collection alone (part of the generation and source separation dimension). Instead, cities must work on introducing an appropriate segregated collection system and setting up sustainable treatment infrastructure (collection, sorting and treatment dimension), establishing appropriate offtake markets for recovered materials (offtake and demand dimension), as well as developing appropriate new bylaws (policies and regulation dimension) to support segregated collection.





GENERATION & SOURCE SEPARATION

Convincing households and businesses to correctly separate their waste in accordance with local waste segregation streams (e.g., recyclable, residual and organic waste) can significantly help drive the transition to a circular economy. The generation and source separation dimension includes all communications and education efforts that take place to change waste disposal habits of community members. In cities with a less developed waste management system, efforts to target waste generators and incentivize source separation are likely minimal or non-existent, both for households and businesses. In the best examples, communities leverage multiple approaches to engage citizens, such as ongoing education campaigns or digital tool integration, which helps to instill source separation practices as a norm within the community. Furthermore, communities with mature waste management programs also rely on targeted efforts to change the behavior of 'big generators' (e.g., large businesses or community organizations), as they often generate a significant portion of the overall waste stream.

KEY ACTIONS:

- Foster a culture of empowered recyclers
- Aim for new habits, not just awareness
- Engage commercial customers differently from residents



RETHINKING RECYCLING ARGENTINA IN OLAVARRÍA

DEVELOPMENT AND RAPID TESTING OF FIVE PILOT PROGRAMS TO IMPROVE RECYCLING PARTICIPATION

SITUATION

Olavarría is a mid-size Argentinian city of around 120,000 inhabitants. It is clean, well-maintained and family-friendly, with a modern infrastructure, a very industrial culture and a small-town feel – a place where neighbors know and recognize one another. Most residents, however, were accustomed to simply leaving their mixed waste on the curb every day, with recycling rates at less than 1%. When interviewed, residents said they wanted to do their part to adopt more modern practices, but also demanded that the municipal government take responsibility for centralizing the collection of recyclables.

ACTION

Delterra, in partnership with the municipality, established GIRO, or Gestión Integral de Residuos de Olavarría (Integrated Waste Management of Olavarría). To drive recycling participation, we:

- Conducted a three-month research phase using human-centered design, and devised cultural and behavioral insights that became the backbone of our design process
- Ran a series of five behavior change pilots to identify the most effective interventions that drove participation at the best possible return on investment
- Developed a resident activation blueprint comprising top-down elements (e.g., mass media campaigns, social media outreach, community events), digital interventions (e.g., a chatbot to answer common recycling queries), and bottom-up activity (e.g., door-to-door visits, waste tags for correct and incorrect separation)
- Supported the city to draft ordinances of municipal solid waste regulations for both households and big generators, requiring them to separate their waste into three streams and dispose of each waste stream on the correct pick-up day
- Developed a monitoring and maintenance strategy to track participation levels and detect any changes in participation trends, with targeted interventions in the case that participation was to decline, ensuring high participation rates with minimal effort and resources

RESULT

Today, among the proportion of households with access to a pilot program of recycling and compost collection services, nearly 50% support the program and consistently separate their recycling (participation for compost is closer to 30%). The per household cost of achieving these results was 50% lower in the final pilot compared to our first pilot. Our work in Olavarría cuts across many of our Six Dimensions and in 2023, collection services are on track to be available to the city's full population of 120,000 people.



GLOBAL CASE STUDY: GENERATION & SOURCE

IMPROVING CITIZEN PARTICIPATION IN SAN FERNANDO, PHILIPPINES¹²

SITUATION

The City of San Fernando is one of the busiest cities in Pampanga, a province in Central Luzon, Philippines. It is divided into 35 villages or barangays and is home to more than 300,000 people, which easily quadruples during daytime.

Waste management in the Philippines is governed by a national law called the Ecological Solid Waste Management Act of 2000 or Republic Act 9003 (RA 9003), which puts the prime responsibility of waste management on the barangay, including segregation, collection, and treatment. Despite a series of trainings for the barangays and the introduction of supporting business regulation, San Fernando struggled to enforce compliance, with open waste dumping and burning remaining prevalent, and recycling rates low.

ACTION

In 2011, San Fernando formed a partnership with Mother Earth Foundation (MEF), an organization that actively promotes Zero Waste. Soon after, when the new administration, led by Mayor Edwin Santiago, took over in 2013, waste management became a key priority for the city.

- An intensive public information, education, and communication (IEC) campaign for residents was launched, including education in schools and businesses
- A novel concept was introduced: a TV show called 'Win-win for all'. The show goes live every Friday and is hosted by a local artist. Every episode, the hosts make surprise visits to unsuspecting households from the week's chosen barangay to check if they do proper waste separation, with five winners being awarded PHP 2,000 (USD 39.21) each if they pass the inspection
- A Plastic-Free Ordinance was introduced in 2014 to phase out single-use plastic bags in businesses, with enforceable penalties; this alongside the introduction of a policy of 'no separation, no collection' for households and businesses alike, has significantly reduced waste going to landfill

RESULT

The city has now covered all 35 barangays and has reported 93% compliance with recycling regulation, with 85 fully functional material recovery facilities (MRFs) located in barangays, private subdivisions, schools, health care facilities, public markets, and business establishments. As of 2018, the city's waste diversion rate rose from 12% to 81%, and they plan to increase that to 91% by 2025. Furthermore, the city only spends PHP 34.6M (USD 677,404) annually on waste diversion, compared to PHP 70M (USD 1.4M) in previous years.



