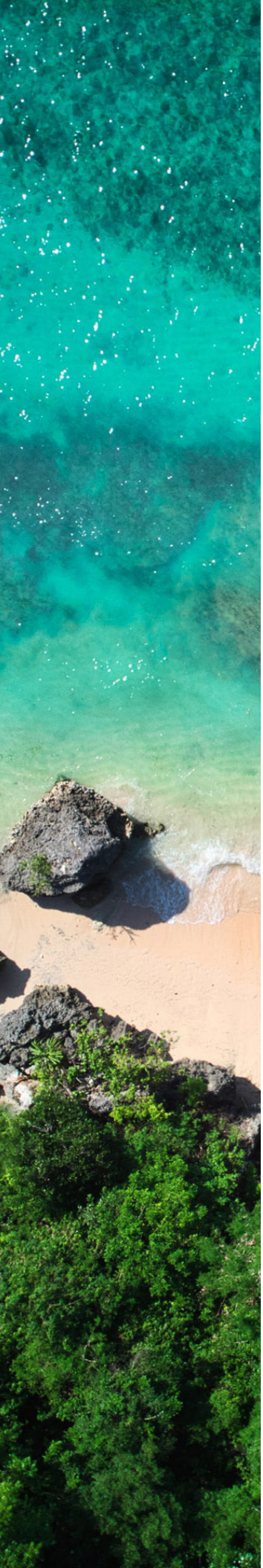
delterra

The Circulate Initiative

MAKING 'CENTS' OF RECYCLING BEHAVIOR:

THE RETURN ON INVESTMENT OF SPREADING THE RECYCLING HABIT



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Behavior Change in Rethinking Recycling Projects

EXECUTIVE SUMMARY

People's behavior has an outsized influence on the economics of recycling. As much as 80%[1] of post-consumer waste could be recycled or composted, but when people don't separate their waste at the source, most of these materials remain out of reach for the recycling industry. With the global recycling rate languishing at 16%[2], we face a pervasive supply shortage of recyclables - even as demand grows, the environmental harms of unrecycled waste worsen, and corporate recycling commitments are increasingly at risk. Activating more people to do their part is more important than ever.

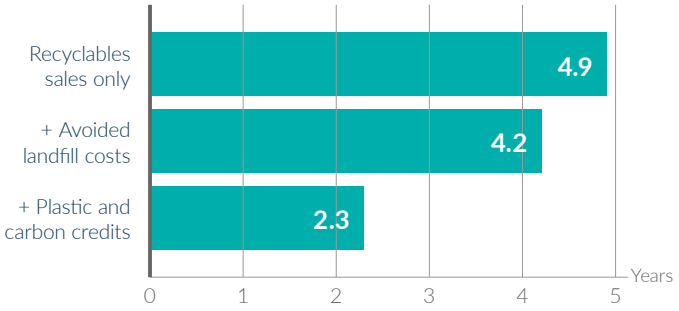
But changing behavior is hard - is it worth the cost? Analysis of Delterra's Rethinking Recycling projects in Indonesia and Argentina suggests the answer is yes. Across an informal settlement in Buenos Aires, a set of urban districts in Bali, and a mid-sized Argentinian city, we found that boosting recycling behaviors costs less than the value of the resulting new recyclables, and is more cost-effective than relying on technology to do the work. With enough smart investment at scale, community participation in recycling can reach levels high enough to support new investments in recycling infrastructure.

OUR KEY FINDINGS

#1 PROMOTING RECYCLING BEHAVIOR CAN PAY BACK QUICKLY, ESPECIALLY WHEN PRICES REFLECT ENVIRONMENTAL IMPACTS

It takes Delterra's projects 5 years to break even on behavior change based on recyclables sales alone, and only 2-4 years with landfill cost savings and environmental credits included. Putting a price on the environmental benefits of recycling matters.

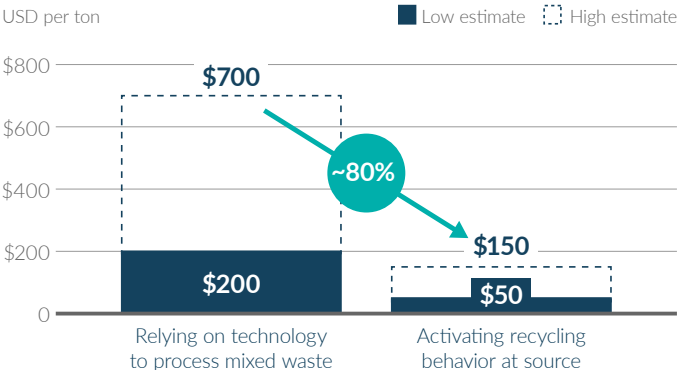
PAYBACK PERIOD BY LOCATION AND SCOPE OF BENEFITS CONSIDERED



#2 BEHAVIOR CHANGE COSTS LESS THAN TECHNOLOGY-BASED ALTERNATIVES FOR BOOSTING RECYCLING OUTCOMES

Promoting recycling behavior costs Delterra's projects $50-150 for every additional ton of recyclables it delivers per year, compared to waste-sorting technology that would have cost $200-700 per ton to achieve a similar effect.

COMPARISON OF INCREMENTAL COSTS OF TWO OPTIONS



#3 DEEPER INVESTMENT IN COMMUNITY ENGAGEMENT IS LIKELY NEEDED TO REACH HIGH RECYCLING RATES

The Delterra projects that invest more per household achieve higher participation rates - rates which we need to meet the world's demand for recyclables.

PARTICIPATION RATE AND INVESTMENT BY PROJECT

	GIRO Mid-sized city, Argentina	ATR Informal settlement, Argentina	RRA Urban districts, Indonesia
Investment Per houshold	$2	$6	$12
Achievement Participation rate	20%	35%	70%

All analysis has been performed based on the Rethinking Recycling programs in Argentina and Indonesia.

THE CONTEXT

RECYCLING BEHAVIOR ISN'T NICE-TO-HAVE; IT'S KEY TO MAKING THE ECONOMICS OF RECYCLING WORK

The success of many sustainability initiatives hinges on behavior: reducing pollution and congestion from cars requires people to incorporate more public transport, biking and walking into their routines, for example. With recycling and composting, source separation behaviors are particularly important, since they directly affect the economics of the entire system. Around 80% of post-consumer waste could theoretically be recycled or composted.[1] But people throw away much of these recyclables and compostables with their mixed waste, resulting in low capture rates. And when people get confused about which items are recyclable and which are not, high contamination rates can limit the amount of saleable materials, as well as damaging equipment and increasing operational costs.

Because so much of what's recyclable goes missing at the source separation step, recycling faces a pervasive supply shortage. Governments and major companies are struggling to meet their recycling commitments, especially for plastics. Recycling businesses around the world operate below capacity, or cannot grow to meet demand. Recent estimates put the global recycling rate at around 16%.[2] Boosting recycling behaviors could unlock tremendous potential throughout the system, and in turn create new opportunities for the circular economy more broadly.

Given the value at stake, it's perhaps surprising that recycling stakeholders have not focused more on getting behavior change right. All too often, financial decision makers invest in infrastructure to boost recycling, only to find that unhelpful behaviors leave capture rates too low and contamination rates too high for their investments to be financially sustainable. By not investing in behavior change alongside infrastructure, they essentially put their investments at risk.

