Developing Priorities in Recycling Markets

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For the **Recycling Development Center**

Washington State Department of Ecology
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Front Matter

Table of Contents

Figures

Tables

Acronyms and Abbreviations

AMERIPEN: American Institute for Packaging and the Environment

C&D: Construction and demolition

Centers: Recycling market development centers

CDPHE: Colorado Department of Public Health and Environment

Commerce: Washington Department of Commerce

Ecology: Washington Department of Ecology

EPA: United States Environmental Protection Agency

EPA WARM: United States Environmental Protection Agency Waste Reduction Model

Evans School: University of Washington's Evans School of Public Policy and Governance Student Consulting Lab

GHG: Greenhouse gas

IDEM: Indiana Department of Environmental Protection

ISRI: Institute of Scrap Recycling Industries

MI EGLE: Michigan Department of Environment, Great Lakes, and Energy

MN PCA: Minnesota Pollution Control Agency

MO EIERA: Missouri Environmental Improvement & Energy Resources Authority

MRF: Materials recovery facility

NERC: Northeast Recycling Council

OH EPA: Ohio Environmental Protection Agency

PA RMC: Pennsylvania Recycling Markets Center

PPW: Phoenix Public Works

RDC: Washington Recycling Development Center

RRS: Resource Recycling Systems, operator of NextCycle Colorado

SERDC: Southeast Recycling Development Council

SC Department of Commerce: South Carolina Department of Commerce

SPC: Sustainable Packaging Coalition

STAR: State of Texas Alliance for Recycling

TCEQ: Texas Commission on Environmental Quality

U.S.: United States

Executive Summary

The Washington Recycling Development Center (RDC) is a collaboration of the Washington Departments of Ecology and Commerce with guidance from a 14-member advisory board. The RDC is directed by state law to bolster recycling markets in Washington State.[1] As a relatively small and recently formed (2019) program, the RDC is working to establish methods to prioritize staff time and resources.

To help shape its approach to prioritization, the RDC contracted with the University of Washington's Evans School of Public Policy and Governance Student Consulting Lab (Evans School) for this study. Evans School consultants aimed to answer the following research questions:

- **What are effective ways for the RDC to use quantitative metrics and qualitative factors to inform its operations, priorities, and decision-making for market development?**
- **What experiences of other organizations could inform the RDC's investments?**

We started by researching the following topics, as summarized in Chapter 2 – Literature Review:

- The concept of a circular economy
- International context causing the need for domestic recycling market development
- Publicly funded market development centers in the United States (U.S.)
- Organizational decision-making
- Factors that typically influence decisions in recycling market development

We conducted interviews with 19 U.S. organizations, including 14 state- or city-level organizations concerned with recycling market development and 5 related entities. Our data collection and analysis methods are covered in Chapter 3 – Research Methods.

We summarize key takeaways from the interviews in Chapter 4 – Findings. The chapter starts with factors that influence decision-making – including mandates, funding, equity, landscape analysis, and stakeholder engagement. The chapter then details how the following types of decisions are shaped: choosing which recyclable materials to prioritize, how to award grants, and how to communicate with different audiences. Next, the chapter covers how interviewees use comprehensive planning, how they are impacted by challenges with data, and the role of strategic alliances in their programs. Finally, we close the chapter with explicit advice interviewees provided.

Chapter 5 provides recommendations based on our literature review and interview findings. These recommendations are consistent with the RDC's current legislative directives and particularly emphasize partnership-building, data processes, and programmatic decision-making. We recommend that the RDC consider the following elements when choosing which activities and materials to prioritize:

1. Engage stakeholders in the recycling supply chain to help shape priorities, invest in impactful projects, and create a network of allies.
2. Rely on allies outside the supply chain to expand functional reach, while prioritizing activities that allies cannot undertake.

3. Consider the Washington recycling supply chain's capacity, challenges, and needs when choosing which recyclable materials to prioritize.
4. Develop strong standards, processes, and systems to mitigate data challenges when relying on quantitative metrics to guide prioritization and operations.
5. Incorporate equity into program decisions by developing clear and formal equity-related processes for RDC programs.

Chapter 1: Project Summary and Research Questions

Definition of "recycling markets"

Recyclable materials collected from homes and businesses are typically transported to a materials recovery facility (MRF) to be sorted and baled. From there, the material is purchased – either directly or through a broker – by entities that process it into "feedstock" (e.g., paper is turned into pulp, plastic is turned into pellets, etc.). Feedstock is then used as raw material to manufacture new products. In some cases, recyclable materials are delivered directly from a commercial or industrial business to a processor or manufacturer without going to a MRF.

The term "recycling markets" predominantly refers to processors and manufacturers that purchase materials like paper, cardboard, plastic, glass, and metals, either from a MRF, through a broker, or directly from a business. The term also refers to entities that obtain and use recyclable materials outside of the traditional recycling pathway. For example, some entities acquire, deconstruct, and recycle items like clothing, carpet, furniture, mattresses, electronics, lightbulbs, tires, lumber, concrete, and more.

Overview of the Washington Recycling Development Center

The Washington Recycling Development Center (RDC) was created in 2019 to strengthen recycling markets in Washington State (see Appendix 1 for statute text).[2] The RDC is a partnership between the Department of Ecology (Ecology) and the Department of Commerce (Commerce), with staff members from both agencies.

While multiple government agencies in Washington focus on various aspects of waste management and recycling, the RDC has a unique focus on developing markets for recyclable materials (see Appendix 2 for details on public agencies that focus on recycling in Washington).

The RDC's founding legislation outlines core duties for each agency in alignment with their strengths and abilities:

- Ecology
  - Make recommendations on state policies that affect recycling markets
  - Work with stakeholders involved in the recycling market and recyclable materials
  - Study and share developments in recycling markets
  - Provide grants or contracts to further develop recycling markets
  - Provide business or marketing assistance to public and private sector stakeholders
  - Represent the state in regional and national market development forums
- Commerce
  - Recruit, retain and expand sustainable businesses, and encourage opportunities to transition from a linear to a circular economy
  - Promote manufacturing of recycled commodities and provide assistance to recycling businesses
  - Promote recycled content for state agency purchases
  - Support industry-led consortiums that drive innovation and solve key challenges

- Support, promote, and identify research and development related to advancing the circular economy

Since its inception, the RDC has made progress on several fronts. It regularly convenes its advisory board, participates in regional and national conferences, publishes reports on markets for specific recyclable materials, and provides solid waste and recycling data to the advisory board and other interested parties. It meets with processors and manufacturers, facilitates business connections among them, and talks with trade associations about how to boost recycling markets. In 2021, RDC grants funded 13 market development projects for local governments and universities.[3] In 2021 and 2022, RDC grants helped establish two market development organizations: NextCycle Washington, which provides technical and financial support for recycling and reuse projects, and the Washington Materials Marketplace, an online platform for businesses to trade recyclable or reusable materials.[4]

Project context

As a relatively small program with limited resources, the RDC must carefully choose activities (e.g., research, grants, presentations) and materials (e.g., paper, plastic, glass) on which to focus. The RDC intends to establish more systematic methods for prioritizing available staff time and resources. To do so, the RDC is exploring various quantitative metrics that may influence prioritization, such as the economic and environmental benefits of increasing recycling for specific types of materials. The RDC is also considering influential non-quantitative factors like Ecology and Commerce priorities, local industry context, and others. Having more structured prioritization processes would help the RDC justify its decision-making and strengthen funding requests.

Project overview

To help shape its approach to prioritization, the RDC contracted with the University of Washington's Evans School of Public Policy and Governance Student Consulting Lab for this study. Evans School consultants gathered and analyzed information about how similar organizations inform their operations, priorities, and decision-making related to recycling market development. Consultants conducted interviews with market development organizations and related entities across the United States (U.S.), with the goal of answering the following research questions:

- **What are effective ways for the RDC to use quantitative metrics and qualitative factors to inform its operations, priorities, and decision-making for market development?**
- **What experiences of other organizations could inform the RDC's investments?**

Chapter 2: Literature Review

This chapter summarizes existing literature relevant to the RDC's desire to develop clear evaluative criteria and decision-making processes to foster recycling market development. It includes background on the concept of a circular economy, international context resulting in the need for domestic recycling market development, and an overview of publicly funded market development in the U.S. Additionally, we explored literature on organizational decision-making and factors that typically influence decisions in recycling market development. We identified appropriate resources through both database searches and guidance from the RDC.

Background on the circular economy

The concept of a circular economy underlies recycling market development. A circular economy is an economic system that is regenerative, minimizes waste by design, and improves the environment. It works to reduce litter, toxic chemicals, material going to landfills, and greenhouse gas emissions through development of new uses and markets for recyclable materials. This resilient system stands in contrast to the current linear economic model, in which most resources are extracted from the earth, manufactured into products or packaging, used, then discarded.[5] In short, a circular economy intends to stop waste from being produced.

This systems concept is based on three principles: eliminate waste, circulate materials at their highest value, and regenerate nature.[6] Circular economy principles aim to shift the economy towards a focus on sustainability and resource renewal. As such, recycling and robust recycling markets are essential elements of a circular economy.

In general, much of the material in municipal solid waste could be recovered and used for other purposes.[7] As detailed in Figure 1, a circular economy is a closed-loop model targeting waste prevention at the highest possible levels at all times. In other words, it effectively minimizes negative externalities because:

1. Biodegradable materials and nutrients are returned to the Earth to actively regenerate nature (building natural capital and balancing the flow of renewable resources) and
2. Products, materials, and technical components are kept in continuous circulation through reuse, repair, remanufacture, and recycling processes (optimizing resource yields).[8]

There are serious critiques of the concept of circularity, including the practical challenges of energy-intensive manufacturing, unintended systems failures, or adverse impacts on climate or ecology.[9] For example, as Llorach-Massana et al. remarked, "the 100% closed cycle is difficult (or even impossible) to implement. The full waste recovery would require an extraordinary increase of transport and management of goods that are associated with higher energy consumption."[10] Nevertheless, the circular economy framework is an important tool in the effort to regenerate our planet through sustainability.[11]

Circular economy initiatives are being developed across the globe—from the European Union's Circular Economy Action Plan[12] to the City of Charlotte's Circular Charlotte[13] to Amsterdam's Circular Strategy 2020-2025[14] to the King County's Zero Waste Plan[15]—to challenge the notion that waste is inevitable. At the national level, the U.S. Environmental Protection Agency entitled

its 2021 National Recycling Strategy "Part One of a Series on Building a Circular Economy for All,"[16] indicating its commitment to the concept. Currently, the RDC works to support innovative actions and encourage opportunities in Washington that will result in positive impacts on the state's circular economy.
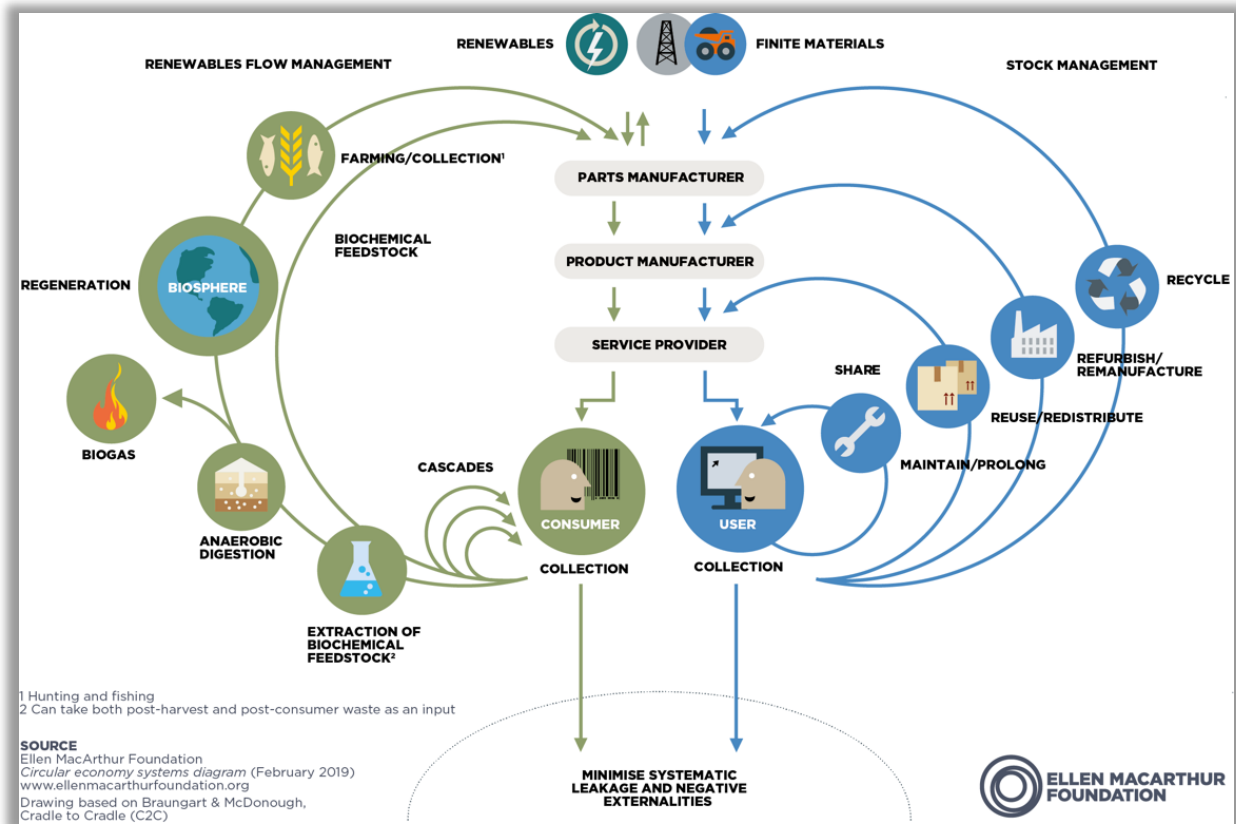
Figure 1: Circular economy system diagram. This diagram ("the butterfly diagram") created by the Ellen MacArthur Foundation illustrates the continuous flow of biological materials [left-hand side] and technical materials [right-hand side] in a circular economy.[17]

Overview of circular economy transition barriers

States, regions, cities, global think tanks, and advocacy organizations are spearheading circular economy efforts. Yet, the barriers are significant. Organizations like the RDC need to develop approaches to overcome such obstacles.