COLLECTION, SORTING & TREATMENT

After waste is generated, the way it gets collected and then further sorted and treated for composting or sale into recycling markets can make a big difference. This includes how cities dispose of the waste that is not recycled or composted, such as through a managed landfill. Municipalities might implement changes in this regard such as introducing a new collection stream (e.g., recyclables or organics), adding collection locations and frequency, or improving sorting infrastructure and productivity. Running an efficient collection, sorting, and treatment operation is critical to economically producing usable recycled material or compost. The communities with the strongest waste management practices typically ensure that the system has reliability across needed technology and machinery, consistency of schedules and expectations, and sufficiency of labor force and system capacity.

KEY ACTIONS:

- Upgrade waste sorting and treatment facilities, and their operations
- Expand service coverage
- Track waste flows to optimize collection routes and monitor system inputs and outputs
- Ensure safe operation of disposal sites



RETHINKING RECYCLING INDONESIA IN DENPASAR, BALI

IMPROVING OPERATIONS OF COLLECTION AND SORTATION IN INDONESIA THROUGH AN EASY-TO-USE DIGITAL SOLUTION

SITUATION

To date, waste management operations in Bali have been largely informal and fragmented. The waste management in place today is not a broadly available public service, but is offered as a paid subscription program at the household level. System records of key metrics such as number of households serviced and volume of waste collected are seldom maintained, and if so, are done manually on paper or in notebooks. Additionally, collection and tracking of subscription payments is highly inconsistent throughout the system, with estimates as low as 30-40% of subscription payments being collected. This creates a lack of accountability and significantly impacts the revenue stability of local sorting centers – a critical factor to achieving financial sustainability. This informal system also contributes to a lack of transparency within the supply chain, ultimately deteriorating system performance and viability. Working with our partners, Delterra set out to help improve the day-to-day processes of collection and sortation in Bali.

ACTION

We wanted to offer the sorting centers in Indonesia (TP3SRs) a simple tool with a big impact – a way to digitize and standardize their data in a simple turnkey solution. To do this, we partnered with waste management company Bintix to re-design a tool they had built for sorting centers in India. Together, we customized it for our communities in both Indonesia and Argentina. Thus, our Operations Platform was born.

The Operations Platform is a simple, easy-to-use solution that improves payment collection, monitoring of waste input volumes and management of post-sorting material offtake through tracking of:

- **Financial activities:** the tool allows users (TP3SRs / sorting facilities) to monitor incoming payments from households, which combine with off-the-shelf accounting tools to ensure that sorting facilities adhere to their budgets
- **Material diversion rates:** by enabling users to track incoming volumes, as well as sorted volumes and offtake, sorting centers and local communities can understand how effectively they are diverting waste from landfills and open dumping – an important performance indicator for any sorting center
- **Offtake by material type:** following sortation, the recyclable materials are typically sold by the sorting facility to an aggregator. Using the Operations Platform, sorting centers can track what materials are sold to which offtakers, as well as prices received. This feature supports price tracking, but more importantly, sets sorting facilities up to leverage material traceability data in the future.

RESULT

Since implementation of our selected solutions, participating centers have seen significant improvements such as:

- Significant decreases in uncollected payments, with routine collection rates of 85%+ every month in multiple villages
- An estimated 70-80% of waste volumes entering the participating sorting centers are tracked through the Operations Platform, as opposed to almost zero tracking prior to the platform implementation
- Offtake volume and price tracking, enabling villages the ability to identify what recyclables are being returned to productive use, as well as monitor trends over time to support informed decision making
- Up to 9x reduction in time spent doing manual processes such as reconciling cash payments and deposits at month-end, freeing up staff capacity .



DIMENSION: COLLECTION, SORTING & TREATMENT

INNOVATIVE WASTE COLLECTION AT THE SOURCE IN VIETNAM¹³

SITUATION

The Mekong River is one of the main entry paths for marine litter, especially plastic waste, worldwide. Vietnam's Long An province, in the Mekong Delta near this river, has a majority rural population of 1.5 million people, 10% of whom live in the capital city of Tân An. The area has poor or no waste collection systems, lacking the capacity to separate, collect, and treat waste adequately, which results in the disposal of waste in unsecured dumps.

ACTION

To curb land-based marine litter, the WWF and Tân An City piloted a new collection concept that would separate and sort waste at the source:

- In August 2020, a decentralized “sorting-at-cart” method was piloted for 425 households (1,855 residents) during door-to-door collection operations. Waste collectors were provided with hand-pushed collection carts equipped with tables to sort waste during collection, with different types of waste being collected on different days of the week (i.e., organic waste on one day, dry recyclables on another, etc.)
- This “sorting-at-cart” method enabled an immediate check on sorting quality at the point of collection, greatly improving the material that ultimately gets sorted for recovery. Many cities use compactor trucks to collect recyclables, and this means that contaminated waste gets “pressed” together with well-sorted recyclables, ultimately reducing the amount of waste that can be recovered at the sorting center. With the pilot’s method of collection, recyclables that have not been well-separated do not end up in the sorting centers, which results in higher recovery rates and better working conditions for workers separating the waste
- The method leads to extensive resource recovery and high waste utilization rates, thus creating high value from the waste

RESULT

Findings in the pilot demonstrated that a labor-intensive, separated waste collection method, with immediate post-sorting led to collection and recovery rates of over 80% for organic waste, which makes up roughly half of all waste collected from households. The pilot also demonstrated the potential for a 50–65% diversion rate from landfill. The separately collected and immediately sorted recyclables were of high-grade purity and quality. Even with higher collection costs, the reduction in residual waste being disposed of at landfill led to reduced total costs due to a decrease in transportation and disposal fees.