THE OPPORTUNITY

NEW BEHAVIOR CHANGE APPROACHES COULD BOOST SUCCESS RATES - AND WE SHOULD MEASURE THEIR RETURN ON INVESTMENT

To put it simply, changing behavior is hard. Many recycling education campaigns over the decades have had only modest success. Even in many communities where recycling services have long been available, participation rates remain low. In emerging economy communities that are receiving recycling service for the first time - and in some cases, switching from burning or dumping their waste to setting it out for collection - the learning curve is even steeper.

In recent years, however, researchers and practitioners in behavioral science and community-based marketing have built a powerful evidence base for what works - and what does not - in shaping environmental behaviors. Typical go-to influencing tactics, such as providing information and financial incentives, are now only part of a broader set of tools that include shaping social norms and removing barriers to action. Design thinking methods, such as rapidly testing prototypes, can also reveal important insights about how to better activate specific populations. Together these techniques can drive smarter design decisions, and therefore deliver more impact per dollar spent.

Practical guides for applying behavioral insights are increasingly available. Rare's Center for Behavior and the Environment, which applies behavioral solutions to issues like fishery management and climate mitigation, uses a framework of behavior change levers that includes both traditional approaches (rules and regulations, information, and material incentives) as well as less commonly deployed but powerful techniques (emotional appeals, social influences and choice architecture).[3] A recent report on promoting sustainable plastic use, Campaigns That Work, synthesized an analysis of 50 campaigns and the behavioral literature into a set of recommended strategies and common mistakes to avoid.[4] For recycling in particular, The Recycling Partnership, which advances curbside-style recycling in U.S. cities, has published detailed case studies and guides on guiding household behaviors, including how to gather useful data from recycling carts to inform the focus of behavioral interventions.[5,6]

Still, the evidence base for return on investment of these techniques remains sparse. Few studies or campaigns report the full cost of delivering the behavioral interventions, especially labor hours. Most research looks at the effects of standalone, focused interventions, rather than full campaigns with mutually reinforcing elements - the kind necessary to achieve large-scale adoption of recycling behaviors. And decision makers still lack a standard methodology for evaluating investments in recycling behavior.

TWO U.S. CASE STUDIES OF THE
ROI OF PROMOTING ENVIRONMENTAL BEHAVIORS

The Recycling Partnership partners with cities to run targeted campaigns to improve curbside recycling performance, in particular increasing capture rate (how much of total potential recyclables in household waste end up in the recycling cart) and reducing contamination (non-recyclables incorrectly put in the recycling cart). Improving these metrics has immediate benefits at the material recovery facility (MRF), which becomes more efficient in processing household recyclables into saleable material for the recycling industry. In The Recycling Partnership's work with the city of Akron, Ohio, the behavior change campaign resulted in contamination rate of recyclables reducing from 39.3% to 26.3%, saving the city $166,993 annually after a $92,747 investment in behavior change ($2.81 per household). Campaigns in other Ohio cities reduced contamination by 10-44%, for a cost of roughly $2-3 per household.[7]

Outside of recycling, **Opower** uses carefully designed home energy reports to nudge millions of energy utility customers to reduce their energy use - for example, by showing a comparison of a customer's energy consumption relative to their neighbors. These home energy reports reduce energy consumption by 1.5-2.5% on average, and Opower credits them with generating over $2 billion in customer savings across its client utilities, as well as uplifts in energy efficiency program participation.[8]

THE ANALYSIS

TO BEGIN BUILDING THE FACT BASE FOR RECYCLING BEHAVIOR ROI, WE LOOKED AT COMPARABLE DATA ACROSS THREE PROJECTS IN EMERGING ECONOMIES

Delterra's Rethinking Recycling initiative focuses on scaling up recycling ecosystems in emerging economies, and community engagement is a core pillar of the approach. Rethinking Recycling operates three projects designed to deliver new supply of recyclables to the ecosystem, including compostable organic materials: A Todo Reciclaje (ATR), in the informal settlement Barrio Mugica in Buenos Aires; Rethinking Recycling Academy (RRA), in a cohort of urban districts in southern Bali; and Gestión Integral de Residuos Olavarría (GIRO), in the mid-sized Argentinian city of Olavarría. In each, as the project brings curbside-style recycling service to residents for the first time, staff work with local governments, waste workers, and community members to promote consistent source separation behavior. Each project uses a combination of behavioral techniques, working within local constraints and characteristics, and builds behavior change into the business case for the overall project. See the Appendix for more detail on each project.

	ATR Informal settlement **ARGENTINA**	RRA Urban districts **INDONESIA**	GIRO Mid-sized city **ARGENTINA**
Door-to-door educators	Neighborhood labor cooperative workers	Community groups	Project and municipal staff
Equipment provided to households (beyond basic "how to recycle" reference materials)	Labeled outdoor hooks Compostables bucket Recyclables bag	Set of labeled, colored bins	None (bins distributed only to local shops serving as education hubs)
Publicity/digital	WhatsApp campaign Street stands and events	Community meetings WhatsApp chatbot	Public space advertising Local press campaign Social media & website WhatsApp chatbot
Average # residents / household	3.2	4.0	2.8
Average kg potential / household / year	815	1,077	616
Participation rate (approx.)	35%	70%	20%

To evaluate return on investment of community engagement across the three projects, we first needed to establish consistent definitions for which costs and benefits would be in scope. These can be defined as narrowly as pure implementation costs and recyclables sales revenue, or as broadly as to include up-front behavioral research costs and household hours spent separating waste, as well as societal benefits like job creation and reduced public health risks. Different decision makers might choose different scopes, depending on their interests and goals.

For our purposes, we took the perspective of Rethinking Recycling's **LOCAL GOVERNMENT PARTNERS**, who seek to divert more waste from landfill without significantly growing their waste management spend. We therefore looked at all costs that would come out of their budgets and staff time, and all benefits that they could theoretically capture (Scope 1-3 in the table below). However, other scenarios could include:

A RECYCLING INDUSTRY GROUP

looking to improve system productivity by scaling up the supply of recyclables, might include the costs to deploy community engagement across multiple cities at once, and the benefits to the rest of the circular economy (Scope 1-4).

AN IMPACT FUNDER

who aims to improve environmental and societal outcomes through broad investments, might consider the increased burden on households (especially women) on the cost side, and include a broader set of societal impacts in benefits (Scope 1-5).