Some government agencies and solid waste industries have been slow to adopt circular economy principles, evidenced by inadequate capitalization and business planning for a shift away from waste management toward sustainable product development. Examples of barriers include:

- Governments and industries lack recycling technology or infrastructure for waste processing, slowing the change towards new uses for old materials.
- Government programs may lack funds for circular economy initiatives due to competing pressures for scarce resources.

- Circular economy entrepreneurs may not have access to seed money opportunities generated by private industry, academic institutions, or other government agencies.
- Manufacturers and producers do not bear responsibility for the disposal of their products, so they do not have incentive to shift towards sustainable product development.
- Supply chain members benefit from a friendly political and regulatory environment, creating resistance to change in the waste industry.
- Consumers worry about the inconvenience of recycling and reusing materials.[18]

While the obstacles confronting circular economy projects are significant, the urgency with which society must act to protect itself from environmental damage demands that we embrace the challenges of circular economy implementation.

Any organization that is shifting from the linear "take-make-use-dispose" model to a circular regenerative growth model must consider technological, policy and regulatory, financial, economic, managerial, measurement system, customer, and social barriers. As such, the RDC will need to strategically overcome barriers across the multiple stages of the shift from status quo to waste minimization.[19] In all aspects of waste management—including the design of new products, financing, evaluation planning, education, retooling recovery, processing, and operations—transforming into a holistic circular economy requires barrier resolution and meaningful measurements.

Context for domestic market development

China's National Sword policy

While recycling market development could be pursued at an international scale, recent events have underscored the need for domestic recycling capacity in the U.S.

Until the mid-2010s many West Coast MRFs sold recyclable materials to processors and manufacturers in China. In 2017, for example, about 70 percent of plastic recyclables from the U.S. were exported to China,[20] since China had the willingness to purchase and process these materials at a high market price.[21] Domestic infrastructure development and maintenance was inadequate for processing the totality of U.S.-generated recyclable materials.

However, in January 2018 the Chinese government enacted the National Sword policy that limited scrap imports. The policy banned post-consumer plastic and mixed paper imports and only allowed other materials with a 0.5 percent contamination rate.[22] Contamination refers to anything that makes recyclable material more difficult or impossible to process. Contaminants include food residue, liquids, broken glass, and non-recyclable material. Mixed paper is especially vulnerable to being rendered unusable by contamination. Since the typical U.S. contamination rate is 5-15 percent, the policy effectively prevented Chinese industries from purchasing recyclables from the U.S.[23]

National Sword had a profound effect on the export of recyclable materials across the U.S., as the decades-old end markets for these materials were abruptly made unavailable, threatening total collapse of the U.S. recycling market. For example, Republic Services, one of America's largest waste collectors, sold about 35 percent of its recyclables to China in 2017, but only 1 percent in 2018.[24] Overall, U.S. scrap exports to China decreased by 38 percent in 2018.[25] As MRFs across

the U.S. scrambled to find alternative buyers, prices for recyclable materials plummeted.[26] Many recyclables were collected and sent to landfills or no longer collected, while residential recycling rate fees increased. Plastics, specifically, were landfilled at an additional 22.3 percent.[27] While prices for recyclable materials have rebounded significantly, they are still below previous levels nationally.[28] This rebound reflects increased demand from new recycling markets. While a positive sign, recycling in the U.S. remains in a period of transition.[29]

Impact on recycling in Washington

The fallout from National Sword greatly impacted recycling within Washington State. Ecology reports that, prior to National Sword, more than 60 percent of Washington recyclables were shipped to China due to the ease of shipping from Washington's ports.[30] Following National Sword, Washington's recyclables were still picked up (curbside or drop box), however once processed many of these materials had no viable sales channel, resulting in stockpiles at MRFs.[31] Mixed paper storage was of particular concern as it could not be stored inside due to fire hazard yet would begin decomposing outside due to the local climate.[32] As a result, large MRF operators, such as Waste Management, Inc. and Republic, were granted temporary authorization to landfill hundreds of tons of Washington's recyclable materials.[33] Prices for baled recyclable materials plummeted from between $95-$100 per ton in 2017 to approximately $5 dollars per ton in 2018,[34] leading solid waste collection companies to request an unprecedented amount in rate increases from their clients and the Utilities and Transportation Commission.[35] It is not expected that China will lower its standards for imported recyclables under National Sword, and MRFs do not currently meet the 0.5 percent contamination standard.[36]

Publicly funded recycling market development in the U.S.

Across the U.S., a variety of state and city governments have established entities focused on recycling market development. Although these efforts have renewed urgency since China's National Sword policy was passed, some state recycling market development centers (centers) have been operating for decades.[37] Many of these longstanding centers were supported by the EPA's Jobs Through Recycling grant program in the 1990s.[38]

Publicly funded centers are structured in various ways. Most are housed within state or city government, but some are independent non-profits funded by a government agency. For example, the Pennsylvania Recycling Market Development Center is a non-profit funded by the Pennsylvania Department of Environmental Protection and headquartered at a public university.

Publicly funded centers focus on a wide range of priorities, influenced by their level of maturity and state or local context. Table 1 provides an overview of the objectives and activities that centers typically pursue.[39] Note that some centers address broader circular economy goals, but this table focuses specifically on recycling market development and excludes topics like composting, reuse, and repair.

Table 1:A Typical objectives and activities for publicly funded centers. This table details example activities for 6 recycling market development objectives.

General objective	Example activities
Increase the value of recyclable materials by reducing contamination[a]	• Run public education campaigns to reduce contamination before materials reach MRFs • Provide grants and technical assistance to help MRFs upgrade sorting equipment • Advocate for policies that reduce contamination (e.g., multi-stream collection systems)
Support businesses in the recycling supply chain (i.e., increase processing of recyclable material into feedstock; help manufacturers adopt or increase the use of recycled feedstock as raw material in place of virgin materials)	• Provide direct funding (e.g., grants or low-interest loans) • Promote federal or private funding opportunities • Provide technical consulting, business consulting, and education (either 1:1 or via events like webinars, workshops, or conferences) • Assist with regulatory compliance • Connect MRFs, processors, and manufacturers through direct referrals, events, and online marketplace tools • Support and/or host startup incubator programs (e.g., NextCycle Washington) • Recruit businesses to relocate to their jurisdiction
Support local governments	• Provide funding and consulting for projects related to recycling market development
Track and report on local recycling activity	• Collect and maintain updated data on the volume of recyclable material that is disposed vs. collected for recycling • Maintain a list of local entities involved in the recycling supply chain • Estimate the volume of demand in the local supply chain for different types of material
Promote recycling to policymakers and the public	• Report on the positive economic and environmental impacts of recycling • Promote products made with recycled materials to consumers (often through online 'Buy Recycled' directories) • Advocate for relevant legislation (e.g., extended producer responsibility laws, procurement laws requiring governments to purchase products made with recycled materials, tax incentives for recycling-related equipment, landfill bans for certain materials, etc.)
Promote waste reduction	• Advocate for relevant legislation (e.g., bans on plastic bags and other single-use plastics, requirements that allow for reusables etc.)

[a] In Washington, Ecology's Contamination Reduction Outreach Program focuses on this issue

Publicly funded centers do not operate in a vacuum. They collaborate with other organizations, non-profits, governments, businesses, and universities. Collaborations identified in our research include:

- The EPA, which includes "improve markets for recycled commodities" as an objective in the 2021 National Recycling Strategy
- Regional organizations like the Southeast Recycling Development Council (SERDC) and Northeast Recycling Council (NERC)
- Private consulting firms like Resource Recycling Systems (RRS), Reclay Group (formerly RSE USA), Burns & McDonnell, and Circular Matters
- Industry organizations like AMERIPEN (American Institute for Packaging and the Environment)
- Non-profits like the National Recycling Coalition and The Recycling Partnership
- Local universities, such as the Pennsylvania center's affiliation with Penn State University and Phoenix Public Works' partnership with Arizona State University

Other private and non-profit organizations work on related issues but are not directly involved with publicly funded centers. These include:

- The Institute of Scrap Recycling Industries (ISRI), the Sustainable Packaging Coalition (SPC), Cradle to Cradle Products Innovation Institute, the Ellen MacArthur Foundation, and the investment firm Closed Loop Partners

Organizational decision-making

Because our analysis investigates how public market development centers prioritize and make decisions, this section summarizes relevant literature on organizational decision-making.

Many decisions in public organizations require formal processes and multiple approvals. However, smaller decisions are frequently made in less formal contexts at multiple levels within organizations.[40] Without well-considered processes for these smaller decisions, decision-maker biases and organizational power dynamics may easily diminish decision accuracy because perceptions from any role rarely align closely with objective performance measures.[41] Allowing decisions to rest on intuition also makes those decisions more difficult for other stakeholders to interpret.[42]

Organizations often turn toward data-centered decision-making to remedy challenges with an intuition-based approach. Highly successful public organizations often focus on measuring progress towards mission-oriented goals.[43] This focus is often emphasized in their cultures and internal communications.[44]

However, good decisions rely on shared goals, common understanding, and integrating information well, which can be challenging as an organization expands its data usage.[45] Pressure to move towards data-driven decision-making too quickly can result in an organization collecting more data than it has the capacity to interpret.[46] Collecting too much data too quickly also makes it more likely the organization will capture redundant or irrelevant information, further taxing their analytical capacity.

In response to data over-collection, organizations may revert to intuitive decision-making or seek even more data.[47] These coping strategies often create a false sense of certainty, leading organizations to ignore many possible outcomes of their decisions in favor of a preferred outcome.[48] Furthermore, because individuals often weigh competing goals sub-consciously, intuition continues to play a large role in data-centered organizations. [49]

To help alleviate these challenges, organizations can develop processes to 1) better identify what type of information will improve decision accuracy and 2) integrate that information into decisions.[50] Academic organizational psychology literature is rich with analyses of decision-making processes. We summarize some broad categories of processes below.

1. **Learning forums for single and double loop learning:**[51] Single-loop learning is the practice of establishing performance measures and progress reviews for programs and activities with the goal of streamlining processes and improving productivity. Double-loop learning is the practice of evaluating underlying organizational assumptions, questioning organizational goals, and determining the value in pursuing different strategic courses of action. Learning forums are regular events with third-party facilitators with the goal of sharing both quantitative and experiential knowledge about organizational position and reasons for that position. When used to establish bottom-up and top-down communication channels between managers and staff, these forums can build shared understanding and lead to more accurate decisions. If used to reinforce hierarchy or present data confrontationally, the impact of these forums is limited.

2. **Action planning:**[52] This approach focuses first on identifying an organizational vision that incorporates viewpoints from multiple stakeholders within and outside of the organization, followed by compiling data to assess the current state of the organization relative to that vision. After assessing gaps, planning committees develop short, medium, and long-term goals to close those gaps together with relevant measures to assess progress. This approach prioritizes immediate actions to reach short-term goals and uses frequent short planning periods to reassess progress. This approach balances mission-alignment and agility, but it can be challenging to implement if the organization does not already have sufficient data available for initial assessments.

3. **Analytically simplifying multiple objectives**:[53] This class of processes attempts to break a complex issue into smaller components, each of which has clearer decision-making criteria or ways of rating potential actions and outcomes. Sub-objectives are assigned weights, and weighted outcomes on each sub-objective are summed to determine a course of action. These approaches allow for formal sensitivity analyses and serve as communication tools in and of themselves. It can be challenging to incorporate qualitative attributes.[54] The focus on a fixed set of alternative courses of action can limit decisionmakers' perceptions.[55]

4. **Decision trees**: The class of processes attempts to create flowcharts that end in decisions based on attributes of the challenge at hand. They are commonly used in situations where similar decisions occur regularly but are complex. They enable complex decision-making structures but must be completely specified in advance. These also focus on deciding between preset alternatives and encourage a belief that outcome and risk are completely designated by the position of the decision in the tree, creating a false sense of security.[56]

5. **Scenario planning**: In this approach a group considers multiple plausible futures. They either select a scenario they find robust and develop solutions for that scenario or find solutions that work across many scenarios. Overreliance on a single scenario can lead to maladaptive action and high belief that the specifics of that scenario will actually occur.[57] Considering multiple scenarios reduces participant confidence in any particular outcome, but increases their confidence in their selected actions and may enhance organizational adaptability.[58] Scenario construction can be biased towards optimistic scenarios, complex scenarios, and scenarios that reflect the past.[59] Actively engaging in scenario construction to stretch thinking and avoid these biases improves the range of scenarios and potential solutions developed.[60]

6. **Decision conferencing**: In this approach a third-party decision analyst facilitates a multi-day discussion, walking the organization through several decision-making processes. The common purpose of the event and commitment to action may spur greater organizational buy-in and create greater space for discussing disagreements in assessments. Empirically the success of these events is difficult to measure.[61]

The literature suggests several safeguards that can improve decision-making outcomes regardless of the process used. A key strategy is to develop multiple ways to respond to potential decision outcomes in advance.[62] Formal planning, receiving feedback from a wide range of individuals, or including generalists as team members are good ways to help develop these responses.[63] For greatest impact, these responses should focus on areas where unlikely outcomes have the potential to have the most severe consequences for the organization.[64] Organizations must both notice detrimental outcomes and implement responses effectively.[65] Other potential safeguards include making incremental decisions and assessing outcomes prior to large investments and incorporating educational events during planning activities to encourage individuals to share their perceptions of organizational status and risk.[66]

Decision-making factors and considerations in recycling market development

Numerous governmental organizations have established indicators for tracking the development of recycling programs specifically, and progress towards a circular economy more generally. In Chapter 4, we will consider such factors in use by state and municipal organizations with mandates similar to the RDC's. In this section, we provide additional context to better situate those findings.

Lack of standardized definitions and evaluation criteria for recycling programs

States and municipalities across the U.S. measure the success of their recycling programs in various ways. Given this lack of standardization, the EPA's 2021 National Recycling Strategy set an objective to "standardize measurement and increase data collection" for U.S. recycling systems, including the following sub-objectives:[67]

- Develop and implement national recycling system definitions, measures, targets, and performance indicators.