The initial pilot was expanded to a further 4,800 households in October 2020 and to the rest of Tân An city shortly thereafter, with future plans to expand to other towns and districts.



OFFTAKE & MARKET DEMAND

Waste management success and the transition to a circular economy depend on a city's ability to put materials back to productive use. Doing so might require the city to work together with the private sector (e.g., waste management companies, processors, recyclers) and the social sector to better link the supply and demand for recyclable materials. With the increasing global focus on strengthening recycling, new opportunities have opened for cities to attract funding, expertise, and other support globally. Ensuring that there are strong and consistent offtake opportunities for recycled content enables further investment in upstream dimensions of the supply chain, thereby strengthening the full circular flow.

KEY ACTIONS:

- Secure offtake agreements for all compostable and recyclable materials recovered
- Create public-private partnerships to grow demand for recovered materials
- Support creation of ethical and transparent supply chains to help meet the needs of offtakers



RETHINKING RECYCLING ARGENTINA IN BUENOS AIRES

COORDINATING WITH VALUE CHAIN PARTNERS TO BOOST DEMAND FOR LOW-VALUE PLASTICS

SITUATION

Low-value plastics, such as packaging (PP), shopping bags (LDPE), or yogurt cups (PS), have proven challenging to recycle. In the City of Buenos Aires, these low value plastics make up 20-50% of the plastic waste collected by the city, yet the majority of that waste is sent to landfills (3,000-8,000 tons per year).

A disconnect between supply and demand lies at the root of this challenge. Due to their smaller size, lighter weight and higher level of contamination, more effort is required from waste workers to separate these materials than other plastic types. Waste workers argue that the market price for these materials does not justify their separation efforts. Meanwhile, recyclers in Greater Buenos Aires argue that they have invested in the machines and installed capacity to recycle these low value plastics yet can't find sufficient and reliable supply of materials.

ACTION

Together with our partners, the Alliance to End Plastic Waste and Amiplast (recycler for LDPE and PP), Delterra established a productivity improvement program and small incentive fund to boost the separation and transport of low-value plastics in the 16 sorting centers of the City. Our efforts targeted three key levers:

- **Address productivity bottlenecks.** In all sorting centers observed, over 80% of the waste workers are dedicated to sorting 20% of the recyclable waste in kilograms (albeit highest in \$/kg). Through our initiatives, we incentivized sorting centers to increase the number of waste workers targeting the most voluminous materials (e.g., low-value plastics) that would otherwise go to rejection waste
- **Prioritize volume over quality at the sorting center.** Through short term pilots, we tested the amount that a sorting center can collect if it maximizes volume of LDPE and PP over cleanliness or quality. To enable maximum recovery of these materials, a team of polymer experts from the recycler trained waste workers on identifying LDPE and PP, improving their sortation effectiveness.
- **Trace data from collection to recycling.** Together with Empower.eco, we introduced a digital solution to trace data from the collection route to the recycler. This can be shared with the brands that bring the plastics back into productive use. The blockchain system allows for two-way verification to ensure that data is accurate. Next, we will be tracking QR codes at each step to facilitate inventory management and planning

RESULT

We discovered that although price per kg of low-value plastics is lower than PET and HDPE, the volume that can be collected quickly makes up for it. At the largest sorting center in Buenos Aires, these initiatives helped boost volumes recycled by 140%, increasing from 30 to 70 tons of LDPE separated per month. At the second largest recycler, volumes increased by 50% and could have grown further if not for limited conveyor belt space. So far, we still require a financial incentive to help demand meet supply, but over time, we believe this incentive can be phased out by increased synergies of scale and efficiency.



DIMENSION: OFFTAKE & MARKET DEMAND

BUILDING AN OFFTAKE MARKET FOR ELECTRONIC WASTE IN BRAZIL¹⁴

SITUATION

In 2019, Brazil was identified as the fifth largest producer of electronic waste globally, producing more than two million tons of electronic waste per year. At that time, less than 3% of the electronic waste was recycled and a significant portion of the population had never heard of waste collection and disposal locations for electronic products. While there may have been a lot of waste, without the presence of offtakers, there was minimal opportunity for Brazil to divert this waste out of landfills.