NARROW AND BANKABLE ↓ BROAD AND THEORETICAL

SCOPE	COST	BENEFITS	POTENTIALLY RELEVANT FOR: LOCAL GOVERNMENTS	RECYCLING INDUSTRY GROUPS	IMPACT FUNDERS
1 **"Hard" costs and benefits only**	Cash costs required for campaign implementation (e.g., printed materials, wages for hired personnel)	Revenue from MRF sale of recyclables (and/or composted organics)	✓	✓	✓
2 **Local resources used and savings generated**	In-kind contributions of labor (e.g. municipal staff time)	Avoided costs of disposal (e.g. gate fees for landfilling or incineration) and transport to disposal sites	✓	✓	✓
3 **Additional potential needs and income streams over time**	Follow-up campaigns to sustain behaviors over time[9]	Monetizable environmental benefits (e.g. plastic credits and/or carbon credits)	✓	✓	✓
4 **Non-local contributions and value generated**	Diagnostics and development of behavior change approach	Recycling system productivity gains (e.g. reduced idle capacity) Avoided use of virgin materials		✓	✓
5 **Societal costs and benefits**	Household recycling effort (e.g. time spent source separating)	Estimated value of non-monetizable benefits (e.g. avoided air and ocean pollution, reduced public health risks, job creation/ improved livelihoods)			✓

KEY FINDING #1

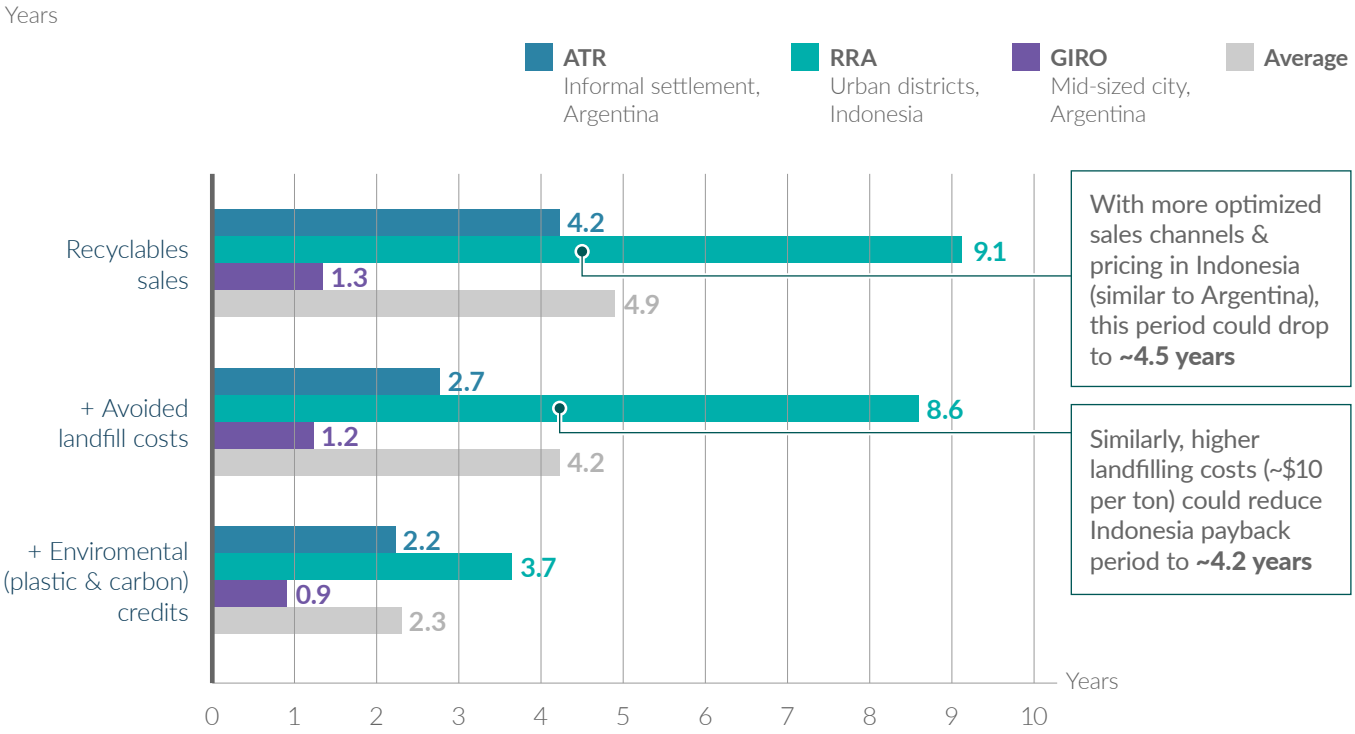
PROMOTING RECYCLING BEHAVIOR CAN PAY BACK QUICKLY, ESPECIALLY WHEN PRICES REFLECT ENVIRONMENTAL IMPACTS

Using the narrowest scope of benefits - revenue from selling recyclables into local markets - the value of additional waste recovery still exceeds community engagement costs within a few years: around 5 years on average across the three projects. The mid-sized Argentinian city project breaks even soonest, in 1.3 years, since it uses low-cost engagement techniques and is able to secure decent prices for recyclables. In the Indonesian urban districts, by contrast, lower sales prices mean that the project generates only modest value per ton; combined with the decision to invest more in community engagement, this results in a long payback period of around 9 years. If the Indonesia project could bypass some inefficiencies in local recycling markets and sell to larger buyers at higher prices, as the Argentina projects do, the payback period would drop significantly, to roughly 4-5 years.

The effect of prices also comes into play with waste management cost savings, such as landfill fees and transport, especially for projects like Rethinking Recycling's that divert organic waste to composting as well as dry recyclables. In the informal settlement in Buenos Aires, unrecycled and uncomposted waste goes to the landfill outside the city, incurring landfill fees of around $22 per ton; each ton of recyclables and compostables diverted through source separation behavior therefore generates $22 in cost savings for that project. When these savings are included, the payback period for community engagement in the informal settlement drops from 4.2 to 2.7 years. On the other hand, the other two project locations both have negligible financial incentives to divert waste from landfill, with avoidable landfilling costs of only $1-5 per ton. Since organic waste is heavy and a large proportion of household waste, source separation did result in modest cost savings, but overall payback periods remained similar for these projects. If landfilling costs were set higher at $10 per ton, payback periods for these projects would drop by roughly half. We did not include transport costs in the analysis, but savings there could be considerable, especially in Indonesia where all-day trips to the landfill are common.

Under a third, more speculative scenario, all three projects would pay back community engagement costs in less than 4 years - bringing the payback period within typical political cycles and investment horizons. This scenario assumed that in addition to sales revenue and landfill cost savings, carbon credits could be issued for composted organic waste at around $5 per ton,[10] and plastic credits issued at around $200 per ton of eligible plastic.[11] While securing buyers and pricing for these credits is far from guaranteed, credit systems are a proxy for additional value generated by recycling and composting - value that could potentially be monetized.

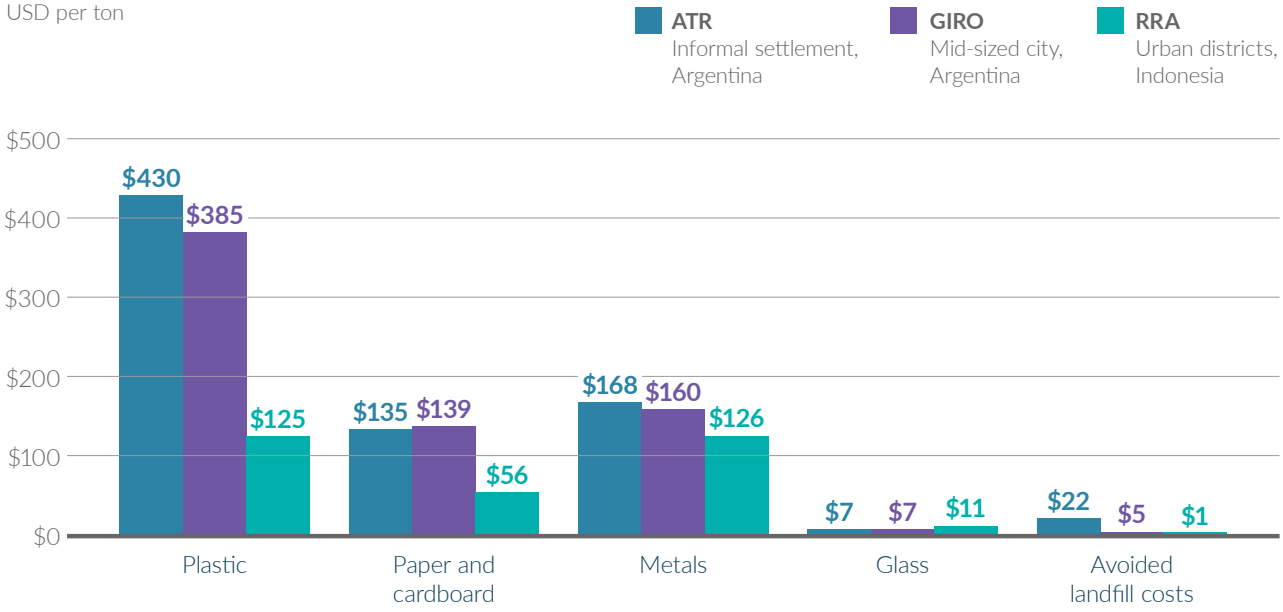
PAYBACK PERIOD ON CONSUMER ENGAGEMENT VARIES BY LOCATION AND SCOPE OF BENEFITS CONSIDERED