- Create a tracking and reporting plan.
- Create recycled content measures.
- Coordinate domestic and international measurement efforts.
- Increase data availability and transparency about recyclable materials generated and the materials manufacturers need.

While these goals are valuable, accomplishing them will take years of work. In the meantime, recycling programs in the U.S. – and thus publicly funded recycling market development centers – continue to use various definitions, tracking systems, and success metrics for similar processes.

Solid waste characterization and recycling collection studies

Most states use solid waste characterization studies to estimate the tons of each type of recyclable material that is disposed in landfills. For example, Ecology hires a third-party consultant to conduct a state waste characterization study approximately every five years. The most recent Ecology study estimated the composition of Washington's disposed municipal solid waste in 2020-2021 by taking 520 samples from landfills and waste transfer stations and reviewing four local studies conducted in Seattle, King County, Bellingham, Pierce County.[68]

States also conduct studies to estimate the tons of each type of recyclable material collected for recycling.[69] In WA, regulated recyclers and MRFs must annually report the tons they handle to Ecology, and Ecology asks non-regulated collectors of recoverable material to report what they collect through an annual survey.[70]

States often use these studies to calculate various ratios and percentages to measure the success of recycling programs overall and for specific materials. For example, a state's "recycling rate" or "diversion rate," measures the tons of material collected for recycling, composting, and other forms of material recovery divided by the total tons of solid waste (recovered, landfilled, or incinerated).[71] The recycling "capture rate" or "recovery rate" measures the tons of material collected for recycling or composting (adjusted to exclude estimated contamination) divided by the tons of recyclables or compostables in the entire waste stream.[72] States may also track the weight of collected recyclables per capita and total solid waste per capita (pounds per person per day) over time.[73]

Common quantitative measurements of recycling benefits

This section provides an overview of two specific types of quantitative metrics that centers commonly estimate: the positive economic and environmental impacts of recycling. While this section explains the benefits in general, centers typically attempt to calculate specific local or regional benefits.

Environmental benefits of recycling – typical quantitative metrics

Recycling reduces three key measurable negative environmental impacts: landfill volume (measured in tons), greenhouse gas (GHG) emissions (measured in metric tons of carbon dioxide equivalents), and energy use (measured in kilowatt hours). Details about these outcomes are below.

- Reduction in landfill volume and associated GHG emissions:
  - Landfills pose a risk to water and soil quality through leachate leakage, which occurs when precipitation seeps through a landfill into the soil and groundwater, carrying contaminants with it.[74]
  - Landfills also emit GHGs, including carbon dioxide and methane.[75] In 2017, municipal landfills accounted for about 14 percent of methane emissions in the U.S.[76]
  - Delivering recyclable materials to a landfill eliminates the benefits of recycling or reusing that material.
- Reduction in energy use and associated GHG emissions:
  - In addition to averting GHG emissions by reducing landfill volume as discussed above, recycling also lowers emissions by decreasing the amount of energy used for resource extraction and manufacturing. For example, compared to making products using virgin raw material, using recycled content in manufacturing processes reduces the amount of energy required by up to 95 percent for aluminum, 88 percent for plastic, 85 percent for copper, 74 percent for steel, 68 percent for paper, and 25 percent for glass.[77]

Recycling market development centers typically use the weight of material recycled within their jurisdiction to estimate the local contribution to GHG emission and energy use reduction. The EPA Waste Reduction Model (WARM) calculator[78] is frequently used to compare the emissions and energy use associated with recycling a certain material to those associated with landfilling the material.

Economic benefits of recycling – typical quantitative metrics

Across the U.S., entities like MRFs, material processors, and manufacturers employ hundreds of thousands of people and thus generate economic activity. The EPA estimates that in 2012 alone, recycling and reuse activities contributed 681,000 jobs, $37.8 billion in wages, and $5.5 billion in tax revenues.[79]

Recycling market development centers typically estimate these local economic benefits based on the companies involved in the end-market ecosystem in their jurisdiction. They often use input-output models such as IMPLAN to estimate the direct, indirect, and induced economic impacts of those companies.[80] In these models, indirect impacts represent the economic activity generated by businesses that interact with recycling businesses, and induced impacts represent the economic activity generated by recycling business employees' spending.[81]

Additional non-quantifiable economic and environmental benefits

Recycling has many other environmental and economic benefits that are not easily quantifiable. For example, as resource extraction has more than tripled since 1970,[82] recycling uses the earth's

limited resources more efficiently and reduces the loss of economically valuable material to landfills and incinerators. Recycling also reduces litter in the environment, such as the millions of tons of plastic in the oceans.[83] While these broad benefits are widely touted by market development centers, they are not usually estimated and used as quantitative metrics.

Relationship to social impacts

Environmental and economic benefits are only two of the many societal effects of circular economy and recycling programs. Such programs tend to overlook many social and community-level considerations, including impacts on culture, psychological state, health, and wellbeing.[84] The World Health Organization suggests numerous potential positive and negative social impacts from circular economy development,[85] though additional research is necessary to better understand appropriate measures.[86]

Washington RDC evaluation criteria

The RDC has developed success targets in collaboration with its advisory board (see Appendix 3).[87] Some of these indicators focus on the completion of particular types of engagements with stakeholders, while others focus on specific material and economic targets.

The RDC is currently piloting a project ranking system across Ecology goals, Commerce goals, Advisory Board goals, and their legislative mandate.[88] Specific prioritization criteria include: reducing greenhouse gas emissions, supporting equitable economic growth, engaging stakeholders and conducting outreach to facilitate market development, increasing material for circular end use, compiling and disseminating knowledge, providing grants, supporting research and development efforts, and diverting materials from landfills.

Chapter 3: Research Methods

In alignment with our research questions, we designed our research methods to identify effective ways for the RDC to inform its operations, priorities, and decision-making for market development.

Following our literature review (see Chapter 2), through discussions with the RDC we identified an initial list of recycling market development centers to investigate. We added to that list over time by asking organizations we interviewed to recommend additional contacts and by independently identifying other mature state-level recycling market development centers. For each organization, we gathered information in three ways:

1. Examination of publicly facing websites and reports,
2. Interviews with senior organization staff, and
3. Follow-up emails to confirm and clarify interview takeaways.

We used qualitative analysis methods to evaluate the information we gathered and produce summaries of our findings (see Chapter 4).

The rest of this chapter provides greater detail on our data collection and analysis designs, closing with a discussion of limitations of this research approach.

Data acquisition and organization

Choosing organizations to investigate

Our research focused on publicly funded recycling market development centers ("centers") and their direct partners, including nonprofits and consulting organizations working in this space.

We completed two rounds of interviews. The first round was comprised of organizations the RDC suggested. The second round was comprised of centers identified during our literature review and suggestions from organizations interviewed in the first round. We prioritized the organizations the RDC suggested in the first round because of the RDC's interests and their ability to facilitate interview scheduling.

In total, we interviewed representatives from the 19 organizations listed below.

We interviewed 14 organizations regarding their own recycling market development activities:

- State level
  - Colorado Department of Public Health and Environment (CDPHE)
  - Indiana Department of Environmental Management (IDEM)
  - Massachusetts Department of Environmental Protection (MassDEP)
  - Michigan Department of Environment, Great Lakes, and Energy (MI EGLE)
  - Minnesota Pollution Control Agency (MN PCA)
  - Missouri Environmental Improvement & Energy Resources Authority (MO EIERA)
  - Ohio Environmental Protection Agency (OH EPA)
  - Pennsylvania Recycling Markets Center (PA RMC), a non-profit funded largely by the Pennsylvania Department of Environmental Protection

- - - Resource Recycling Systems (RRS), operator of NextCycle Colorado, itself a nonprofit funded by CDPHE
    - South Carolina Department of Commerce
    - Texas Commission on Environmental Quality (TCEQ)
- City level
    - Envision Charlotte (North Carolina), a nonprofit
    - Phoenix Public Works (PPW) Circular Economy Initiative (Arizona)
    - Another city-level program (anonymized)

We were also in discussions with the California Department of Resources Recycling and Recovery to arrange an interview, which they unfortunately ultimately declined.

We interviewed 5 other organizations regarding their own operations and those of the centers they support or encourage:

- American Institute for Packaging and the Environment (AMERIPEN)
- Burns & McDonnell, a private consulting firm interviewed specifically about their work with TCEQ
- Circular Matters, a private consulting firm
- Northeast Recycling Council (NERC), a regional non-profit providing services in 11 states
- Southeast Recycling Development Council (SERDC), a regional non-profit providing services in 11 states
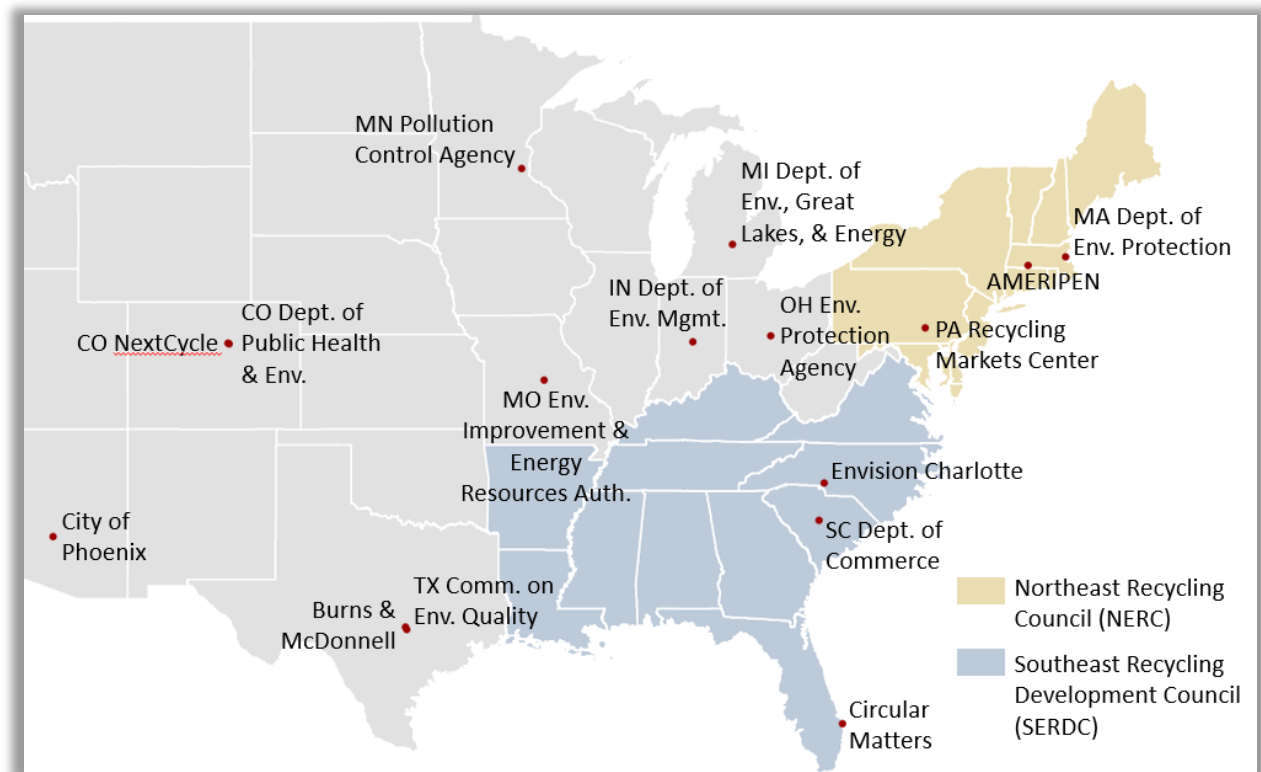

Figure 2: Map of interviewees. This map displays the 19 organizations we interviewed for this project.

Data collection

Online data

Before engaging organizations in interviews, we examined sources from our literature review (see Chapter 2), organizational websites, and publicly available reports. From this research we identified key decision-making arenas, processes, goals, and evaluative criteria in use.

Interviews

We created a standard list of interview questions based on the findings of our literature review (see Chapter 2), our review of interviewees' online resources, and the RDC's interests. We aligned our questions with interview format best practices, including appropriate consent and data use disclosures, wording, and question order.[89] Please see Appendix 4 for our interview protocol and general interview questions. We added a few customized questions for each organization based on their websites and reports.

We sent interviewees copies of disclosures and questions ahead of interviews to help them prepare. A single team member conducted each interview. Multiple team members provided notetaking and recording support. We recorded interviews and used voice-to-text software to create interview transcripts. These transcripts allowed us to better identify and track commonalities across organizations during the analysis phase of the project. To encourage interviewees to be candid in their responses, transcripts were only used internally and were deleted after analysis was complete.

Follow-up emails

At the completion of the interviewing phase of our project, we emailed interviewees to clarify technical details and request some additional information regarding organizational resourcing. Each organization was given the opportunity to review a draft of our findings to verify the accuracy of our portrayal of their interview responses.

Analysis design

We used standard content analysis methods to examine our interview transcripts.[b]

First, we identified concepts to look for in the interviews based on the interests of the RDC (a "deductive" approach). We then read the interview transcripts to identify additional concepts pertinent to our research questions ("inductive" approach). We compiled the important concepts (called "themes") and specific cases of those concepts (called "codes") into a shared document.

The full list of themes and codes we used is available in Appendix 5.

Next, we made note of where each "code" appeared in every transcript (called "coding"). Two team members independently coded each transcript to ensure that nothing was missed and to account for different interpretations of the codes. We resolved coding disagreements through

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[b] For a full treatment of content analysis and related concepts see H. Russell Bernard, Gery W. Ryan, and Amber Y. Wutich, *Analyzing Qualitative Data: Systematic Approaches*, SAGE Publications, 2016.

group discussion (rather than the more scientific practice of computing intercoder reliability statistics).[c]

We used coded transcripts to aggregate information shared by our interviewees about specific measures, processes, activities, and challenges.

Limitations and mitigation strategies

Our research methods had several weaknesses, which we attempted to mitigate through our sampling design.

First, the way we chose our interviewees led to limitations in our findings. Our initial sample was a convenience sample[d] that in some ways also served as a purposive sample.[e] Convenience and purposive sampling can lead to bias in results. Both approaches may limit findings to researcher favored perspectives.