ACTION

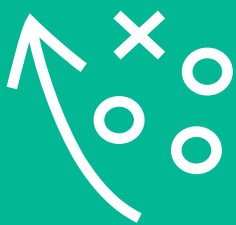
In 2020, to address this gap in the waste management system, the Brazilian federal government:

- Defined standards to enforce their existing National Policy for Solid Waste, requiring that manufacturers, importers, distributors and resellers of electronics products and their parts create and implement a reverse logistics system, allowing consumers to return their electronic waste through collection points specific for e-waste
- Passed a bill that created fiscal incentives for the recycling industry
- Created a support fund (Favorecicle) and an investment fund (ProRecicle) for recycling projects
- Instituted deductions from income taxes for money spent on recycling projects, with a limit of up to 1% of total income taxes for companies and 6% of total income taxes for individuals

In effect, the implementation of this policy and the associated economic incentives requires that companies be responsible for the waste associated with their products, thereby creating an offtake market for collected electronic waste.

RESULT

The Brazilian government has set near-term targets for this policy, aiming to have 17% of electronic products and parts collected and properly recycled by 2025. To date, more than 1,900 collection points have been installed across the country, with more sites anticipated by 2025 based on the number of inhabitants in each municipality. By 2025, more than 400 Brazilian cities will have electronic waste collection points, enabling citizens to responsibly dispose of their used electronics, thus minimizing the amount of landfill disposal needed.



STRATEGY & BUDGET

Municipalities need a long-term vision and actionable strategy to transition to a circular economy. For example, a city might develop a strategy to increase waste recovery, which might require sufficient knowledge, infrastructure capacity and personnel to pursue. This operational planning must be made in parallel to adequate financial planning, considering most waste treatment infrastructure will have a lifespan of 15–20 years. In the vast majority of Global South cities, municipal income from waste fees and other waste-related services and fines does not cover the cost of waste management, making financial planning complex. Articulating a clear strategy and budget helps to give direction to all system participants, plus can help to unlock further investment from external sources.

KEY ACTIONS:

- Define your circular economy vision
- Understand your main cost and revenue drivers
- Secure appropriate funding to achieve your goals
- Identify where new technology can help
- Update and revise your strategy and budget as your city's waste flows change



RETHINKING RECYCLING ARGENTINA IN OLAVARRÍA

*ENABLING WASTE MANAGEMENT IMPROVEMENT THROUGH DEVELOPMENT
OF A LONG-TERM STRATEGY AND BUDGET*

SITUATION	<p>Olavarría was the perfect pilot city for our initiative in Argentina due to its size, political commitment to a sustainability agenda and willingness to invest in the necessary infrastructure. We had to ensure that the way we designed the whole system – from the behavior change interventions and collection system, to the operation of the processing plants – was within the city's waste management budget and not more than they were willing to spend to implement the program.</p>
ACTION	<p>Delterra and the City of Olavarría co-designed the GIRO – Gestión Integral de Residuos de Olavarría (Integrated Waste Management of Olavarría) – program in true partnership. Some of our key strategy and budget design decisions included:</p> <ul style="list-style-type: none">• Decreasing the collection of mixed waste in the residential system from three or six times per week to two or three so that we could add a once-per-week collection of recyclables and compostables• Separating the residential and commercial systems, and proposing a big generator fee that would cover the higher proportion of waste generated, thus covering the increase in collection costs and part of the operating expenses of the sorting and composting plants• Including source-separated collection in three streams in the new waste management RFP for the city and supporting the city to draft ordinances for approval by council versus the rotating position of Mayor, ensuring the system would be embedded in the city for the long term (a waste management contract is seven to ten years and changing a city ordinance entails a complex process)• Deciding to RFP the management of the sorting and composting plants, considering the city's capabilities and willingness to operate a plant themselves. After researching different management models and visiting many plants across Argentina, we developed a checklist of requirements for the management model such as productivity, costs, environmental goals, municipal leverage, or social goals. Based on this checklist, we concluded that contracting a private operator was the best long-term solution, both for municipal financial health and for their management capabilities• Ensuring that our day-to-day work considers that every initiative we launch must eventually be led by the city staff on their own, by working closely with the local team and building capabilities and team governance in parallel
RESULT	<p>Olavarría's Municipality has launched a series of public enablers to embed GIRO principles in the waste management system, ensuring a roadmap for success and the financial balance to secure necessary resources. This set of products include the long-term sorting and composting infrastructure, the public service's contracts, and the legal tools to promote and enforce the system.</p>



DIMENSION: STRATEGY & BUDGET

A STRATEGY FOR TRANSFORMING WASTE MANAGEMENT IN CURITIBA, BRAZIL¹⁵

SITUATION

Curitiba, Brazil, experienced large population growth from 150,000 people in 1940, to almost two million today. Growth was uncoordinated and included favelas (or slums), where ~10% of the population lives. Large conventional collection trucks could not access narrow streets in the slums. The city could not afford new trucks and routes for separated collection. As this rapid growth impacted many aspects of life in Curitiba, the community worked to develop a master plan in the 1960s, which included the important aspect of waste management strategy.

ACTION

Through strong planning and long-term community engagement, Curitiba created a cohesive strategy to become the most sustainable city in Brazil. Born from this strategy, Curitiba's innovative waste management approach was launched, which included:

- Introduction of different collection routes for different streams
- 'Trash That Is Not Trash' pilot program to test trash-for-transport theory at small scale
- 'Green Exchange' behavior change program, which offers community members transport passes in exchange for collected recyclables
- Strong focus on communications and consumer education (e.g., classes and demonstrations) to support incentive programs
- Increase in collaboration with and recognition of the informal sector involved in waste management
- More material recovery facilities (MRFs) that are strategically linked to collection routes

RESULT

Today, segregated collection is available in almost the entire city, contributing to citywide recycling rates of 20%. 500,000 tons of PET flakes are produced for recycling per year. Furthermore, 40 waste cooperatives were integrated and workers are remunerated based on recycling yield, creating 2,500+ formal jobs.