Overall, our analysis points to the importance of creating monetary value for the benefits of recycled and composted materials. Environmental policies could ensure that purchase prices for both virgin and recycled materials include their environmental impact. Cities and sub-national governments could create stronger incentives for waste diversion, such as higher landfill fees. Clearer standards could bring greater confidence and more transactions in carbon credit and plastic credit markets. These and other measures could strengthen the business case for promoting recycling behavior - and for investing in the recycling system as a whole.

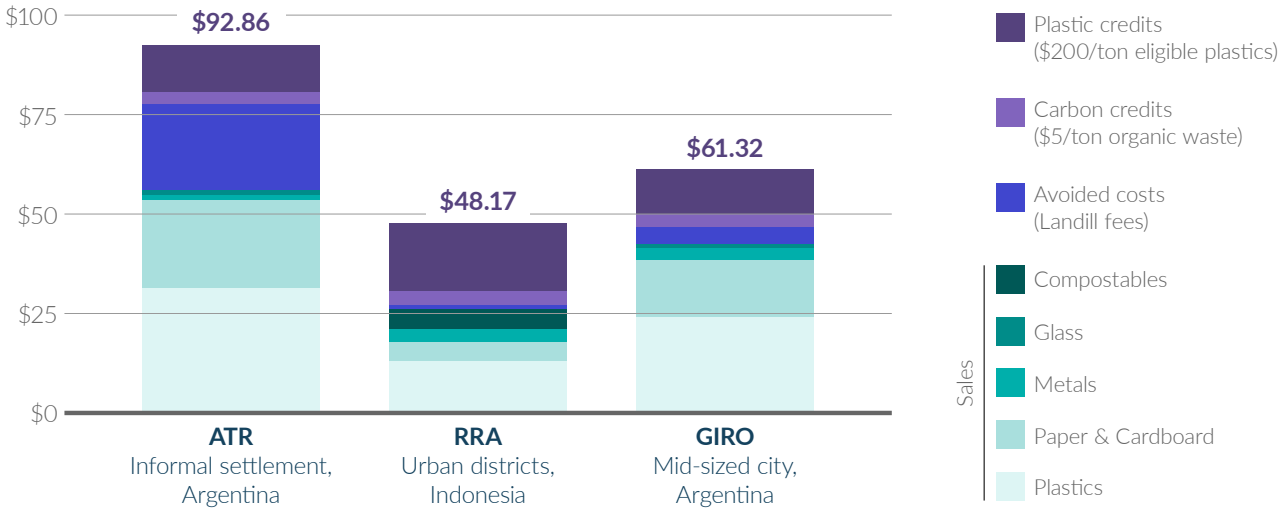
DIFFERENCES IN SALES PRICES AND WASTE MANAGEMENT COSTS AFFECT ROI ACROSS LOCATIONS

USD per ton



BEYOND SALES REVENUE, EACH TON OF RECOVERED WASTE GENERATES SIGNIFICANT VALUE IN AVOIDED COSTS AND ENVIRONMENTAL BENEFITS

USD per ton per year



KEY FINDING #2

PROMOTING RECYCLING BEHAVIOR COMPARES FAVORABLY AGAINST MECHANICAL MIXED-WASTE PROCESSING TECHNOLOGY, AS WELL AS TYPICAL COSTS FOR OTHER TYPES OF BEHAVIOR CHANGE

As another perspective on ROI, we compared Rethinking Recycling's cost of activating recycling behavior against two benchmarks: a technological alternative, and other types of behavior change campaigns.

We found that promoting source separation behavior is clearly more cost-effective than relying on technology to process mixed waste, assuming compostables are included in both systems. Source separated waste typically goes to a sorting facility for dry recyclables and a composting facility for organic waste. For mixed waste, a process called Mechanical Biological Treatment, or MBT, can extract some saleable dry recyclables and process organic waste into low-grade compost or other products. The incremental cost of MBT over source separated recycling infrastructure ranges from roughly $200 to $700 per ton of recovered material.[12] By contrast, Rethinking Recycling projects indicate that, for each $50-150 in up-front investment, recycling behavior can deliver one ton per year of recovered material - typically higher-grade dry recyclables and compost than MBT can produce. Even assuming some additional costs are required to sustain behavior over time - Rethinking Recycling estimates around 10% of up-front investment per year - community engagement can capture recyclables for a fraction of the cost of technological methods.

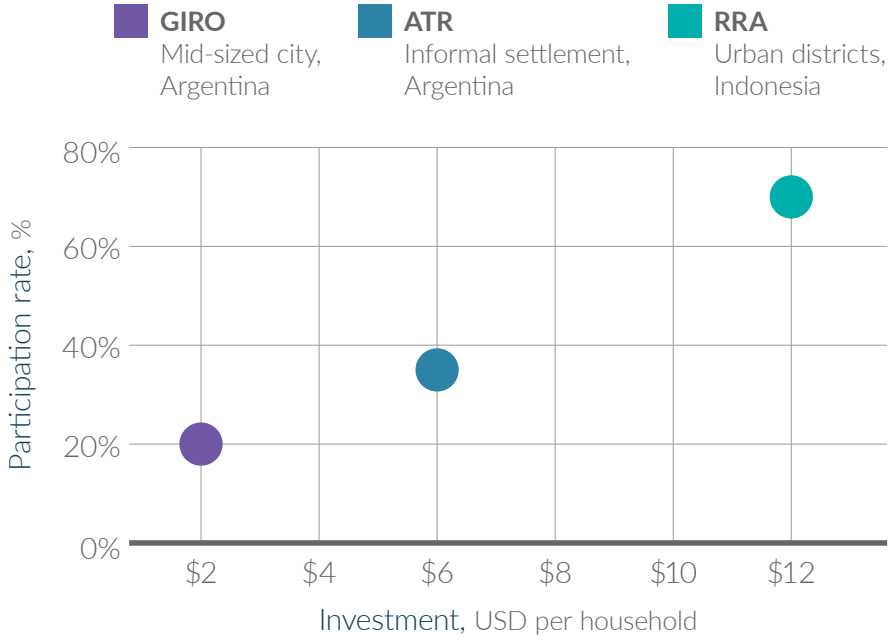
On a per-household basis, Rethinking Recycling also spends comparable amounts to similar efforts to influence behavior at scale. The U.S. Census, for example, spends about $25 per person for moderately intensive outreach, such as training trusted messengers to have in-person conversations.[13] Adjusting for Indonesia and Argentina's GDP per capita and household sizes, the equivalent cost would be around $6-10 per household - in line with the $2-12 per household Rethinking Recycling projects spent on similar outreach activities. The Recycling Partnership estimates that in the U.S., an investment of $10 per household annually is needed to achieve the levels of source separation needed by the recycling industry, on top of expanding service and infrastructure such as curbside carts.[14] Again adjusting for GDP per capita, this equates to $0.60-$1.30 per household annually in Indonesia and Argentina - in line with Delterra's estimate of $0.20-$1.20 per household per year to sustain recycling participation after the initial campaign and equipment distribution.