The following aspects of our sampling design reduce the potential bias introduced by starting with a convenience sampling approach:

1. Four organizations the RDC suggested offer a broad view on recycling market development organization data and decision-making practices across several entities, including industry viewpoints:
    a. An industry-oriented organization that provides services across several government programs and affiliated business partners: AMERIPEN
    b. Two organizations that provide regional services to several states regarding recycling market development: SERDC and NERC
    c. A consulting firm that provides services across several public entities: Circular Matters
2. We enhanced our list of potential interviewees through two methods described below. From this list we selected additional organizations to interview, prioritizing mature organizations whose online presence indicated they may have different perspectives from organizations we had already investigated:
    a. We conducted snowball sampling, that is, we asked for suggestions for additional recycling development organizations to investigate from each organization we interviewed.
    b. We compiled a list of state and local level recycling market development organizations operating across the U.S.

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[c] Such an approach supports incorporating multiple perspectives into the knowledge generation framework, as advocated in Lucy Yardley, "Demonstrating Validity in Qualitative Psychology," The Journal of Positive Psychology, Vol. 12, No. 3, 2016, pp. 295-296. The advantages and disadvantages of intercoder reliability statistics are often debated in academic circles. See for instance Cliodhna O'Connor and Helene Joffe, "Intercoder Reliability in Qualitative Research: Debates and Practical Guidelines," *International Journal of Qualitative Methods*, Vol. 19, 2020.

[d] Convenience sampling is the practice of selecting research participants based on the ease of identifying and contacting said participants. See, for instance, Bernard et al.

[e] Purposive sampling is the practice of selecting research participants based on individual characteristics that researchers believe will be correlated with perspectives of particular interest. See, for instance, Bernard et al.

Second, our study reflects the opinions of a small number of organizations. As such, we cannot draw large-scale conclusions about the prevalence of reported experiences or statistically predict how related events may unfold within the RDC.

Lastly, the time-limited nature of our project restricted the extent to which we could engage with each interviewed organization. We interviewed each organization only once – meaning that we did not receive comprehensive, definitive information about each organization, but only a glimpse determined by the person (or people) we interviewed. Also, despite our efforts to standardize our interview questions ahead of time, we discussed certain topics with some interviewees and not others since we asked follow-up questions depending on information that was shared.

As we progressed through our interviews, the content of each interview was increasingly redundant. Given this fact, we are confident in the comprehensiveness of the material we uncovered.

Chapter 4: Findings

This chapter reports the key information learned from our 19 interviews with recycling development centers and related organizations. First, we cover factors that interviewees said influenced decision-making and program activities – including mandates, funding, equity, landscape analysis, and stakeholder engagement. Then we describe how interviewees choose which recyclable materials to prioritize, how to award grants, and how to communicate with different audiences. Lastly, we report how interviewees use comprehensive planning, how they are impacted by challenges with data, and the role of strategic alliances in their program operations. We close the chapter with explicit advice interviewees provided. These topics are shown in Figure 3 below.

Influential factors	Key processes
Goals, mandates, & funding sources	Prioritizing specific materials
Equity & environmental justice	Awarding grants
Landscape analysis & stakeholder engagement	Influencing various audiences

Additional findings	Advice from interviewees	
Planning & progress measurement	Stay on mission	Plan surveys carefully
Data issues	Build relationships	Prioritize data
Alliances	Look across borders	Align with the EPA

Figure 3: Content of Chapter 4 – Findings. This shows the four sections of Chapter 4 and key sub-sections therein.

The interviews were guided by our research questions (see Appendix 4 for specific interview questions):

- What are effective ways for the RDC to use quantitative metrics and qualitative factors to inform its operations, priorities, and decision-making for market development?
- What experiences of other organizations could inform the RDC's investments?

A note on commonly used metrics

Throughout this chapter, we refer to quantitative metrics that interviewees commonly use. Our interviews confirmed that centers use metrics previously mentioned in Chapter 2 to guide decision-making and communicate with various audiences. Key metrics include:

- Volume of recyclable material being landfilled (per waste characterization studies) and collected for recycling, and related ratios (per Chapter 2)
- Reductions of GHG emissions and energy use attributed to recycling (often calculated using the EPA WARM model)

- Direct, indirect, and induced economic impacts, such as jobs, wages, and tax revenue, associated with companies involved in the recycling supply chain (often calculated using the IMPLAN model)

Factors that influence decision-making and program activities

This section discusses specific quantitative and qualitative evaluative criteria interviewees use to inform their operations, priorities, and decision-making for market development.

Market development priorities depend on a center's goals, mandates, and funding sources

Unlike more discretionary decisions discussed in the sections below, centers are obligated to operate according to their goals, mandates, and funding source requirements.

The nature of the center's host agency and founding legislation

Publicly funded interviewees that are not part of environmental agencies – the Phoenix Circular Economy Program, PA RMC, and SC Department of Commerce – tend to focus more on direct assistance for businesses and entrepreneurs. Also, a center's founding legislation may specify a certain focus. For example, the RDC's statute specifies an "initial focus on mixed waste paper and plastics."[90]

Centers may lack the statutory authority to undertake several types of actions that they may otherwise find beneficial to achieving their program goals. For instance, because TCEQ is a regulatory agency and cannot engage in legislative advocacy, the state's recycling market development plan recommends establishing a center as a university affiliate or independent nonprofit.

Direction from state or local policy

Sometimes, market development centers are directly instructed to conduct certain activities by law. For example, TCEQ conducted two studies in response to mandates from the state legislature.

Occasionally, priorities are shaped by relevant policies. For instance, MI and IN have official state recycling rate targets that influence market development priorities. In Michigan, the recycling rate target leads MI EGLE to focus on recyclable collection activities in addition to processing and manufacturing capacity. In IN, construction and demolition (C&D) materials get less attention than traditional recyclables because they are not included in the state's recycling rate target.

While relevant policies shape priorities, market development centers are not solely driven by them. For example, the CO Resource Recycling Economic Opportunity grant fund has a landfill diversion objective per legislation, but CDPHE can also awards grants to projects that do not contribute to that objective. Projects that address tires and e-waste are not technically contributing to landfill diversion because those materials are banned from landfills in CO, but they have still received grants from CDPHE.

Directives from authoritative "higher-up" entities

Interviewees are sometimes instructed to focus on certain activities by an authority at the state or city level. For example, both city-level government programs we spoke to are strongly influenced by their city councils. The SC Department of Commerce has focused on specific recyclable materials that are important to the Department of Health and Environmental Control, with which they are under contract.

Interviewees are also sometimes directed by boards of directors with decision-making authority. For instance, IDEM's market development board chooses their priorities and activities in strategic planning sessions every couple of years. At PA RMC, the board of directors historically chose certain recyclable materials to prioritize (although now those are chosen based on waste characterization studies). Many interviewees' boards, advisory councils, and steering committees do not have decision-making authority but provide guidance (see sections below for more details).

Funding sources

Clearly, lack of funding limits what centers are able to do. Additionally, centers may receive funding designated for certain purposes. For example, one city department we spoke to is funded specifically by ratepayers rather than by all taxpayers. Their funds must be spent to benefit ratepayers, and they are not able to give large grants to private businesses.

Equity and environmental justice play an increasingly large role

Measures of equity and environmental justice are a relatively new focus of recycling development centers. Some interviewees have recently begun assessing related metrics, but most organizations, including the RDC, are still developing protocols for assessing and implementing equity in their programming. This section focuses on the use of equity and environmental justice in evaluating grant applications, measuring gaps in infrastructure and access, increasing accessibility, and difficulties associated with implementing equity programming and evaluating impacts.

Equity factors incorporated into funding projects and grants

Of our interviewees, two organizations explicitly mentioned incorporating equity as part of their scoring systems for evaluating whether to provide grants to specific recycling projects. While their process is still developing, MN PCA gives points to proposed projects that are sited within low-income areas or historically marginalized communities. MI EGLE also incorporates equity as one of their three key criteria in deciding how to award grants. The criteria in their 2023 request for proposals includes "projects that will benefit an environmental justice community or underserved and vulnerable populations within a community."[91]

While not specifically a grant program, NextCycle Colorado seeks to make its program accessible to all by simplifying the application process. Additionally, MassDEP provides information in multiple languages to attract more diverse applicants to their grant program.

Increasing access to curbside recycling and processing capacity

Rural areas are less likely to have access to curbside recycling collection than urban areas because collection routes and MRFs are typically more cost-effective in high-population areas. Many interviewees, such as SERDC, identified increasing collection access in rural areas as a key strategy for increasing waste diversion. Only a handful of organizations identified rural access as an issue of inequity, however.

Diminished access to recycling in rural areas was a uniform response among interviewees that mentioned access to curbside recycling programs. Processing centers are typically more cost-effective to locate in high population areas. Due to limited funding, the centers we interviewed typically focus funding on population-dense regions to have a greater impact on waste diversion per dollar spent. Data collected by CDPHE that tracks the recycling and composting rate by city and county exemplifies these discrepancies Using this data, CDPHE has singled out lack of rural access as a challenge for meeting their statewide diversion goals.

In addition to CDPHE, both SERDC and MO EIERA have identified that many rural areas have no access to curbside recycling. They are specifically seeking to fund projects that promote such programs in these areas.

Aside from increasing access in rural areas, MI EGLE highlighted how equitable access to curbside collection can be an issue even within large metropolitan areas. Communities of color and low-income communities in Detroit recently have had limited access when compared to higher income communities in the city. Much of MI EGLE's recent work has focused on closing this gap.

Siting new infrastructure

Interviewees gave conflicting perspectives about the benefits and drawbacks of siting new recycling infrastructure within areas that have been historically marginalized such as low-income neighborhoods and communities of high racial diversity. As highlighted earlier, the MN PCA funds projects sited within such areas to promote economic and job growth within these communities. This is in contrast with PPW, which seeks to avoid developing infrastructure that may increase pollutants in marginalized communities, which have historically been impacted negatively by other industrial pollutants. PPW found that incorporating equity specialists from other government departments during project review has helped avoid this scenario.

Difficulties associated with measuring environmental justice and equity

Every organization that highlighted equity or environmental justice also discussed the difficulties associated with implementing and measuring the impacts of equity policies. While most organizations are still developing metrics to evaluate these policies, equity is intrinsically difficult to measure. Kyla Fisher from AMERIPEN shared that the EPA has an Environmental Justice screening tool (which has been utilized by MI EGLE).[92] While this tool is useful, measuring the impact of equity programming depends on the unique equity issues that face each state or city.

Interviewees also mentioned a lack of resources and staff devoted to equity assessments as key barriers to successful equity programming. One interviewee discussed an inter-department equity tool; however, their current staff finds the tool challenging to use and is uncomfortable

incorporating equity into decisions without additional guidance. They suggested the need for dedicated staff to guide equity efforts.

It is also difficult to measure whether the impacts of increased recycling access and infrastructure are having the intended results within targeted communities. MI EGLE is developing methods to quantify environmental justice in projects. In the interim, however, they rely on self-reported data from potential grantees, which may be inaccurate. MI EGLE also highlighted the difficulties of measuring access, as it is difficult to determine whether infrastructure intended for target communities is being used by consumers from other nearby areas.

Interviewees use landscape analysis and stakeholder engagement to remove barriers and enhance support

Interviewees frequently commented on the importance of a deep understanding of the full recycling supply chain in directing their efforts toward the supply versus demand side of different markets. Feedback from supply chain stakeholders can further enhance this understanding by providing interviewees with specific details about barriers these stakeholders perceive and better allowing centers to anticipate new material markets and expansions of existing material markets. Stakeholders outside the supply chain also influence interviewees more generally. This section discusses specific quantitative and qualitative information obtained through landscape analysis and stakeholder engagement, as well as the role of this information in program operations.

Landscape analysis

Motivation, key questions, and assessments

Landscape or supply chain analysis is the practice of collecting and analyzing data about the location and capacity of different entities in the supply chain to better understand material flows and markets. Interviewees shared several specific ways that understanding this information bolsters the effectiveness of their programs, including:

- Knowing imbalances between processing and manufacturing can help to prioritize a focus on supply-side or demand-side efforts.
- Identifying the distribution of materials and markets can point to places where minimal intervention can create large impacts, such as connecting processors and manufacturers unaware of complementary needs.
- Identifying regional imbalances in supply and demand or differences in urban/rural access helps to pinpoint locations for infrastructure development.
- Recognizing dominant market players can help centers develop more useful contingency plans in the case these entities shutter operations or relocate.
- A full view of the landscape can help focus plans to accommodate a new material or expand resources for an existing material.
- Creating stakeholder maps provides a resource for other supply chain members and local governments, as well as an educational tool for public engagement.

More broadly, interviewees use gaps identified through landscape analysis to guide grantmaking for capital investment and program choice. Using landscape analysis to clarify efficient actions makes it a useful tool early in program prioritization. Landscape analysis also elucidates the

required regional investment to see desired changes by industry and material, helping centers better understand necessary investments to improve program access.

Different interviewees found different challenges with their program design through the use of market analysis. For instance, Texas has more than 250 counties, approximately 160 of which are rural. They face high material transport costs and program access issues. In comparison, a government with a high density of material and industry would not face the same transport challenges but may find capital infrastructure investment more costly due to high land values.

Attributes

Key measures integrated into landscape analysis include:

- Location of supply chain elements, including: material generation by consumers and businesses; processors; manufacturers; landfills; transportation and shipping companies; transportation infrastructure, such as rail, ports, and high quality roads
- Material flows, including: between entities; through a single entity; and the stability of these flows
- Limitations on flow capacity, including: location of equipment; location of labor; and transport or sale restrictions, such as landfill bans or cross-jurisdictional transport bans
- Trends in production, consumption, and new material development, such as: the increase in automobile battery consumption due to increases in hybrid and electric car purchasing
- Infrastructure available by material and region
- Regional pricing differences
- Manufacturer dependence on particular suppliers or materials

Many of these attributes are useful on their own, while others are more useful in combination. For instance, understanding the cost-effectiveness of transporting a material to a processor requires knowing the location of both the material and processor, as well as the condition of the transport network. Additional factors, such as the weight of the material or the cost of land for developing infrastructure also impact these assessments.