POLICIES & REGULATION

Related to strategy, municipalities should consider circular economy policies (e.g., creating legal enforcement mechanisms for source separation, segregated waste collection streams) to underpin the system and support ongoing improvements. Implementing these policies may involve new regulations or more regulatory enforcement. However, municipalities have varying levels of regulatory control. Some cities may be able to pass more comprehensive waste management legislation, whereas other municipalities may be more dependent on regulation at the federal or state/provincial level. Regardless of the level where the policy is implemented, public institutions' support of a strong waste management system is a critical unlock to enabling the three performance drivers. For example, governments can leverage policy interventions to help create strong incentives for material offtake, driving demand and supporting system economics.

KEY ACTIONS:

- Establish standards to reduce GHG emissions and other environmental impacts from waste
- Orchestrate waste policies and regulations to incentivize circularity
- Ensure sufficient resourcing for enforcement and monitoring of regulations



RETHINKING RECYCLING INDONESIA IN DENPASAR, BALI

*SUPPORTING LOCAL AND REGIONAL GOVERNMENTS TO IMPLEMENT
POLICIES THAT ENABLE RECYCLING AND CIRCULARITY*

SITUATION	<p>Bali residents, tourists and organizations generate 1.6 million tons of waste per year, of which 303,000 tons is plastic (19.6% of total waste).¹⁶ Most communities in Indonesia lack access to effective waste management systems, leading to widespread dumping and burning of waste, with little to no recycling. To combat this crisis, the Indonesian government's environment agency introduced Indonesia's National Action Plan on Marine Plastic Debris, a commitment to reduce ocean plastics by 70% by 2025. Delterra partnered with village leaders and local communities to develop a meaningful waste management strategy that handles the end-to-end waste stream.</p>
ACTION	<p>Our Rethinking Recycling program catalyzes the development of business models and operations for waste management stakeholders that are necessary for the sustainable enforcement and enactment of regulations on source separation. In our pilots in Denpasar, we worked with different stakeholders such as local sorting facilities (TP3SRs), waste collectors and community educators to build waste management operations that supported existing policies on source separation and enabled access to services for more residents. We did so by:</p> <ul style="list-style-type: none">• Scaling up services to ensure that more communities have access to waste management• Building operating models that integrate existing infrastructure• Improving collection fee payment rates to ensure the operation is financially sustainable in the long run• Improving the operators' financial literacy
RESULT	<p>We have reached participation rates of up to 80% in our first cohort of six villages in Denpasar, through the combination of bottom-up education and top-down regulatory enforcement. In addition, these villages have increased their spend on waste management by 60% year on year since the program was launched. At the national level, the government has unlocked USD 7M in capital funding to build additional waste management infrastructure, as well as putting top-down pressure on local governments to speed up the transformation.</p>



DIMENSION: POLICIES & REGULATION

USING POLICY AND REGULATION TO DRIVE ZERO WASTE TARGETS IN SAN FRANCISCO¹⁷

SITUATION

San Francisco is a culturally diverse city on the west coast of the USA, with a population of over 800,000 inhabitants (as of 2021). Since the turn of the millennium, the city has been committed to an ambitious zero waste agenda.

ACTION

Regulation has played an important part in driving the city's successes in waste management:

- In 2009, the Mandatory Recycling and Composting Ordinance was passed, requiring all residents to separate recyclables, organics, and residual waste – this was the nation's first mandatory composting law and is enforced through penalties to businesses that fail to comply
- In 2018, the Commission on the Environment also adopted a resolution outlining the Department of the Environment's commitment to racial equity and announcing its Racial Equity Initiative. This transformed source separation educational outreach by redesigning materials to use images and provide Chinese, Spanish, and other language translations. Customer service is available in almost any language. Waste management services were also broadened, with a range of bin sizes and frequency of collection options being made available
- San Francisco also has a unique long-term refuse (recyclables, compostables, and residual waste) ordinance where the city sets collection rates. This ensures consistency and fair pricing in waste management services. It also provides the option for behavioral nudging. Initially, trash collection rates were set much higher than those for recycling and compostables (although rates are more comparable now)

RESULT

In 2002, San Francisco adopted a goal of 75% diversion by 2010; a goal that it exceeded two years early, soon recovering over 80% and cutting its disposal in half. In 2018, San Francisco updated its zero waste commitments to reducing solid waste generation 15% and disposal to landfill or incineration again 50% by 2030. San Francisco sends less trash to landfill than any other major US city.



CAPABILITIES & PARTNERSHIPS

Having sufficient staff and distributing talent strategically can help municipalities develop policies, enforce regulation and take other needed steps to improve waste management. Municipalities also often benefit from forming partnerships, such as resource and knowledge-sharing programs with other governments, as well as private-sector entities and civil society. In an ideal waste management system, stakeholders should have clearly defined partnership standards, with a joint strategy, and there should be a clear development pipeline of talent to sustain the system over a long-term time horizon.