KEY FINDING #3

DEEPER INVESTMENT IN COMMUNITY ENGAGEMENT IS LIKELY NEEDED TO ACHIEVE HIGH RECYCLING RATES

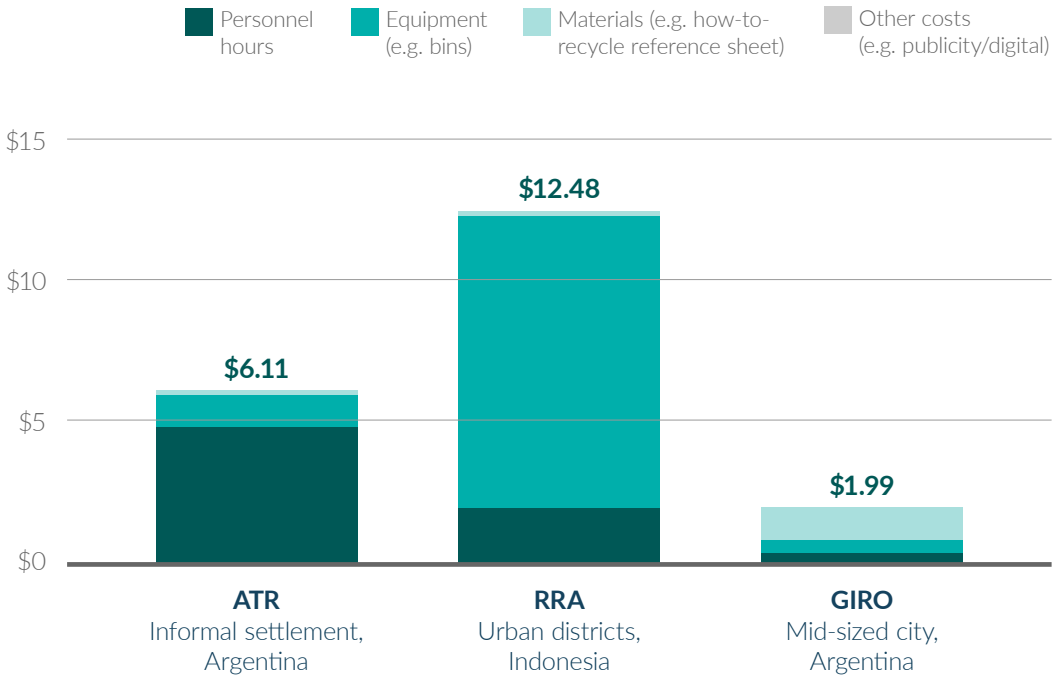
The project in Indonesian urban districts achieves much higher rates of recycling participation than the Argentina projects: about 70% of households in the Indonesia project develop recycling habits, compared to 20-35% in the Argentina projects. It also invests the most in community engagement, spending about $12 per household, compared to $2-6 in Argentina. About $10 of that $12 goes to a set of bins provided to each household, which serve both functional and psychological purposes; Rethinking Recycling is now further testing the effect of these bins on people's behavior, and whether their cost could be reduced. The most cost-efficient project, in the mid-sized Argentinian city, also sees the lowest participation rates.

HIGHER RECYCLING BEHAVIOR CHANGE SPEND CORRELATES TO HIGHER PARTICIPATION RATES



CONSUMER ENGAGEMENT SPEND RANGES FROM $2-12 PER HOUSEHOLD, WITH MAIN DRIVERS OF COST VARYING BY PROJECT

USD per household

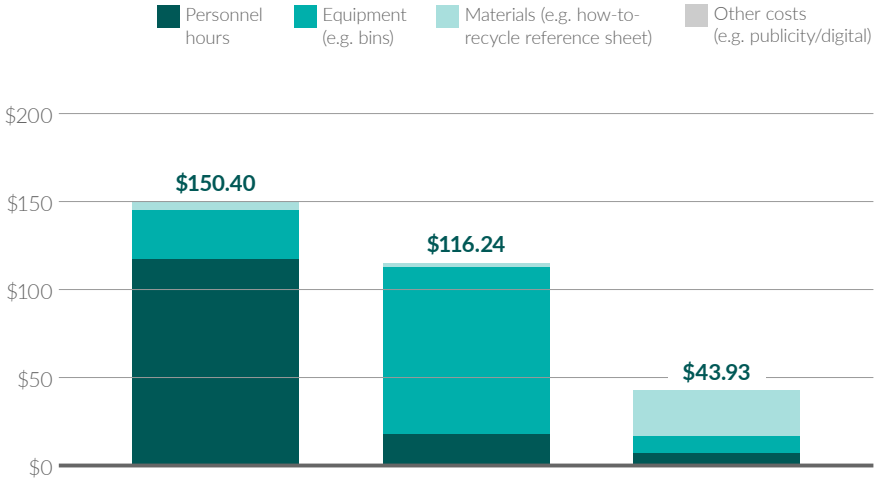


These results, along with observations from Rethinking Recycling staff, indicate that the ROI of promoting recycling behavior varies by segment of the population. Any given community has a mix of profiles: recycling early adopters, willing participants who face barriers to recycling, people who are receptive but passive about recycling, and recycling skeptics. Each requires a different level and type of support. The U.S. Census spends as much as $75 per person on hard-to-reach groups. From a narrow economic perspective, one could invest only in easier-to-reach people, and aim to deliver just the minimum volumes needed to support existing recycling infrastructure. But to deliver the scale of supply needed to meet corporate recycling commitments and expand capacity of the overall recycling ecosystem, we will need high participation rates at scale - and likely the help of many harder-to-reach people.

Higher investment per household can still deliver positive ROI. Rethinking Recycling's Indonesia project achieves lower costs per ton of recovered material than the Argentina informal settlement project, despite higher per household costs. Households in the Indonesian urban districts produce more waste than either Argentina project location: around 21 kilograms per household per week (most of it organic waste) compared to 12-16 kilograms in Argentina. Where households generate more recyclable waste, especially if those recyclables are high-value, investing in widespread source separation behavior may well pay off.