Many interviewees noted the importance of considering extra-jurisdictional players when developing landscape analyses and using them to make decisions. While centers are often focused on benefits within their jurisdictions, material markets do not conform to jurisdictional boundaries. For instance, the presence of a large player just outside of jurisdictional boundaries may change regional access, be useful in developing a regional market, or reduce interest in attracting a similar stakeholder to region within the jurisdiction.

Stakeholder engagement

Interviewees use information from stakeholders in many different capacities across their program operations and typically value this information highly. A statement from Matt Flechter at MI EGLE summarizes the sentiments expressed by many interviewees regarding the importance of this information:

> "Because there has to be a reason to act. And the reason to act is you have a strong voice of people that are able to tell their personal stories about why it's important to their community or their business. And data doesn't really help with that. Data just sets the stage."
> – Matt Flechter, MI EGLE

Further, developing stakeholder relationships over time not only provides interviewees with more information and justification for action, but also builds trust, allowing them to build productive partnerships. This section describes stakeholder categories, the types of information they can provide to enhance market development operations, and strategies for collecting this information. It closes with some general considerations to promote effective stakeholder engagement.

Business and supply chain stakeholders

Key stakeholders across the supply chain include waste haulers, MRFs and other material processors, commodity brokers, manufacturers, reuse industry participants, recycling-oriented nonprofits, industry and recycling professional associations, and businesses and nonprofits with large material needs or who generate large amounts of potentially reusable waste (e.g., Habitat for Humanity, erosion control companies, construction companies, and large companies regardless of industry).

Engaging across these groups provides interviewees with information about desired materials and specific barriers interfering with capacity, enabling them to prioritize programs or materials more effectively. In particular, centers may be able to identify small investments with impacts that will reverberate throughout markets.

Haulers and MRFs can provide detailed information about waste stream contamination, helping interviewees direct their public outreach efforts and construct more regionally relevant contamination metrics. Engaging with manufacturers and large businesses to identify synergies between their business goals and the goals of the center can create an opportunity for rapid program advancement. Some interviewees noted that business goals were often not what they anticipated.

Many interviewees mentioned business requests for specific materials as being highly influential in material prioritization. Similarly, business requests for technical assistance are often highly influential over the types of outreach programs centers make available. These requests sometimes cause resource allocation tensions within a center if the business is not in a priority market, however publicly funded centers must be careful not to provide preferential treatment

to specific businesses. Being able to clearly articulate center priorities to businesses approaching a center for assistance can help to alleviate these resource tensions.

Direct information requests directed towards haulers, processors, and manufacturers are often ineffective (discussed in more detail in a later section), however stakeholder forums seeking feedback from supply chain participants are often fruitful at generating information about the biggest challenges participants face. Third party forum organizers can act as connectors between centers and industry members, though many centers noted that government organized forums can also be effective. Participation in business funded recycling market development organizations, such as The Recycling Partnership or The National Recycling Coalition, provides several similar benefits to public forums with a greater focus on business goal alignment. In considering forum design, focusing on a single industry or supply chain element may help identify specific blockers, whereas cross-industry forums allow for a broader perspective. Cross-industry forums may help centers trace how blockers for one industry arise and enable a wide array of supply chain participants to share ideas and engage in collaborative problem solving.

Stakeholders within government

Key stakeholders within government include local recycling programs, regional planning commissions, other government departments (including commerce and economic-focused departments and strategic planning divisions), similar programs in other states and regions, and participants in other levels of government. Authoritative stakeholders, such as legislative bodies and public executives, have been discussed in an earlier section.

Several interviewees noted the importance of finding supportive government stakeholders in other areas to build coalitional support for recycling market development during planning cycles. Engagement across government stakeholders often influences program decisions through enhancing understanding of feasibility, enabling group problem-solving, and creating opportunities for partnerships and regional planning. Cross-agency or cross-department workgroups help interviewees generate ideas, understand available resources and feasibility, and delegate or divide responsibilities. Centers may use these as an opportunity to benefit from well-established processes in another related organization, such as a strategy or equity office. Many interviewees formally partner with economic development offices. A municipal center we spoke with shared that they also work closely with ordinance implementation and marketing teams to make use of their specialized expertise. Similarly, EPA regional workgroups offer opportunities for learning and engagement with other related public entities. Targeted engagements with local governments can enhance alignment between levels of government and surface implementation concerns witnessed at the local level.

Tense political situations between players may have more impact on their program decisions than specific policy goals or more scientific factors. Tensions may arise between governmental branches, levels, or departments. A priority at one level of government may impact decisions at lower levels of government, even if its execution is not mandated. Some interviewees noted partisanship concerns, though often recycling market development is a bipartisan issue.

Other stakeholders and the general public

Other stakeholders include residents, multi-family property owners and managers, organizations with specific recycling goals or expertise (for example, environmental organizations), and members of underserved communities or communities often excluded from public decision-making.

Engaging with members of underserved communities was discussed in depth in the previous section on equity and environmental justice. Communities residing close to industrial areas or recycling infrastructure sites, low-income communities, and racial minorities who have faced historic challenges with public engagement are of prominent concern.

Engaging with the other stakeholders mentioned can help centers to appreciate community interests, desired collection expansions to new materials, community confusion that results in contamination, differences in challenges associated with single and multi-family collections, factional interests, and specialized or technical information.

Often communications initiated by residents and property managers showcase confusion about recycling requirements. These communications can inform outreach programs to reduce contamination. Public forums and surveys, often required as part of the planning cycle, can uncover general public sentiment or be targeted to solicit specific types of information from residents. Some interviewees discussed the role of legislatively sanctioned citizen commissions. Findings of these commissions may influence legislative action and resulting center actions.

General stakeholder engagement considerations

Interviewees expressed four key considerations for engaging stakeholders:

1. Centers may find it difficult to integrate stakeholder feedback effectively when their recommendations are different from existing center objectives. Stakeholders may not understand the limitations of center authorizing legislation or focus on benefits to themselves instead of the common good. For instance, residents may favor prioritizing certain materials because they perceive large environmental benefits but prioritizing other materials may actually lead to larger gains. In spite of this, often a stakeholder group understands their portion of the recycling system more deeply than a center does. Finding ways to integrate these perspectives can increase center effectiveness and efficiency.

2. Often important information that influences center decisions is not collected through formal methods but arrives through opportunistic encounters and conversations. For instance, several interviewees discussed the value of conversing with stakeholders at conferences to identify partnership opportunities or specific businesses interested in relocating to their jurisdiction. More broadly, developing stakeholder relationships over time enhances center opportunities. Greater stakeholder trust increases the level of information they are willing to share. Centers often require partnerships with other organizations to effectively engage in lobbying, conduct research activities, or fund projects outside of their jurisdiction that create a jurisdictional benefit.

3. Stakeholder engagement forums are an inexpensive way to quickly obtain lots of information and better understand what types of data to begin to formally collect. Forums can also help centers identify potential ongoing collaborations. A variety of forums or workgroups with different goals may help to satisfy both the need for understanding group-specific concerns and aiding in cross-group understanding. When determining how to move forward with feedback provided in these forums, consider the most frequent comments, the breadth of comments provided, and comments heard from the most different types of stakeholders.

4. Many interviewees discussed the value they find in drawing on the expertise of their advisory board, observing that the mixed expertise of the board enhanced the quality of advice. Typical board participation noted included members of related public agencies, trade organizations, recycling nonprofits, recycling industry associations, and business participants from key industries.

How metrics and qualitative information shape decisions

This section discusses findings related to how factors discussed in the previous section come into play in several common activities that centers undertake.

Centers use various methods for prioritizing specific materials

Some market development centers choose to prioritize developing markets for specific recyclable materials, such as paper or plastic. This section outlines the factors that influence material priorities according to interviewees.

Volume of certain recyclable material going to landfills

As mentioned above, waste characterization studies estimate the tons of each type of recyclable material landfilled each year. Several interviewees prioritize recyclable materials that are landfilled at a high rate. For example, CDPHE has awarded special grants specifically for projects that divert C&D waste and organic material from landfills because they are heavier materials that occupy a relatively large amount of landfill space. MN PCA, SC Department of Commerce, and MassDEP also mentioned prioritizing materials with low landfill diversion rates (i.e., tires and plastic film in MN; food waste in SC; mattresses and textiles in MA). For PA RMC, although material priorities were chosen by the Board of Directors using various factors in the past, as of 2023 the center plans to begin prioritizing materials based on the state's waste composition study.

Average material prices

In addition to waste characterization studies, MN PCA also considers average material prices when choosing material priorities. They formed special advisory groups for paper, glass, and compost based on the low average prices for those materials. Notably, glass was chosen as a priority due to its negative average price, even though the glass recycling rate in Minnesota is relatively high.

Emerging materials

MassDEP, MI EGLE, and MO EIERA are all considering how to develop markets for materials that are not currently a large portion of the waste stream but are likely to become so in coming decades – such as solar panels, wind turbine blades, and electric vehicle batteries.

Policies and regulations

Local policies may influence material priorities. In SC, developing end markets for food waste became a priority after the state's Department of Health and Environmental Control passed a new composting regulation. SC also prioritizes tire recycling because state law bans putting whole tires in landfills. CDPHE has grant programs specifically for tires because of a state landfill ban. Likewise, MassDEP initiatives focus on materials that have recently been banned from landfills – such as organic waste, textiles, and mattresses. Staff reach out to generators of those materials to build relationships and provide education and technical support.

Input from stakeholders in the recycling supply chain and related organizations

Many interviewees prioritize certain materials based on input from stakeholders. For example:

- Pennsylvania RMC considers feedback from county recycling coordinators.
- The SC Department of Commerce prioritizes materials based on conversations with recycling haulers, processors, and manufacturers. For example, it launched a public outreach campaign to increase plastic bottle recycling after stakeholders from the Carolinas Plastic Recycling Council, an industry association, said they needed more feedstock.
- MN PCA prioritizes materials based on input from local MRFs about which material markets are strong or weak.
- In the process of developing its state solid waste management plan, OH EPA chose four priority materials based on advice from stakeholders.[93]
- MN PCA and OH EPA also react to interest in certain materials from local processors and manufacturers; if many entities contact the center looking for the same type of feedstock, they will focus on shoring up supply of that material (i.e., helping paper mills locate feedstock in OH).

Recycling barriers and opportunities

In partnership with Burns & McDonnell and Circular Matters, Texas CEQ used a unique method for identifying high-priority recyclable materials.[94] First, they identified the most common barriers that prevent recyclable materials from reaching end markets through a series of meetings with stakeholders in the recycling supply chain, interviews with market research representatives, and internet research. Contamination and competition with low-cost disposal options were among the identified factors. Then, materials that faced the most barriers that could be addressed through market development efforts were designated as high priority.

Local industry landscape and capacity

Many interviewees mentioned that their material priorities are influenced by the presence of, absence of, recent closure of, or industry trends related to specific types of manufacturers or processors. For instance, Colorado has a strong market for glass due to the presence of Coors

Brewing and Rocky Mountain Bottle, so end market development for glass is not a high priority in that state but increasing glass collection is. On the other hand, glass became a priority for MassDEP after a major glass processor and a glass beneficiation plant both shut down operations in the state.

MN PCA responded to local industry circumstances in several ways. After a paper mill closed and created a hole in the old corrugated cardboard market, MN PCA "directed traffic" to prevent the material from being landfilled. A local can-making plant also recently closed, so MN PCA has been working with a local aluminum smelter to see if they can buy the plant. Because local manufacturers demand polyethylene terephthalate (PET) plastic feedstock, but the state lacks an intermediary processor for non-objection PET, MN PCA has been working to recruit one to the state.

The SC Department of Commerce has not only ramped up programs due to industry trends, but also ramped them down. Carpet recycling was once a high priority, but after the industry shifted from valuable nylon to less valuable polyester, it was de-prioritized. Meanwhile, lithium-ion battery recycling has become a priority in recent years due to increased electric vehicle manufacturing in the state. SC also prioritizes tire recycling because the state is a national leader in tire manufacturing.[95]

MI EGLE identifies high priority materials through an annual study with NextCycle Michigan that reveals gaps in processing capacity and end markets. Those materials are prioritized when MI EGLE awards grants.

GHG emissions related to specific materials

For MI EGLE, while specific materials are prioritized for grants per the gap analysis mentioned above, the agency also favors projects that result in a higher reduction of GHG emissions. Grant applicants must estimate their project's impact on emissions using the EPA WARM model. So, materials for which recycling reduces more emissions have an advantage.

MN PCA does not currently use emissions reduction data to prioritize certain recyclable materials but plans to do so in the future. The state's Solid Waste Policy Report recommends considering "alternative measures to weight-based reporting which encompass the environmental impacts of a material."[96] For instance, if glass and cardboard have the same capture rate, but recycling cardboard results in greater emissions reduction, then MN PCA could direct more resources toward market development for cardboard.[97]

Although we did not interview the Oregon Department of Environmental Quality's Materials Management agency for this study, it is well-known for prioritizing GHG emission reductions. It has done lifecycle analysis for various types of materials to determine how recycling impacts emissions for each one. It concentrates on landfill diversion and recycling for more high-impact materials.[98]

Influence from leadership

The SC Department of Commerce focuses on tire recycling because it has been a commodity of interest for the Department of Health and Environmental Control, with which Commerce is under contract. The state's $2.00 recovery fee for tires does not currently generate enough revenue to cover disposal costs.

Case study: Charlotte, NC

Circular Charlotte is unique in this study because it is a non-profit, not a publicly funded entity. It focuses on making direct business-to-business connections between generators and end users or incubating new businesses that use recyclable materials. As such, staff chose four priority material categories (plastics, organics, textiles, and C&D) for which they could feasibly accomplish those goals. That said, Circular Charlotte also works opportunistically on projects related to other materials if they arise, such as wood waste and grain bags from breweries. Additionally, because it is a non-profit that needs to fundraise, within the four priority categories, it aims to support attention-grabbing projects that will resonate with donors.

Unused factors

It is worth noting that none of the centers we interviewed said they prioritize certain recyclable materials based on the estimated economic impact of recycling more of those materials (i.e., job creation, tax revenue, etc.), even though almost all interviewees had completed economic impact studies that made material prioritization recommendations. Interviewees primarily use these studies to demonstrate the benefits of recycling market development to the public and legislators (see section below about communicating with various audiences).