KEY ACTIONS:

- Embed circular economy specific KPIs in municipal departments
- Develop circular economy capabilities across waste management stakeholders
- Incentivize and empower waste workers to keep improving the system
- Broker effective partnerships between formal and informal waste actors



RETHINKING RECYCLING ARGENTINA IN BUENOS AIRES

PARTNERING WITH INFORMAL WASTE COOPERATIVES TO INCREASE MATERIAL DIVERSION FROM LANDFILLS AND IMPROVE WAGES RECEIVED BY WORKERS

SITUATION

Most cities in Argentina have a formal waste collection service with unionized workers. In addition to this, the country has long had marginal numbers of "cartoneros", or informal waste collectors that have historically picked cardboard from street bins to sell for recycling as a means for living.

Following the 2001 economic crisis, the number of informal cartoneros working on the streets and in landfills skyrocketed. The informal workers organized themselves into cooperatives to benefit from synergies of scale and management. These cooperatives have since been able to collaborate with some local governments, for example, to expand the types of materials they pick (thereby helping some cities with recycling collection) in exchange for benefits like income subsidies and personal protective equipment.

ACTION

As part of the process of social and economic integration of Barrio Mugica into the rest of Buenos Aires, the city wanted to create initiatives to drive greater economic inclusion alongside the end goal of improving waste management and increasing recycling rates in the neighborhood. To do this, we:

- Partnered with the city and the 13 active labor cooperatives in Barrio Mugica to establish recycling and composting services
- Worked alongside the 13 cooperatives to formalize the labor conditions of waste workers in the Barrio, 67% of whom are women
- Provided training or upskilling for over 400 co-op workers in three stages to enable them to provide education on waste separation and recycling, and to deliver waste collection and sorting services for the Barrio community

RESULT

This led to the diversion of 510 tons of materials from landfills, of which, 340 tons was of recyclables (over 15% of dry recyclables generated in the area) and 170 tons was of organic materials. Workers' salaries were improved by about 10%, driven by the proceeds from the sales of recyclable materials, as well as the formalization of their employment to ensure they have health benefits and job stability.



GLOBAL CASE STUDY

PARTNERSHIPS FOR LOCAL CAPABILITY BUILDING IN SOUTH AFRICA¹⁸

SITUATION

Informal waste pickers are integral to recycling in South Africa, collecting 80–90% of post-consumer packaging and paper from the waste stream, but were not formally recognized by the municipalities. Furthermore, there was also no waste collection strategy for informal settlements. From 2015–2017, Oxfam Italia, the Ekurhuleni Metropolitan Municipality in South Africa, the City of Johannesburg and a number of other Italian and South African governmental partners embarked on a project to improve waste management in an area of Ekurhuleni, while also creating local job opportunities for unemployed people. The project focused on capacity building for the local government, as well as local waste pickers and cooperatives.

ACTION

The project piloted an improved waste management model in three areas of Tembisa, Ekurhuleni by:

- Working with partners to change a by-law which outsources waste collection to cooperatives and/or small enterprises, rather than solely establishing private provider companies
- Providing capability-building with three local cooperatives and building new infrastructure for waste collection and sorting for the cooperatives
- Capability-building with Ekurhuleni Metropolitan Municipality officials, such as improving knowledge and competencies of environmental issues, the green economy and waste management
- Increasing local community awareness of the value of recycling, both from an environmental and social point of view

RESULT

Overall, the efficacy of waste collection in Tembisa increased significantly. In the 12 months before the pilot project was introduced, the cooperatives collected 296,317 tons of waste. However, after only six months of the pilot project, the cooperatives had collected 210,009 tons of waste. Thus, the cooperatives collected more than 70% of the prior year's waste in half of the amount of time. The local municipality continues to work with Oxfam South Africa and other partners, multinationals (including Unilever), and private corporations to scale capacity building with cooperatives, among other initiatives. To date, 66 recycling cooperatives and small enterprises have been supported to establish the Ekurhuleni Waste Management Association.



SIX DIMENSIONS IN ACTION

To make the framework more actionable for cities, we developed a set of 80 indicators that span the Six Dimensions with the goal of helping cities to identify the gaps in their waste management systems. We then compiled these indicators into an aggregated “waste management index”, with five maturity levels ranging from “incipient” to “great”, to assess where cities are on their journey.

WASTE MANAGEMENT INDEX MATURITY LEVELS

INCIPIENT

Waste management in the city is largely not managed with limited coverage of collection, sorting and recycling and unmanaged dumping

EMERGING

The city has rudimentary waste management with some emerging efforts to improve the circular economy

AVERAGE

The city has basic waste management, and the circular economy is beginning to grow with basic recycling underway

GOOD

The city enjoys reliable waste management, and the circular economy is strengthening with ongoing recycling

GREAT

The city has a world-leading circular economy program with more than 40% of dry materials recycled and full-scale composting

Ultimately, defining each dimension across the various maturity levels provides cities with a clear progression path for each dimension. Furthermore, we have defined “critical path” steps for improving across each dimension. While there may be other activities that take place in each dimension, the activities outlined below have been identified as most foundational to a strong integrated waste management system, and therefore where priority attention should be directed.