SPENDING MORE PER HOUSEHOLD ON ACTIVATING BEHAVIOR CAN STILL BE COST-EFFECTIVE IN TERMS OF RECYCLING OUTCOMES

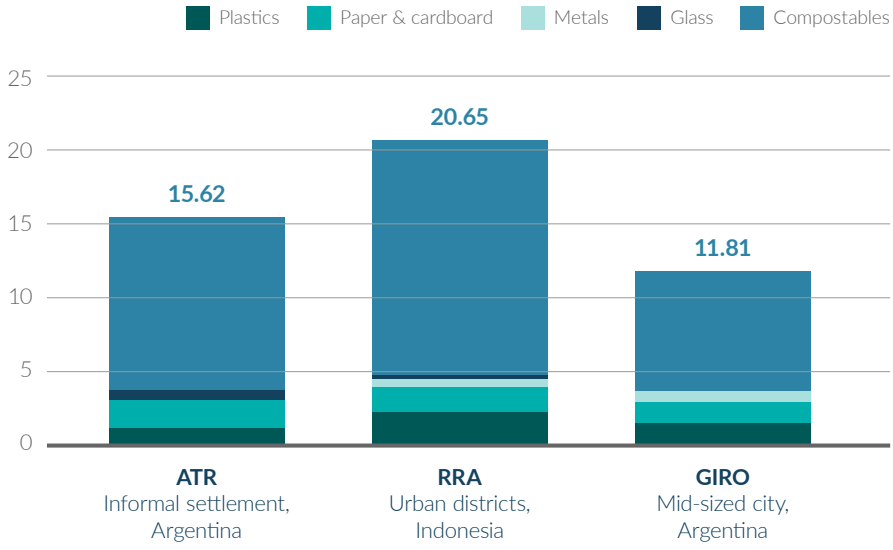
USD per ton recovered annually



	ATR Informal settlement, Argentina	**RRA** Urban districts, Indonesia	**GIRO** Mid-sized city, Argentina
Per-household costs	**$6.11**	**$12.48**	**$1.99**

COMPOSTABLES ACCOUNT FOR MUCH OF THE DIFFERENCE IN WASTE RECOVERY POTENTIAL ACROSS LOCATIONS

Average kg per week per household



TO ENABLE SMARTER INVESTMENT, WE ENCOURAGE BUILDING A ROBUST FACT BASE ON RECYCLING BEHAVIOR ROI

Our analysis provides one case study to suggest that promoting source separation behavior delivers positive ROI for recycling systems in emerging economies. Across multiple geographies and types of communities, the environmental value generated by activating recycling behavior is expected to exceed the cost within a few years - outperforming technological alternatives, and in line with behavior change benchmarks elsewhere. While multiple factors contributed to different levels of success across the three projects in Indonesia and Argentina, higher rates of waste diversion corresponded to higher investment in community engagement.

We believe these findings warrant a mindset shift. What if decision makers thought of recycling behavior as part of recycling infrastructure - not nice-to-have community outreach, but a core component of the circular economy, requiring smart investment to build and run effectively? Circular economy funders might consider more behavioral interventions alongside other investments aimed at increasing recovery of waste materials. Local governments might approach waste management more holistically, budgeting for deeper community engagement on recycling and accounting for potential savings on landfilling costs. National governments and corporate players might work to bring prices for recycled and virgin material in line with their respective environmental impacts, so that investing in recycling behavior - and the recycling ecosystem as a whole - simply makes business sense.

We welcome you to join us in building out the fact base on recycling behavior's return on investment. In coming months, we plan to release tools to enable other organizations to analyze their own data, and to develop investment scenarios for community engagement. We will publish practical lessons we're learning in the field about the tactics that provide the greatest return on investment, and invite other organizations to share their insights about effective behavior change as well. Recycling behavior can reshape what's possible for the circular economy. Let's find out how to make the right investments in that potential.

ENDNOTES

1 World Bank, What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050 (2018). Cited figure is calculated from Figure 2.8, Global Waste Composition; categories included are food and green (44%), paper and cardboard (17%), plastic (12%), glass (5%) and metal (4%). https://openknowledge.worldbank.org/handle/10986/30317

2 Verisk Maplecroft, Waste Generation and Recycling Indices 2019, p. 5. https://www.circularonline.co.uk/wp-content/uploads/2019/07/Verisk_Maplecroft_Waste_Generation_Index_Overview_2019.pdf

3 https://behavior.rare.org/resources/a-quick-guide-to-the-behavior-levers/

4 https://www.campaignsthatwork.org/#group-section-CAMPAIGN-STRATEGIES-WsQo0wLmxY

5 The Recycling Partnership, "Start at the Cart™: Key Concepts for Influencing Behavior" (February 2021). https://recyclingpartnership.org/blog-start-at-the-cart-key-concepts-for-influencing-behavior/

6 The Recycling Partnership, "Start at the Cart" (April 2018). https://recyclingpartnership.org/start-at-the-cart-2/

7 City of Akron Press Office, "City Of Akron And Partners Launch Another Round Of The Recycle Right Campaign To Further Improve Curbside Recycling" (June 2021). https://www.akronohio.gov/cms/news/f523dc50886d24ba/index.html
The Recycling Partnership, "Recycling Contamination Reduction Kit: Ohio Case Studies" (2021). https://recyclingpartnership.org/wp-content/uploads/dlm_uploads/2021/09/OH-Case-Studies-Recycling-Partnership-1.pdf

8 https://www.oracle.com/a/ocom/docs/industries/utilities/utilities-opower-energy-efficiency-cs.pdf. The behavioral effect and cost-effectiveness of Opower's reports, including persistence over time, has been confirmed by randomized controlled trial data over several years: see Hunt Allcott and Todd Rogers' paper "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation" (2014). American Economic Review, 104 (10): 3003-37. https://www.povertyactionlab.org/sites/default/files/research-paper/899%20Allcott%20and%20Rogers%20AER2014%20The%20Short-Run%20and%20Long-Run%20Effects%20of%20Behavioral%20Interventions.pdf

9 In order to look at the cost-effectiveness of behavior change specifically, these scope definitions do not include any new waste management costs from handling the increased volume of recyclables and compostables. At high levels of recycling participation, however, waste management systems typically need to expand capacity.