Interviewees consider various factors when awarding grants

Many of the organizations we interviewed award grant funding to government agencies and businesses with the intent to increase recycling capacity and waste diversion. This section illuminates the funding processes, decision-making processes, and grant impact evaluation processes of our interviewees.

Funding processes

Interviewees receive funding for grants in a variety of ways. Most reported wishing they had more funding to provide grants, however one state organization, Ohio EPA reported having more funding for grants than they have spent in recent years. While funding for grants typically comes from the state or city's general fund, Ohio EPA, CDPHE, and Phoenix reported receiving at least a portion of the funds for their grant programs through landfill tipping fees. The Reimagine Phoenix Circular Economy Program is a unique case as its tipping fees first go into the city's public works solid waste fund before they can be allocated back to their grant program. None of the organizations interviewed reported giving grants that would cover full operating costs of a grant recipient's business. Reported grants ranged from a few thousand dollars to several hundred thousand dollars, however even on the higher end of that spectrum organizations reported that grant recipients were expected to either gather other investments or cover the rest of their operating costs themselves. One organization, Ohio EPA, reported having a matching grant

program for private businesses, allowing for smaller match amounts for non-profits and local governments.

Structure of decision-making boards

While most organizations reported having decision making authority over grant funding, TCEQ and SC Department of Commerce reported a lack of authority in deciding recycling grant investments as their state governments had separate departments which managed grants in general. In these two states, the governments did not have unique grants for the recycling industry and recycling businesses needed to compete with all other industries. Additionally, Phoenix Public Works has a Solid Waste Advisory Committee consisting of business leaders and experts in the community that provide an advisory role for funding choices. Also, a center's organizational structure and host government agency may affect its decisions in rewarding grants.

Factors involved in grantmaking decisions

The centers we interviewed highlighted these seven grant award criteria:

- **Tonnage diverted** – Most interviewees highlighted waste diversion and increased recycling processing capacity as key metrics when evaluating grant applications. MN PCA, for instance, only provides funding for applicants that can divert more than 500 tons of waste per year.
- **GHG emissions decreased** – MI EGLE prioritize grant applicants that can quantify their potential impacts in decreasing GHG emissions through waste diversion or improved recycling processes, while CDPHE tracks the GHG emissions of grant recipients post award.
- **Economic impact** – Most states assessed potential economic impact as a key metric for evaluating grant applications. CDPHE, IDEM, MN PCA, MO EIERA, and MI EGLE all consider potential job creation when evaluating grant applications. Additionally, MO EIERA reported assessing applicants based on avoided costs of wasted materials and disposal fees avoided.
- **Type of material** – MI EGLE and MN PCA both reported material preferences as one of their key criteria in scoring grant applications each year. See section above about how they set material priorities.
- **Credibility and strength of business plan** – Many interviewees noted that they aim to provide grants to organizations that have the expertise and finances to succeed. This includes having feedstock sources lined up or having buyers lined up to purchase feedstock produced by the project, for example.
  - Most interviewees excluded startups or research and development (R&D) projects from their grant programs, preferring to give funding to businesses that could prove a certain amount of economic viability. However, IDEM considers providing funding for exceptionally innovative R&D projects, while PA RMC may defray a portion of the costs of an R&D project based on availability of funding. CDPHE is the only the interviewee that mentioned giving grants to startup organizations, although only with a specific mini grant program.
  - While most interviewees provide grants for market development activities in general, both OH EPA and IDEM have simplified their grant processes by primarily investing in equipment that business cannot afford alone.

- o PA RMC highlighted "believability" as a key metric when evaluating which organizations will be economically feasible long term. Factors such as experience, adequate staffing, and proven financial stability are examined by MN PCA, PA RMC, and OH EPA when deciding which organizations to provide grant funding.
- **Type of project** – Additionally, supply side versus demand side needs may impact decisions on what projects to fund in a given year, such as investing in processing or collection infrastructure. IDEM's processes rest heavily on similar considerations.
- **Equity** – This measure considers improvements to fairness in accessibility across a state, city, or region. As part of their scoring processes, both MN PCA and MI EGLE award points for grant applicants that can demonstrate how their projects will improve environmental justice and equity within their states.
- **Grant program statute** – The CO Recycling Resources Economic Opportunity grant fund's dual objective of landfill diversion and job creation was established in the founding legislation. Similarly, the CO Front Range Waste Diversion grant program was set up to focus on tonnage diversion, though it also considers volume for lighter weight materials.

Evaluating grant impacts to demonstrate the center's impact and value

Interviewees mentioned continuing to monitor the progress of grant recipients as a way to ensure their funding dollars are having the intended impacts on the factors outlined in the previous section. Organizations typically rely on the self-reported expected tonnage of waste diverted from landfills and increased recycling capacity of grant applicants. Colorado requires business to report baseline and target amounts of expected waste diversion and requires progress reports every six months. Some Colorado businesses have had less waste diversion after six months than their self-reported baseline expectations, highlighting the difficulties of relying on self-reported expectations to award grants.

Case study: Missouri

In this section we discuss the grantmaking program of the MO EIERA in detail because of its long history in providing grants and its unique funding structure. MO EIERA found marketing grant opportunities to the right manufacturers challenging, an issue echoed by many other interviewees. To encourage applications, they try to make their application process as simple as possible. For example, many of the questions on their application have yes or no answers. They also provide pre-application consultations, and aid companies in completing the financial aspects of the application. Like many other interviewees, Missouri prioritizes funding in rural areas to increase the generally lower recycling access and infrastructure in those areas. They also prefer to offer grants to businesses that have already invested other assets in their project.

In their application they ask for potential tonnage diverted, job creation (broken down into part time, full time, and type of positions), avoided costs of materials landfilled, and disposal fees avoided as part of a unique scoring system.[99] Like most other interviewees, MO EIERA tends to reject research and development and startup grant applications, preferring to invest in equipment that will have a more near-term impact. One such example given was providing funding for new sorting equipment at Ripple Glass in Kansas City, a glass processing facility that serves around a 500-mile interstate radius. The new equipment allowed the facility to sort through and accept close to 80 percent of its discarded glass pile, allowing the business to add

two additional full-time employees and plan investment in similar sorting technology in their St. Louis facility. While Missouri has minimal reporting requirements, consisting of self-reported application data and site visits at the beginning and end of the grant project timeline, they attempt to gain the first position on liens for equipment for investment security.

Angie Powell, of MO EIERA, highlighted another example of how a successful grant program can help change local and state policies. MO EIERA funded a metering box that allowed Capital Materials, a local manufacturing firm, to use crumb rubber in asphalt. This new mix needed to be examined by the Missouri Department of Transportation. Since the mix surpassed the department's expectations, MO EIERA is optimistic that the Department of Transportation will change their required asphalt specifications, which will in turn influence cities and counties, creating momentum for a large recycling market development opportunity with asphalt.

Centers use both metrics and storytelling to influence audiences

Interviewees use a combination of quantitative metrics and narrative storytelling to strategically influence legislators, the general public, and members of the recycling industry. When sharing quantitative information, interviewees expressed the importance of using metrics that resonate with the specific audience and their goals, especially when speaking with legislators. Interviewees also highlighted the importance of sharing success stories and case studies to influence various audiences. As the interviewee at PA RMC stated, it can be "very difficult to quantify benefit. And as a result, we try to tell, we try to be a better storyteller." Metrics should be used when it helps tell the story better.

Efforts to influence legislators

Interviewees said that communicating with and influencing legislators is paramount to securing funding, advocating for beneficial policies, and allocating resources. They have developed successful communication strategies by framing arguments in terms of legislative goals (such as job creation or revenue generation), pointing to program success stories (such as case studies from communities in their state or other states), and allowing non-profit allies to advocate in political environments where public agencies cannot. Legislative goals vary from state to state, so the metrics used must be adapted accordingly.

Market development specialist Matt Flechter (MI EGLE) spoke about his interactions with legislators in growing Michigan's circular economy over the past 22 years:

> "The ultimate reason we were able to be successful is we were able to make a strong case that Michigan was not a leader, and was falling behind, and other States were making progress that we were not able to capitalize on because investments weren't coming to our State. And ultimately, we wanted to be able to tell a story of a state that is environmentally minded that is able to attract investment into that space. So that's what worked in Michigan... The messaging that we used in the administration was specifically tailored to what was going to work because we listened to what our leaders' goals were. And frankly, with this particular leader or this governor, we needed to back everything up with measured data, and we came right out of the gate, creating this dashboard where we put things like Michigan's recycling rate, and we did it intentionally.... We needed to use that to say, look, you want to show progress. Look! This number is red. It hasn't moved. Why didn't it move? Well, it didn't move, because we didn't have investment. We didn't have what other States had, which was stable funding.
> – Matt Flechter, MI EGLE

Metrics about the economic impact of recycling are especially salient. In fact, several interviewees – Phoenix, IDEM, and TCEQ – mentioned that the primary purpose of gathering economic impact metrics is to share them with legislators.

Kyla Fisher at AMERIPEN stated the importance of noting what speaks to the specific legislators and framing the metrics accordingly: "What's the data I can get so I can make a convincing argument to my legislators about why they need to maintain my center?"

Efforts to influence the general public

Interviewees communicate with the general public to garner support, increase public participation in recycling initiatives, or provide education. For example, North and South Carolina got national attention by launching a "Your Bottle Means Jobs" information campaign that emphasizes the connection between recycling plastic bottles and creating local jobs.

Anna DeLage, Director of Recycling Market Development at the SC Department of Commerce, discussed the strategy which emphasizes:

"Storytelling around the people behind the bottles. The fact that your bottle becomes car parts, t-shirts, textiles, pillows, carpet — things that you just wouldn't know... We brought the industry together for the plastics recyclers in the Carolinas, and we asked, "What are your biggest challenges?" And they said, "We just can't get enough material. We need more supply. We've got the processing capacity; we just need more material." So, how do we capture more? Most of those bottles are coming from individuals, so we needed a business-to-consumer approach. So, we created that consumer strategy, which is, "When you recycle, I work" and "Your bottle means jobs.""
– Anna DeLage, SC Department of Commerce

Additionally, many interviewed organizations relayed the importance of public education and participation. For example, several agencies acknowledged that they must invest in public education about recycling contamination and that such outreach takes public relations acumen, strategic messaging development, and an accessible easy-to-understand data display. A better-educated public is essential to reducing the contamination rate and the amount of materials ultimately going to landfills.

Efforts to influence industry

Interviewees often speak with members of the recycling industry to gain information, which we discussed in an earlier section. This section is about how interviewees use certain information to influence members of the industry.

Interviewees communicate with the recycling industry—both processors and manufacturers—to recruit businesses to relocate to their state or encourage manufacturers to increase their use of recycled feedstock. The key messages targeted to the industry include feedstock availability, revenue opportunity, and organization-specific incentives. For example, Kyla Fisher (AMERIPEN) stated:

"What is it that someone who is looking to locate a recycling facility would need to know? Do they need to know what's only within your state? Or do they need to know what the opportunity to sell is outside of your state, or the opportunity to collect material from the XY region?"
– Kyla Fisher, AMERIPEN

Similarly, Anna DeLage, SC Department of Commerce, explained that it is useful to provide the economic supply and demand metrics that resonate with the recycling companies. She said:

> "If we have a company that wants to land in South Carolina, and they are a recycling company, they want to identify how much material they're going to need to be successful. We need to know the landscape. The more information we have, the better."
> – Anna DeLage, SC Department of Commerce

Having data available to reference in these conversations is a benefit (e.g., current tonnage of recycled commodities generated by the state annually). Essentially, persuasive communication begins with understanding what your industry partner wants and needs to hear.

Advertising innovative technologies that industries can take advantage of can also be a useful approach. For example, Envision Charlotte, recognizing that they ship all their recycled glass to Atlanta at a loss, is conducting a pilot program with a local company to turn glass into sand. If successful, this effort will be marketed widely to the industries that might also take advantage of the innovation.

Another powerful influencing method is education and consultation. MassDEP provides free technical assistance to businesses and institutions to reduce waste, maximize recycling, and find reuse/recovery opportunities. This consultation approach is another direct way to encourage those who may be able to develop manufacturing options for recycled materials.

Overall, the effort to influence industry is about partnerships with industry, more than regulation. Industry must, like individuals, see a return for the risk they take on.

Additional findings: Planning, data processes, and alliances

This section discusses findings pertaining to how the factors and activities discussed in the previous sections come into play in organizational planning and how data challenges may stymie the effectiveness of these efforts. It closes with findings pertaining to how partnerships can help centers to expand their reach and alleviate resources constraints.

The role of comprehensive planning and measuring progress varies across agencies

Many of the topics discussed above come together in formal planning processes. All interviewees developed plans that identified overall goals, short- and long-term objectives, and activities. These strategic plans are often based on the realities of outreach, volume, funding, and stakeholder input. Prioritization of effort, for example, was sometimes based on an internal ranking process as well as project bandwidth. Plans changed as original objectives were found to be unfeasible, too expensive, or misdirected. Senior staff changes also sometimes resulted in plan modifications. COVID conditions resulted in slowdowns for some planning processes.

Formal planning processes

Formal planning processes for interviewees usually involved the creation of a comprehensive master plan with strategic long-range goals, an effort often supported by outside consultant groups. Annual reviews of such plans were mentioned frequently. Stakeholder identification was conducted early in the process. From the Master Plan, which carried the larger vision of the goal, spun more targeted plans, including Market Development Plans, Climate Action Plans, Public Engagement Plans, Data Management Plans, Solid Waste Management Plans, and Governance Plans. Plans are generally aligned with those of other government agencies and are situated into larger strategies at the state or federal levels.

Limitations of the annual budget process

Municipalities voiced concern regarding decision-making timelines due to the lengthy cycle times and bureaucratic obstacles required for budgeting and financing the plans. Nimbleness and flexibility are important to interface with manufacturing and supply chains but are not typical characteristics of cities eager to strengthen the recycling value chain. For example, SERDC's Will Sagar mentioned that "local governments are not in a position to deal with the flex of fluctuating markets," due to the limitations and slow process of the annual budget and planning cycles. In addition, as in Phoenix, funding can be reallocated to other projects, slowing down the development and implementation of plans. Ultimately, directives and priorities that have come from the legislation influence the budget process, which in turn impacts public organization resource allocation and planning decisions. As such, a nonprofit agency may have more responsiveness and capability of partnerships to carry out municipal plans.