SIX DIMENSION ACTIVITIES BY WASTE MANAGEMENT INDEX MATURITY LEVEL

Dimension	INCIPIENT	EMERGING	AVERAGE	GOOD	GREAT
Generation & Source Separation	<ul style="list-style-type: none"> There are no specific campaigns to promote recycling, no/little recycling by citizens 	<ul style="list-style-type: none"> Campaigns were launched, but they don't seem to have had a lasting effect on citizen behavior 	<ul style="list-style-type: none"> Awareness-raising strategies are launched, but only a minority of citizens recycle 	<ul style="list-style-type: none"> Campaigns launched less than 3 years ago and recycling rates are growing 	<ul style="list-style-type: none"> Citizen participation program in place for 3+ years and most citizens comply / show interest in recycling
Collection, Sorting, & Treatment	<ul style="list-style-type: none"> <90% of households and commercial generators have regular collection of unseparated waste No infrastructure or equipment for differentiated household or large generator collection At least 1 large unmanaged dump and several small dumps, burning waste is common practice No plans for managed landfill 	<ul style="list-style-type: none"> >90% of households and >50% of commercial generator have regular collection of non-separated waste Infrastructure and equipment are scarce, low quality or unreliable, and/or not used properly At least 1 large unmanaged dump Plans for managed landfill not yet in place 	<ul style="list-style-type: none"> >90% of households and <50% of large generators have differentiated collection of two streams Infrastructure and equipment are reliable but not used to their capacity Sanitary landfill exists, but with technical defects Unmanaged landfills on the outskirts of the city Overflow "recycling containers" with mixed waste 	<ul style="list-style-type: none"> >90% of households and >50% of commercial generators have separated collection of dry and organic materials Infrastructure and equipment are reliable and actively used Recycling containers regularly emptied but with mixed waste Effective landfill with no uncontrolled waste 	<ul style="list-style-type: none"> >90% of households and >80% of commercial generators have separate collection of dry and organic materials Reliable on-site equipment and infrastructure actively used at utilization rate of >75% Recycling containers working properly No unmanaged dumps Effective landfill and plan for a new landfill when needed
Offtake & Market Demand	<ul style="list-style-type: none"> Most sales are informal and not tracked There are no known material buyers, and no formal relationships in place 	<ul style="list-style-type: none"> There is a market for some materials Formalized relationship with known buyers and sellers 	<ul style="list-style-type: none"> Multi-year agreements between buyers and sellers in place, but without city participation Most sales are formalized, with several bases of sales 	<ul style="list-style-type: none"> There is a sustainable market for most of the materials that are recovered Regular meetings are organized at which the majority of material off-takers are represented 	<ul style="list-style-type: none"> Mature markets for all materials which contribute to operations innovation Materials can be digitally and confidentially tracked along the value chain (from collection to final buyers)
Strategy & Budget	<ul style="list-style-type: none"> No strategy or multi-year vision for the circular economy Waste characterization took place >5 years ago No specific budget, limited cost transparency 	<ul style="list-style-type: none"> No strategy or vision for the circular economy Budget for circular economy exists but is inadequate, with limited cost transparency 	<ul style="list-style-type: none"> A multi-year strategy and vision for circular economy in development Budget is regular and stable, based on high level estimates of cost factors 	<ul style="list-style-type: none"> Multi-year strategy and vision for circular economy exist, but are not yet implemented Budget is regular and stable according to specific revenues and cost estimates 	<ul style="list-style-type: none"> The multi-year strategy and vision for the circular economy exists, is implemented, and monitored regularly The budget originates from specific revenues and granular cost data
Policy & Regulation	<ul style="list-style-type: none"> No policies for the integration of the informal sector, waste segregation, large generators, or tariff systems Cooperatives / waste workers are not formally included in the city's strategy 	<ul style="list-style-type: none"> No policies for large generators and/or tariff systems, but plans to introduce them within 3 years Circular economy principles in development Approved strategy to include informal workers / co-ops 	<ul style="list-style-type: none"> Existing policies for the integration of the informal sector and/or large generators There is progress towards inclusion of informal workers / co-ops, but not fully in place 	<ul style="list-style-type: none"> Policies for the integration of the informal sector and large generators Approved participation of cooperatives / informal waste workers 	<ul style="list-style-type: none"> Existing policies for the integration of the informal sector, waste segregation, large generators, and fee systems Plan to include co-ops/waste workers is approved and the budget is agreed upon
Capabilities & Partnerships	<ul style="list-style-type: none"> No dedicated waste department No human resources strategy Co-operatives and waste workers are not involved No attention is paid to staff performance 	<ul style="list-style-type: none"> Dedicated department for waste management / circular economy No human resources strategy City oversees informal recycling Little attention is paid to staff performance 	<ul style="list-style-type: none"> Dedicated department for waste management / circular economy Formulation and implementation of the human resources strategy for the next 1-2 years City oversees informal recycling Performance of supervised but undirected staff 	<ul style="list-style-type: none"> Municipal service entity engaged in waste management / circular economy Formulation and implementation of the human resources strategy for the next 1-2 years City has formal relationship with informal waste pickers Staff performance is actively monitored and managed 	<ul style="list-style-type: none"> Independent institution for waste management / circular economy Development and implementation of human resources strategy for 3+ years Established relationship with co-operators and waste workers Staff performance is actively monitored and managed

NOTE: The full self-assessment tool for will be published on the Delterra website in Spring 2023, please visit [Delterra.org](https://delterra.org) to learn more.