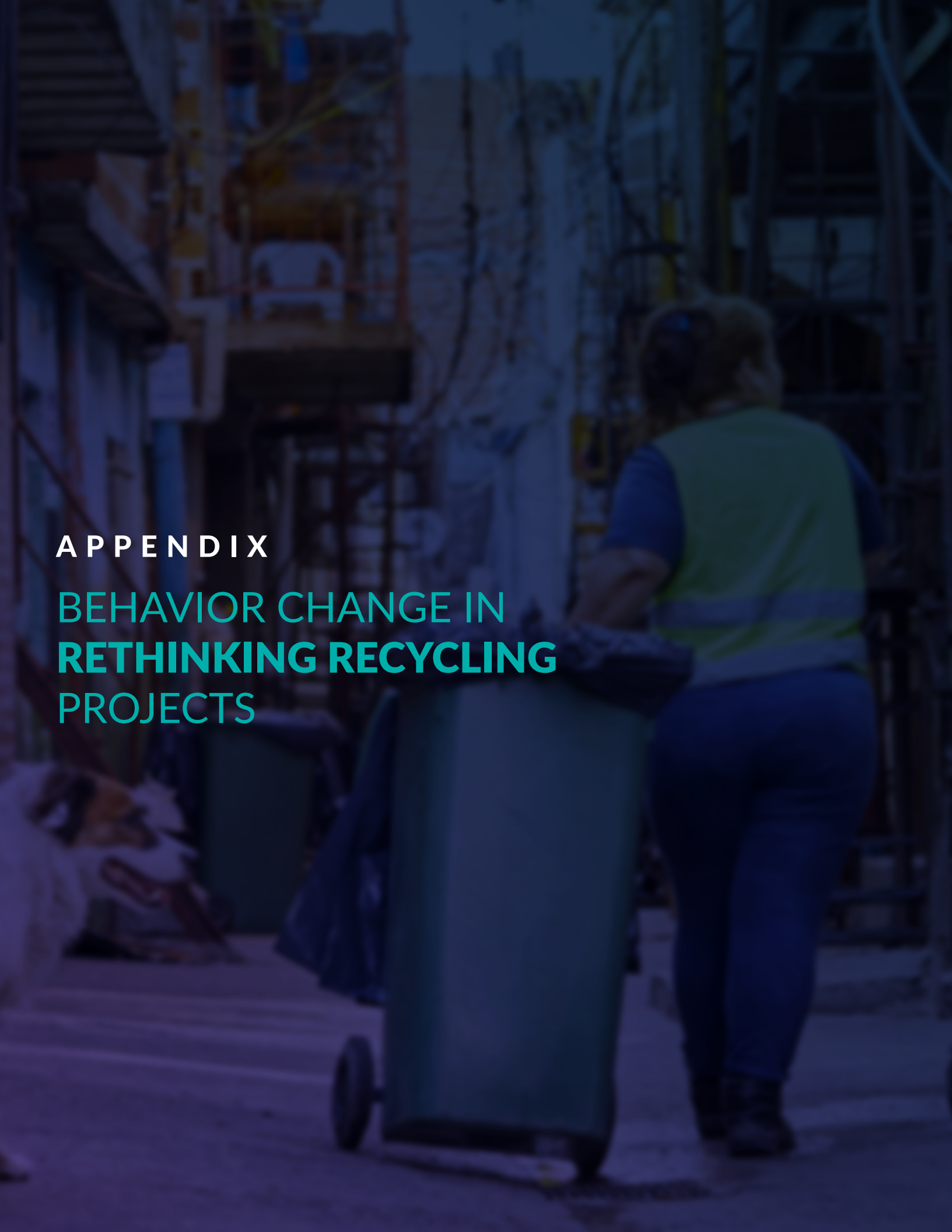
10 Carbon credit price of $5 is based on going carbon credit prices for waste management projects, adjusted for loss of organic waste weight during the composting process.

11 Plastic credits are new products with an uncertain market, and listed prices currently range from as low as $10 to over $500 per ton: https://www.circularactionhub.org/ Generally PET (#1), HDPE (#2), LDPE (#4), PP (#5) and PS (#6) plastics are eligible, which make up 80-90% of total plastics recovered by Rethinking Recycling projects. Our analysis assumes $200 per ton of eligible plastics, for a range of $150-170 per ton total plastics.

12 Calculated from cost estimates by C40-CCAC Waste Finance Academy (June 2019), and yield estimates from Waste Advantage Magazine (April 2015). Mechanical Biological Treatment is estimated to cost $400-750 per ton of treated waste on a blended capex basis, yielding 65-90% recovered material, versus costs and yields of a standard "clean" material recovery facility ($80-150 per ton and 50-90% yield) and open windrow composting ($130-160 per ton and 90-95% yield).

13 Census Counts, "Preparing for the 2020 Census: Estimating Outreach Costs for Hard-to-Count Communities" (March 2019). http://ilcountmein2020.org/wp-content/uploads/2019/03/Preparing-for-the-2020-Census-Estimating-Outreach-Costs-for-Hard-to-Count-Communities-1-3.pdf

14 The Recycling Partnership, Paying It Forward: How Investment in Recycling Will Pay Dividends (2021), p. 22. https://recyclingpartnership.org/read-paying-it-forward/



APPENDIX

BEHAVIOR CHANGE IN **RETHINKING RECYCLING** PROJECTS

DENPASAR, BALI, INDONESIA
RETHINKING RECYCLING ACADEMY

CONTEXT

Much of Indonesia's waste management system is fragmented and informal, resulting in high rates of open burning and dumping in forests, canals, unmanaged landfills and the ocean. With a population of over 280 million people and 17,000 islands, Indonesia ranks as the second largest contributor to ocean plastic pollution in the world.

Local district governments are generally responsible for waste management, with waste collection services provided by a mix of local independent waste collectors and district-owned facilities. Independent collectors typically take waste directly to dumpsites, skimming some of the high-value recyclables to sell into the informal market. District-owned facilities are designed to sort recyclables and compost organic waste, but few operate efficiently or profitably.

RETHINKING RECYCLING APPROACH

Following a successful pilot in 2019 in one district in Bali, Delterra launched the Rethinking Recycling Academy in 2020 to partner with cohorts of districts in transforming their waste management systems. Each district in a cohort moves through a structured program of capability building and planning (via a digital-hybrid curriculum), which is then supported by financial investment and on-the-ground implementation support from the Academy. Through the program, districts optimize their waste management operations, expand service coverage, and run source separation campaigns in their communities. Participating districts develop profitable and professionalized waste management systems within months, while improving working conditions for waste workers and increasing their wages by as much as 200%.

BEHAVIOR CHANGE ROI ELEMENTS

INSTITUTIONAL CHANGE

The Academy supports district governments through an end-to-end transformation program, including creating local legislation requiring source separation of waste, accessing public funding, and setting up the legal entity for their waste management system.

SYSTEM DESIGN

Based on user research and testing, the Academy helps districts create a mutually reinforcing system of household equipment and collection operations. On the household side, the program distributes a set of labeled, color-coded bins, along with a durable reference card showing what goes in each bin. These high-quality items signal the seriousness of the district's commitment to recycling, and help make residents feel that they receive something of value as part of the agreement. On the collection side, different waste categories are collected on different days, signaling to residents that their source-separated waste is not being mixed back together during collection.

EDUCATIONAL OUTREACH

District governments in Bali are culturally influential as well as holding administrative responsibilities, with community meetings and groups shaping much of residents' everyday lives. The Academy's outreach approach therefore emphasizes recycling behavior as both a social and legislative norm and something that district leaders expect of their constituents. Community groups serve as door-to-door recycling educators, wearing badges that identify them as official district representatives, and printed materials include the official district seal. Community meetings enable announcements and reminders about recycling and composting to reach a wide audience. A WhatsApp chatbot provides additional support to residents, answering questions about their collection service or questions about source separation categories.

VALUE OPTIMIZATION

Along with operational and infrastructure improvements, the Academy helps these district owned waste management facilities to sell collected recyclables to local aggregators, as well as to sell processed compost to hotels, other tourism businesses, and community residents for landscaping. Additional initiatives are underway to connect these facilities with larger buyers that pay higher prices, and to explore other sources of revenue.