A spectrum of formal and informal strategic planning processes

For interviewees, planning ranges on a continuum from formal to opportunistic. Both PPW and MI EGLE sustain more formal planning, although their goals are different. For PPW, planning has been top-down, driven by several concerned mayors over the last 10 years, which resulted in a progressive Climate Action Plan and a Zero Waste & Circular Economy Roadmap planning process. This includes a public engagement process and detailed action plans for reaching 2030 and 2050 milestones. PPW partnered with Arizona State University to conduct important waste stream studies that informed plans to develop the Resource Innovation Campus.

Meanwhile, MI EGLE's planning processes are designed to encourage legislators, the public, local government and the business community—through storytelling, data, policy development, and messaging—that stable funding and local planning would result in more progress in environmentally sustainable achievements. In part, MI EGLE links their planning effort to availability of funding, stating, "Resources are so tight that we have to be very strategic about what we do." However, they also prioritize "capacity building at the local level" rather than launching specific circular economy initiatives themselves. In practice, MI EGLE facilitates local governments and organizations in setting reasonable goals, based on funding and state policy: "The planning process is going to activate and get people there so that we can actually just start the conversation. Figure out what can be done."

Non-profits, on the other hand, may operate more opportunistically and less based on formal plans than public agencies. For example, on a limited discretionary basis, PA RMC may elect to complete projects that are not specifically delineated in their work plan with the Pennsylvania Department of Environmental Protection. At times, planning can be flexible and able to respond rapidly to requests. Similarly, Envision Charlotte's planning is fluid and responds creatively to requests for support from various project initiatives. Amy Aussieker explained that their adaptive process as an innovation center includes asking, "How can we make the biggest impacts? What partners do we bring in? How do we get quick wins that lead to longer-term success?"

Formalized ranking systems

Ranking systems are often used for grant decisions. Some interviewees use formal scoring systems: processes designed to rank alternatives according to a points-based or other mathematical system. Notable programs that used specific scoring tools included IDEM, MN PCA, MI EGLE, and MO EIERA. Rankings and prioritization are described in detail in the earlier sections on grant decision-making processes. As discussed in earlier sections, many other organizations make decisions without a formal ranking system, based on many factors including stakeholder engagement.

Progress and accountability

Interviewees use various methods for measuring and reporting their progress. Reporting was both formal, consisting of internally or externally prepared and published reports, or less formal, characterized by discussions with oversight management like state agencies or boards of directors. Nevertheless, all interviewees identified a requirement to account for program activities and strategic/tactical progress using either qualitative or quantitative data, budgetary accounts, structural, process, or outcome milestones, anecdotal reports, or other types of summaries to one or many stakeholders.

Data issues impact program operations

Challenges acquiring, managing, and interpreting data often limit centers' ability to effectively use quantitative metrics in their decision-making and program operations. The first part of this section presents an overview of data and goal misalignment, difficulties with data acquisition and use, and data gaps several centers face. The section closes by describing how these challenges present when attempting to acquire data about supply chain capacity.

Goal and data alignment

Across interviewees there was general agreement on the importance of setting organizational goals and using quantitative metrics to measure progress against those goals, with few exceptions. Determining the appropriate metrics to measure progress can be challenging. Uncertainty about goals at higher levels of an organization can make measuring those goals difficult at lower levels of the organization. For instance, uncertainty about whether a zero-waste goal applies to a municipality or metro area creates uncertainty about whether the data collected should focus on internal solid waste programs or on external partnership development.

Targeting data tightly to specific projects can limit the ability of a center to use its collected data to make decisions about its scope of projects. Some centers found it difficult to obtain organizational support for ongoing broad data collection that would help them prioritize projects. Timed cycles for comprehensive report development can help to mitigate this challenge, however funding reauthorization can pose challenges due to changing priorities or political realignments. Many organizations did not act on recommendations in comprehensive reports, sometimes due to limited jurisdiction, and instead used report results primarily as a communication tool with legislators or the public. Some organizations had challenges aligning expectations with third parties who conducted comprehensive studies about scope or methodology, limiting the usefulness of these studies in program operations.

Focusing too early on a popular metric is another challenge to goal and data alignment. In Michigan early political support for recycling volume metrics resulted in large infrastructure investments to enhance collection. However, volume metrics can be slow to respond to infrastructure investments as they depend on program uptake as well. This delay makes it challenging for Michigan to both see and advertise progress, which may reduce public support for continued investment overtime. Many economic metrics, for instance job creation, can have similar delays. NERC noticed similar challenges when a state agency focuses too strongly on either quality or volume metrics, to the exclusion of the other. Too strong a focus on quality discourages expansion. Too strong a focus on volume can result in high contamination rates.

Logistical and technical challenges to data acquisition and use

Different expectations between organizations about what it means to collect data can limit the ability of centers to partner with each other and with third parties to enhance knowledge sharing. Centers who perceive themselves as data-focused have a wide range of data storage and analysis practices, including keeping key metrics in handwritten notes, manually maintaining spreadsheets of project relevant quantitative information, contracting out most or all of their data collection and analysis to third parties, and having extensive data warehousing systems. Comprehensive analyses may require more data than centers have available or there may be a mismatch between center records and the quality of data needed for a firm to complete work.

Similarly, different jurisdictions, regions, and scenarios may require or simply result in methodological differences in metric computation. These differences make it difficult to compare metrics between centers, and to compare metrics between centers and supply chain members. Differences in recycling protocols and the myriad of ways to compute environmental impacts exemplify this challenge. Across the supply chain and across geographies, even the same metrics computed the same way result in comparison difficulties. For instance, even if per capita glass recycling volume metrics match, a glass-kiln in California may be powered using solar-generated electricity, whereas the same kiln in Pennsylvania may be powered using natural gas, resulting in dramatically different environmental impacts. Within a single jurisdiction, population and product changes may make volume metrics difficult to compare, and metrics may change over time to more accurately reflect scenarios a center is facing. For instance, one interviewee mentioned thinner plastics used in beverage containers relative to twenty years ago make tonnage comparisons difficult. It is difficult to compare metrics even within a single center without grounding in the center's history.

Technical and methodological challenges do not just limit metric comparisons. Several centers noted challenges integrating the results of environmental impact modeling tools into their program operations. Interviewees mentioned that these tools sometimes consider environmentally focused decisions using a substantially different framing from those interviewees typically use. For instance, a tool used in Minnesota suggests that glass baby food containers made from recycled and recyclable glass have a larger carbon footprint than recyclable baby food pouches made from virgin plastic. While the former generates more emissions in transport to recycling facilities, it is a fully circular product. The latter introduces new virgin plastic into the waste stream. Similarly, in some instances EPA WARM suggests that high carbon yard waste should be landfilled instead of composted because landfilling results in carbon capture, whereas composting high carbon yard waste into soil results in some greenhouse gas emissions. In these examples, tools focused on carbon footprint specifically, to the exclusion of other circular economy principles.

Capacity constraints make it difficult for centers to compile data for use in program determinations. Large data volume is one concern. Resource needs are higher to make collected data valuable for decision-making versus for general organizational knowledge due to the need to both identify pertinent details instead of general themes and contextualize these details in ongoing decision-making processes. MassDEP collects extensive data related to waste and recycling. They have several staff who work with conducting entry, review, quality assurance, and analysis of this data. TCEQ and SC Department of Commerce shared the importance of automating data processes to enhance capacity in the long run but acknowledged that doing so requires large upfront investments in data infrastructure. Despite the upfront cost, these investments are often best made early. Delaying may result in additional costs to remedy existing processes or limit collaboration opportunities. Envision Charlotte mentioned challenges beginning a collaboration with a consulting firm due to the limited data systems they had in place. Additionally, state-level investment creates spillover effects, enhancing data access for local governments and the public. While we were unable to interview representatives from the California Department of Resources Recycling and Recovery, the data portal they provide is an excellent example of the potential of such efforts.[100]

Logistical challenges often reduce the quality of survey data, making it difficult for centers to use in program decisions. Effective surveys require appropriate infrastructure support, including outreach efforts, databases to track responses, and easy ways for respondents to return responses. Long or complex surveys are unlikely to receive many responses.

Finally, even when centers make decisions using solid data, unconsidered implementation details may lead to unexpected results. For instance, logistical implementation challenges stymied Envision Charlotte's well-considered decisions to assist with recycling hospital linens and campaign signs.

Data gaps

Interviewees shared several types of information they would like to have to improve their program operations but that they did not currently have access to:

- Fine-grained volume measures that include greater detail on material and location can help centers to focus outreach messaging to reduce contamination. Tying this information to particular building types, residential arrangements, and hauler routes can help to identify effective local equipment and infrastructure investments.
- Detailed supply chain information, as discussed in the landscape analysis section, is often difficult to obtain. We discuss these challenges in depth in the next section. Here we note that additional information about the entire circular economy supply chain, including repair and reuse, may aid in identifying appropriate markets to develop.
- Information about the breadth of use of infrastructure in surrounding communities can help to assess equity impacts. For instance, Michigan invested in a paper shredder in one community under the assumption that it would also benefit many surrounding communities, many of which had a history of low infrastructure investment.
- Information about individual-level engagement with programs, such as attendance and learning outcomes, can help to target outreach activities and messaging for future events.
- Information about interactions between different people at conferences can help people across the supply chain to generate leads. Unfortunately, this type of information is especially difficult to track.

Challenges of collecting and using data from across the supply chain

As noted above in the section on stakeholder engagement, accurate data about the location of feedstock, processing capacity, manufacturing capacity, material transportation capacity, and actual material flows are essential to market development program prioritization. In particular, these data can help centers make effective and efficient use of limited internal capacity. Supply chain entities are often reluctant to provide centers with detailed information on their operations. This section discusses difficulties that arise when centers try to obtain this information, limiting their ability to use supply chain information effectively in their program decisions.

Many types of supply chain information are difficult for centers to collect including:

- Material flows from collection, though processing, to end-use manufacturing
- Feedstock availability, contamination, and location
- MRF material throughput, potential throughput, and related capacity-related information including equipment, shifts, and employment
- Manufacturers use of virgin versus recycled materials in their products, the potential of manufacturers to expand recycled feedstock use, and where manufacturers are located

Information about material origination is difficult to obtain because haulers often will not share material volumes without contractual obligations in place. Depending on their routes, information they do report may conflate volumes across multiple jurisdictions. Business-to-business arrangements for direct transportation of waste to processors further complicate

obtaining this information. MO EIERA noted recently discovering a large tire recycling program by an in-state business, for instance.

Interviewees shared that information about processors' throughput is often difficult to obtain without regulatory reporting obligations. Sometimes recycling regulation limits reporting requirements to promote the creation of more recyclers. Without detailed requirements, processors report how much material arrives at their facility disregarding how much is usable and how much processed material is sold. Resulting numbers may suggest higher volume metrics than are true in practice. Some interviewees noted that while processors typically did not report throughput, they also did not strongly oppose regulation obligating them to do so.

Interviewees found information about manufacturer use of recycled materials even more difficult to obtain. Manufacturers typically have a high rate of survey and phone call nonresponse, often declining to even verify information centers have obtained through other means. Several centers shared that personalized efforts to encourage engagement have had only limited results on improving survey participation. Reasons interviewees posited for manufacturers declining to provide detailed information include:

- Desire to maintain a business advantage: Specific concerns here include disclosing market position, pressure on pricing models, and disclosure of internal processes or trade secrets.
- Worry about negative press: Disclosing job cuts may create a negative public impression of a business. More broadly, NERC shared that many businesses worry that "the public does not trust recycled content."
- Not maintaining internal records: If recycled material use is not a marketing point for a business, they may not track the information centers are looking for.
- Material use may fluctuate often or dramatically, based on pricing, for instance.

Even when strong relationships with companies result in substantial data sharing, this exchange can stop abruptly when a liaison or a senior company representative leaves their role.

Information that supply chain entities provide can be difficult for centers to use effectively without proper verification. Inaccurately reported material needs may result in market inefficiencies. For instance, a processor contracted by PPW was unable to obtain the quantities of materials needed to sustain their business model. Inaccurately reported economic benefits can result in negative press when accurate values come to light. Businesses may double count positive impacts that could be claimed by others to increase positive recognition and may undercount other economic metrics due to lack of interest.

Centers reported turning to recycling, trade, and academic publications to find partial supply chain information. Some centers engaged in more extensive investigations, including constructing mathematical models of throughput and using cars in business parking lots on Google Maps to estimate job creation. Many reported that capacity constraints (both time and expertise) severely limited their ability to engage in these types of detailed investigations or to verify supply chain information that was provided. Centers may turn to third parties to conduct these types of analyses. Third parties can also often acquire data and act as aggregators, preserving privacy of manufacturers while making useful information publicly available.

Interviewees rely on alliances to achieve their missions

Several interviewees mentioned that partnerships with non-profits were crucial to fulfilling their mission. These groups offer valuable funding, staff, and expertise to advance market development. For example, TCEQ partners closely with the State of Texas Alliance for Recycling (STAR), which was the driving force behind getting funding from the legislature for two major TCEQ recycling studies. MassDEP funds the Center for EcoTechnology's Recycling Works program, which provides technical assistance to help businesses recover recyclable and compostable material (among other services). As Sean Sylver at MassDEP said, "It has been so helpful to us to have that model where we have an organization that we contract with that are experts in the field."

Economic development entities are also valuable partners. Circular Matters suggests partnering with state and local economic development entities to advanced shared goals. Ohio EPA works with Jobs Ohio, which recruits businesses to the state, and MO EIERA reaches out to local economic development offices.

Working with private companies can also be beneficial. Minnesota PCA mentioned partnering with private companies like Target and General Mills to help recruit a plastic film processor to the state. AMERIPEN also suggested working with the Recycling Partnership, a national organization funded by large corporations and industry associations.[101] As Kyla Fisher from AMERIPEN stated:

> "I think business right now is acutely aware of the need for recycled content. Whether you're a car manufacturer, a solar manufacturer, or a packaging company, I think more and more businesses are recognizing that there's a value to reuse, and so the more partnerships that we can create with business, I think the more leverage you're going to get to meet these goals."
> — Kyla Fisher, AMERIPEN

Advice from interviewees

Many of our interviewees provided explicit advice to aid the RDC as it continues to grow as an organization. This section categorizes and summarizes that advice.