RETHINKING RECYCLING ARGENTINA IN BARILOCHE

SITUATION	<p>When Delterra first began working with the city of San Carlos de Bariloche ("Bariloche") in 2021, recycling rates were less than 1%, and CNN had declared the landfill as one of the 50 largest garbage dumps globally.¹⁹ To improve the situation in Bariloche and increase circularity, we knew that our approach had to go beyond simply establishing new waste disposal sites or methods. Instead, we leveraged Delterra's integrated approach to assess and address all Six Dimensions of Integrated Waste Management.</p>
ACTION	<p>To gain understanding about the state of waste management in Bariloche, we used the Six Dimensions Assessment to:</p> <ul style="list-style-type: none"> • Diagnose the current situation through waste and cost flow analyses, site visits, performance benchmarks, community engagement and focus groups • Identify lagging dimensions with high potential for improvement and design solutions to address these areas, including: <ul style="list-style-type: none"> • Generation & Source Separation: Citizen and big generator engagement and activation campaigns • Collection, Sorting, & Treatment: Operational and infrastructure improvements, such as streamlining collection routes, introducing pruning waste collection, upgrading sorting centers and planning for a managed landfill • Capabilities & Partnerships: Establishment of formal relationships with informal waste workers
RESULT	<p>Following the pilot period for these programs, we observed clear improvement across multiple dimensions, including:</p> <ul style="list-style-type: none"> • Generation & Source Separation: Doubled recycling rates of citizens in two pilot areas, with plans to scale to up to half of Bariloche neighborhoods by end of 2023 and improve MSW recycling rates from 1% to 10%. • Collection, Sorting, & Treatment: Launched a big generator collection route that engages 20 businesses, with plans to scale collection from 60 tons per year to 600 tons per year by the end of 2024 • Collection, Sorting & Treatment: Developed a renovation and capacity expansion plan for Bariloche's sorting center to support increased material processing, with changes set to take place by mid-2023 • Capabilities & Partnerships: Official recognition of the waste worker group ARB as a cooperative, including agreement to a productivity-based contract with the city

Following the success of our pilot programs, we are now scaling these changes city-wide. While these changes are not the only actions needed, they are the critical first steps on Bariloche's path towards a "great" (and circular) integrated waste management system.

CONCLUSION

Improving waste management performance is complex and takes time. By developing the Six Dimensions of Integrated Waste Management framework, we hope to provide a practical way for cities to think about improving their overall waste management system. Examining the case studies included in this report, we have identified two tips to help cities implement the necessary changes across the Six Dimensions.

Improvements do not come for free, and many cities will need to consider where the funds for these changes will come from. One solution to this is tackling existing system inefficiencies. Interventions that address inefficiencies or financially wasteful practices can pay for themselves or even generate ongoing cost savings. For example, idle capacity in material recovery facilities (MRFs) can be put to use if more residents are activated to source separate their recyclables and organics, thereby increasing the amount of material sorted at the MRF and sold for revenue. Costly transporting and landfilling of organic waste can instead be composted and sold closer to the source. In geographies where waste management is not covered by taxes, more convenient payment options for waste collection customers can help boost revenue while also increasing customer satisfaction and recycling participation. In combination, these kinds of actions can help cover costs of implementing changes while increasing the productivity of the overall system.

There is no one size fits all in program design. As a result, it can help to pilot solutions in representative neighborhoods before rolling out to the whole city. Most interventions, even holistic ones that address multiple or all of the Six Dimensions together, can be piloted in smaller scale trials. In a more controlled setting, cities can learn what works and gather data on the impact of a particular approach before broad deployment in the community. Correcting inconsistencies across different dimensions is also more manageable at pilot scale: for example, a MRF may need to realign waste worker incentives to deliver what specific materials new offtake buyers need, or collection trucks may need more capacity as a source separation mandate goes into effect. Testing these changes at a pilot scale can validate that the program delivers the anticipated impact prior to taking on the full investment risk of a city-wide program.

As highlighted by the case studies shared, **cities that significantly increased recycling rates were able to do so by focusing on bottlenecks in particular dimensions and introducing targeted solutions based on their level of maturity.** Unfortunately, we found no “silver bullets” for cities to boost recycling rates, nor “leapfrog” solutions to skip steps. The key for any city is to identify which specific improvements create cascading benefits for the rest of the system. Over time, improvements across each of the Six Dimensions will create a well-functioning, integrated waste management system – a critical enabler for the circular economy.



As we continue to expand the number of communities we work with in our Rethinking Recycling program, we continue to hone our means of assessing waste management systems across these Six dimensions. We believe that our commitment to driving end-to-end solutions by integrating with local governments and community leaders ensures long-term success for our programs across both performance drivers and performance enablers, and is why we are uniquely positioned to drive real and long-lasting impact.



ABOUT DELTERRA

Delterra is a global environmental NGO on a mission to solve the world's most complex systemic environmental challenges—on the ground, at scale, and with urgency. Founded by McKinsey & Company, Delterra uses a systems change approach to redesign entire ecosystems by developing innovative, scalable solutions for the good of people and the planet.

Learn more at: <https://www.delterra.org> and connect with us on [LinkedIn](#) | [Facebook](#) | [Twitter](#) | [Instagram](#)

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ENDNOTES

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