BARRIO MUGICA, BUENOS AIRES, ARGENTINA
A TODO RECICLAJE (ATR)

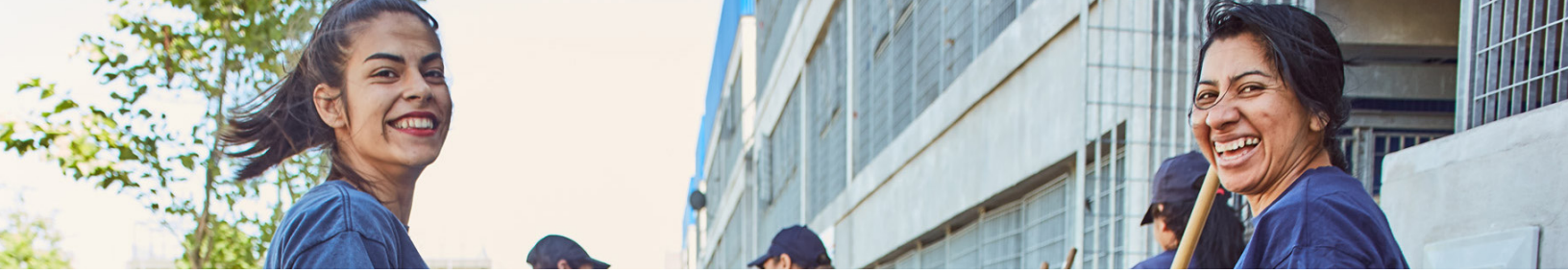
CONTEXT

As with other countries across the global South, rapid urbanization has led to the rise of semi-formal and informal settlements across Argentina, known as villas. Conventional waste management services can provide little coverage for these communities, where streets are narrow, many homes and businesses do not have addresses, and stray animals rummage through any waste left out on the ground. However, some of these communities have formed neighborhood labor cooperatives to provide waste collection and other services, and many residents are familiar with global waste pollution issues and the informal recycling economy.

In Barrio Mugica (formerly known as Villa 31), a 40,000-resident settlement in the center of Buenos Aires, the city government is working with the Inter-American Development Bank on an inclusive, sustainable approach to formalization and economic development of this villa. As part of that effort, Rethinking Recycling and the community's labor cooperatives are partnering with the city and its waste management providers to create a community-led recycling system for the Barrio.

RETHINKING RECYCLING APPROACH

Launched in 2019, A Todo Reciclaje ("recycling for all", or ATR) trains Barrio Mugica's 13 cooperatives to operate an integrated waste management system for the community, from educating residents on source separation to running the waste collection service and the recyclables sorting facility. In addition to receiving city funding to operate the system, cooperative workers - about 65% of whom are women - also receive all revenues from the sale of recyclables. Barrio Mugica currently runs the only waste collection service in Buenos Aires that accepts compostables as well as dry recyclables, and has the city's highest recycling participation rate.



BEHAVIOR CHANGE ROI ELEMENTS

INSTITUTIONAL CHANGE

The ATR team delivers a full training curriculum for cooperative workers, from classroom sessions to observing experienced cooperatives to on-the-job coaching. In addition to building experience and confidence in communicating with residents about recycling, workers develop the teamwork and troubleshooting skills needed to operate the waste collection service and the recyclables sorting facility. They also learn to use data tracking systems, to monitor performance and ensure full traceability of recyclables to increase their value. The ATR team also helps design and create the waste management department for Barrio Mugica, which will oversee and continue to improve the system on an ongoing basis.

SYSTEM DESIGN

ATR distributes low-cost waste equipment designed to address the particular challenges of the villa environment. Instead of outdoor bins that could be knocked over by stray animals, residents get a set of labeled hooks installed outside their homes, where they hang a reusable bag for dry recyclables and a lidded bucket for compostables - both of which are small enough to be used inside the home. The durable, attractive hooks serve as a behavioral cue as well as a publicly visible status symbol, enhancing the social desirability of recycling. Collection crews walk through the narrow streets with rolling bins, working at consistent times each day and calling out to announce their arrival, which helps reinforce the reliability of the service for residents.

EDUCATIONAL OUTREACH

To pique residents' interest in the program, the ATR team works with each cooperative to run a "try recycling, get your equipment" campaign. Residents bring a recyclable item to an ATR stand in the street or a neighborhood gathering place, and a cooperative worker registers them for a home visit by a recycling educator and schedules the installation of their hooks. Through the initial "try recycling" action and the subsequent home visit, residents get hands-on coaching on how to source separate their waste correctly, and begin to build an ongoing relationship with the program.

VALUE OPTIMIZATION

ATR collaborates with the city's composting plant, which typically works with landscaping waste, to process Barrio Mugica's household organic waste, which provides landfilling cost savings to the city. The sorting facility also sells to larger buyers of recyclables, including directly to a plastic recycling plant in Buenos Aires, in part because its data tracking enables full traceability of materials and the social impact of recycling activities.

OLAVARRÍA, ARGENTINA
GESTIÓN INTEGRAL DE RESIDUOS OLAVARRÍA (GIRO)

CONTEXT

Mid-sized cities in Argentina increasingly seek to shift their waste management systems to more inclusive, circular models, while facing different financial and logistical constraints from major cities like Buenos Aires. Collectively these cities generate much of the country's municipal solid waste, which in turn represents the livelihoods of many recycling cooperatives and waste pickers working on landfills.

The city of Olavarría, an industrial city of about 120,000 people several hours' drive from Buenos Aires, has set an aspiration to modernize its waste management system. Starting from a formal recycling rate of less than 1%, the city is moving beyond its existing system of recycling drop-off points and curbside mixed-waste collection to capture more of its recyclable waste at the source.

RETHINKING RECYCLING APPROACH

Gestión Integral de Residuos Olavarría (GIRO) launched in 2020 with the aim of developing a replicable, economically sustainable, and inclusive waste management model for cities across Argentina, that achieves recycling rates comparable to leading cities globally. Using human-centered design as a guiding principle, GIRO builds municipal government capacity for coordinating the local waste management ecosystem and promoting recycling behavior, while collaborating with local stakeholders - including recycling cooperatives and informal waste workers - on collection service changes, infrastructure setup, and business model innovation.

BEHAVIOR CHANGE ROI ELEMENTS

INSTITUTIONAL CHANGE

A joint GIRO team of municipal and Rethinking Recycling staff identify opportunities to shift the system toward circularity and recycling, such as updating waste management contracts to encourage diversion of waste from landfill. The team also runs qualitative and quantitative community research to inform educational outreach strategies, and develops an ongoing collaborative relationship with residents, businesses, and community leaders to continuously refine the program.

SYSTEM DESIGN

To reinforce source separation behavior, GIRO has changed curbside collection service from mixed-waste collection 3-6 times a week to a weekly schedule of dry recyclables, compostables, and residual waste pickups. While the same fleet of trucks is used to pick up each type of waste, trucks display different banners on different collection days, to help assure residents that their source separated materials are being handled properly.

EDUCATIONAL OUTREACH

Distributing bins or other equipment to all households is not financially feasible for GIRO, so community engagement focuses on providing a supportive experience for residents throughout their behavior change journey. Outreach conversations address common biases and barriers to participation, and subsequent check-ups provide quick feedback to residents. Along with public space advertising, a local media campaign, and social media to build familiarity with GIRO, a WhatsApp-based chatbot (adapted from the Rethinking Recycling Academy in Indonesia) provides an additional touchpoint and a convenient way for residents to get answers to their questions.

VALUE OPTIMIZATION

Local industries, such as cement production, provide access to potentially large markets for recyclable material. In addition to improving the quality and yield of materials recovered through waste management operations, GIRO works to improve revenue from recyclables, including exploring markets for harder-to-recycle materials.

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