Stay on mission

Circular Matters and PA RMC advise that with a small staff, it is important to be wary of projects that are not central to a center's goals. Be wary of projects that make use of staff member skills but are outside core objectives. MI EGLE adds to choose project-focused metrics that reflect these objectives and are tailored to the outcomes desired from the specific project. General volume metrics, such as recycling rate, are difficult to use for this purpose. Instead, choose metrics focused on expanding access, creating new material opportunities, market generation, and influencing individual actions. Be mindful to collect information that will assist you in making decisions and evaluating progress, which may be qualitative instead of quantitative. Also, Envision Charlotte and AMERIPEN suggest collecting data that demonstrates success measures that are meaningful to your funders and business stakeholders.

Build relationships

All interviewees stressed that investing time to create trustful relationships with stakeholders enhances long-term outcomes, including with:

- **Businesses**: Providing business assistance and striving to understand business barriers strengthens relationships and improves cooperation. Making data products that are valuable to companies raises the willingness of those companies to share information about their operations. Strong relationships with dominant market players may enhance the trust of smaller players. AMERIPEN and NERC in particular encouraged engaging with business-funded market development initiatives and industry associations to better understand needs and build relationships. As trust develops with these organizations, synergies in goals may influence their projects, expanding the reach of a resource-constrained center. CDPHE suggested that startups and tech accelerators have novel approaches to market development that may make developing partnerships with such firms beneficial.
- **Recycling nonprofits**: The goals of these groups often overlap with center goals, making them a natural source of support. Further, they are often less constrained in their modes of operation than centers are. They may be able to support center objectives through legislative advocacy or centers may be able to influence their project selection, effectively expanding center resources.
- **Public economic development agencies**: Many interviewees suggested engaging with business stakeholders through commerce and economic development focused agencies may accelerate relationship development because businesses stakeholders will initially have more trust in these agencies. To build a strong working relationship with public economic development staff, find common ground between their agency mission statements and the center's objectives. Focus early conversations on how building a circular economy is economic development.
- **Other agencies**: Building an interagency network helps centers to better use their existing funding by making use of common tools, aligning goals, creating coalitions of recycling supporters within government, and increasing awareness of additional funding mechanisms. MI EGLE noted particular benefits of such coalitions during planning cycles.
- **National peers**: Communicating with peers at other centers encourages knowledge sharing and allows centers to leverage the experiences of others in similar situations when facing new challenges.

Look across borders to understand markets

Look broadly for where there are markets and what it takes to move materials to them to ensure supply and demand are in balance. Many interviewees recommended investing early to identify processing capacity, competition, and end market opportunities to see what barriers exist. Circular Matters encouraged centers to select barriers to work on that they have the authority to address, use resources efficiently, and will have a large impact once removed. Materials travel across state lines, and so should these analyses. A narrow focus may ignore important market drivers. SERDC was particularly supportive of broad supply chain analyses.

Plan surveys carefully

While collecting supply chain information is difficult, interviewees suggested some remedies to improve limited engagement while a center is still developing stakeholder relationships. Many interviewees emphasized including data collection terms in contracts can improve the quality and quantity of information collected. SERDC discussed the importance of providing assistance to localities in improving related practices. Often MRFs are not resistant to data reporting requirements, especially if they are able to use data products developed with this information to enhance their sales. Many interviewees mentioned MRF reporting requirements as essential. Collaboratively developing reporting requirements with MRFs has the potential to be a mutually beneficial enterprise, especially as they may have particular insight into beneficial contamination metrics. Many interviewees reported that to enhance data collection from other types of manufacturers, working through a third-party firm who will collect and aggregate data while ensuring business confidentiality often gets stronger results than publicly run collection efforts. Regardless, TCEQ shared that strategic outreach efforts to encourage participation and find appropriate contacts are also beneficial. Plan for uncertainty in results, as it is unlikely survey responses will report full information.

View data processes as program operations

View data collection, analysis, and maintenance as part of standard program operations. A municipality we interviewed emphasized the importance of explicitly planning for goal-definition, metric selection, data collection, data use, and incorporating data in decision-making, including resource estimates. Doing so will enable centers to value data program development against other objectives, including enhancing understanding of how a data program contributes to other program components. While developing organized state-level data systems is resource intensive, investing in these systems accelerates data use in the long run and frees up resources for use in analysis and other program functions, notes MassDEP and TCEQ. Such systems become more difficult to implement over time, as dependency on existing inadequate infrastructure grows. Data systems can act as a resource for multiple entities, other departments, other levels and branches of government, and the public.

Align with the EPA

PA RMC suggested that aligning with the EPA National Recycling Strategy as it continues to unfold increases the likelihood of centers being able to take advantage of federal funding opportunities in recycling market development and circular economy more generally. Portions of this plan focus on data standards and equity improvements. While there has been limited action to date, as centers continue to develop data and equity programs, contributing to EPA discussions on these topics will influence and enhance their own programs and the national conversation.

Innovate

Some centers we spoke with are integrating novel technologies into their operations to improve program outcomes, including but not limited to: electrifying hauling truck fleets to reduce emissions, using on-truck cameras to assess household-level contamination, and incorporating artificial intelligence into industry trend analysis and data collection.

Chapter 5: Recommendations

This chapter provides recommendations for the RDC based on our literature review and interview findings. The RDC's small staff is faced with limited funding and a broad mandate for recycling market development (see Appendix 1). Our recommendations aim to help the RDC shape its process for choosing which activities and materials to prioritize. We are recommending decision-making elements for the RDC to consider, rather than recommending particular metrics or a specific prioritization method.

We aligned recommendations with our interview findings, the RDC's constraints, and the mandates of the RDC founding legislation. Overall, these recommendations are consistent with the RDC's current legislative directives, and particularly emphasize partnership building, data processes, and programmatic decision-making.

When creating its prioritization methods, we recommend that the RDC:

1. Engage stakeholders in the recycling supply chain to help shape priorities, invest in impactful projects, and create a network of allies.
2. Rely on allies outside the supply chain to expand functional reach, while prioritizing activities that allies cannot undertake.
3. Consider the Washington recycling supply chain's capacity, challenges, and needs when choosing which recyclable materials to prioritize.
4. Develop strong standards, processes, and systems to mitigate data challenges when relying on quantitative metrics to guide prioritization and operations.
5. Incorporate equity into program decisions by developing clear and formal equity-related processes for RDC programs.

Recommendation 1: Engage stakeholders in the supply chain

Engaging stakeholders in the recycling supply chain can guide the RDC towards impactful projects and, over time, create a network of allies.

Identify members of the supply chain

The first step is to identify as many members of the supply chain as possible (MRFs, processors, manufacturers, etc.), which the RDC has already begun to do. The RDC funded a King County study that identified 11 MRFs and 6 plastic processors.[102] It has located 79 paper processing facilities,[103] several glass processing and manufacturing facilities,[104] and 88 companies that manufacture plastics.[105] Recent reports written in partnership with Western Washington University identify MRFs, material wholesalers, and processors using NAICS (North American Industry Classification System) codes.[106]

- Widen your net beyond the typical NAICS codes.
  - Many companies that are not classified as recyclers are involved in processing recyclable material or using recycled feedstock. For example, MO EIERA works with a trucking company that also happens to recycle tires. PA RMC's 2017 economic impact study with IHS Markit Economics identified 6,400 companies in the state's recycling

ecosystem, including many with NAICS codes that hadn't been included in previous studies. They used a combination of staff expertise about the recycling industry and IHS Markit's proprietary database.

- o Include manufacturers that are not currently using recycled feedstock but could in the future.
- o Work with economic development organizations and industry associations and use resources like Choose Washington.
- o Reach out to Impact Washington and mine information used by EPA to develop their Recycling Infrastructure and Market Opportunities Map.[107]
- After identifying supply chain companies in Washington, look across state lines to Idaho, Oregon, and British Columbia as well.
- In addition to cataloging supply chain members, also identify market gaps – such as a lack of plastic processing facilities, for example.

Build relationships and gather information from supply chain members

Once you've identified supply chain members, build relationships with and seek information from them. This aligns with the RDC's founding legislation, which says to "undertake studies on the unmet capital and other needs of reprocessing and manufacturing firms using recycled materials" and "conduct research to understand the waste stream supply chain."[108]

- Use forums and interviews to discover 1) the amount and type(s) of materials each company produces or buys and 2) barriers that prevent them from processing more recyclable material or using more feedstock in manufacturing processes. Example barriers include:
  - o MRFs and material processors: contamination, lack of equipment capacity, lack of demand for bales/feedstock, operating costs, etc.
  - o Manufacturers: lack of feedstock supply, cost of feedstock, quality of feedstock, lack of necessary equipment, lack of desire to use feedstock, regulatory barriers, etc.
- Optimize the method of engagement for forums and interviews.
  - o Let RDC staff at the Department of Commerce take the lead.
  - o Convene forums around a specific type of material.
  - o Avoid long written surveys; conversations are more beneficial.
  - o Seek only actionable information (e.g., knowing precisely who buys from or sells to whom, and at what price, may or may not be actionable for the RDC).
  - o To protect private information (and encourage participation), use confidentiality agreements and contract with third-party researchers where appropriate.
- Demonstrate to participants how sharing information with the RDC will ultimately bring them value. For example, having more complete information will allow the RDC to:
  - o Better facilitate connections in the recycling industry.
    - ▪ Help MRFs and processors locate potential buyers.
    - ▪ Help manufacturers locate recycled feedstock.
  - o Recruit new processors and manufacturers to the state using information about available feedstock, which brings new customers to MRFs.

- Promote products that are made using recycled feedstock (if the manufacturer wants that information to be publicized).
- Strategically focus its efforts on programs that address recycling entities' challenges (e.g., recommending funding opportunities, increasing collection or reducing contamination of a certain material, advocating for regulatory changes or sales tax exemptions, conducting relevant research).

Overall, building relationships with and learning from supply chain members will help the RDC effectively prioritize its efforts and can lead to some companies becoming long-term allies.

Recommendation 2: Rely on allies to expand RDC reach

Our second recommendation is to work with allies outside of the supply chain to expand the RDC's reach. Partnerships can enhance success by leveraging much needed project support, funding, and staff bandwidth to pursue interventions that align with the RDC's mission but are outside its jurisdiction or its funding capacity.

To start, the RDC should expand its collaboration-building to other departments across Washington State government agencies and local municipalities as well as economic development agencies and nonprofit partners. For example, CDPHE has various divisions involved in meeting components of their integrated waste management plan as well as strong ties to local municipalities across the state. Several interviewees also described a broad network of organizations and/or businesses that they partner with to accomplish projects, such as MA Recycling Works (focused on recycling assistance to businesses and communities), Job Ohio (a state-authorized private economic development corporation), or Texas STAR (a 501c3 nonprofit advancing recycling through partnerships, education, and advocacy for the benefit of Texas). These types of partnerships can functionally expand the RDC's reach.

Next, the RDC could invite stakeholders from advocacy groups, government agencies, industry associations, community groups, and other relevant entities to support its operations. This would provide a similar benefit to the advisory board but expand the voices included. Volunteer and stakeholder support has bolstered other agencies by extending their staff, such as Envision Charlotte's ongoing use of volunteers to support their innovation and education center operations, or MassDEP's use of public stakeholder working group meetings to guide the development of its Recycling Market Development Action Plan. Michigan also discussed the vital importance of having a strong independent stakeholder advisory group. These networks can expand the RDC's knowledge base and outreach potential.

Finally, we appreciate that the RDC already has alignments and projects with University of Washington, Washington State University, and Western Washington University. We recommend continuation of joint projects with these academic settings and expansion of programs into new departments (e.g., communications, marketing, economics, environmental sciences). The Phoenix Mayor's Office commissioned Arizona State University to conduct a GHG emissions inventory and a waste characterization study that identified the environmental impacts of the "business as usual" scenario of landfilling valuable recyclable material. These studies ultimately resulted in the formation of their Resource Innovation Campus. The non-profit PA RMC maintains an affiliation

with Penn State University to strengthen the demand side of the recycling industry. The RDC should continue to leverage the research, enthusiasm, and skills of their university affiliations.

We recommend that the RDC continue developing its efforts to build a regional commitment to the circular economy — perhaps using MassDEP's model of multiple working groups drawn from the public, industry, academia, and government. The RDC's founding legislation already has such a scope, as defined by representing "the state in regional and national market development issues and work to create a regional recycling development council that will work across either state or provincial borders, or both."[109] Implementing this recommendation starts with a dedicated effort to tell a compelling story at the right time and to the right audiences. These stories should have a regional lens, backed by legislation, in order to assure a strong mandate and broad reach.

Recommendation 3: Choose material priorities pragmatically

When it comes to choosing which recyclable materials to prioritize, the RDC's founding legislation says that after an "initial focus on mixed waste paper and plastics," the center must focus on "developing markets for commodities comprising a significant percentage of the waste stream."[110]

As discussed in Chapter 4, the volume of certain recyclable materials going to landfills is just one of many factors that centers consider when choosing material priorities. In fact, some individual interviewees mentioned multiple factors – meaning that they do not have a rigid system for choosing priorities and may be influenced by different factors at different times.

Therefore, when choosing among materials that "comprise a significant percentage of the waste stream," we recommend that the RDC consider 1) Washington's recycling supply chain landscape and capacity and 2) feedback from stakeholders in the supply chain about their challenges and needs (see Recommendation 1). If appropriate, also consider other factors listed Chapter 4, such as GHG emissions and emerging markets.

Considering these elements will help the RDC choose priority materials for which it can make the largest impact with its limited resources, and it will further strengthen relationships with stakeholders.

Recommendation 4: Develop data processes and standards

Continuing to develop processes, standards, and systems for data collection and analysis will help mitigate many of the data challenges discussed in Chapter 4 and increase the ease and speed of data integration over time, freeing RDC resources for use in other areas. In addition to data system development, we recommend paying close attention to what data is collected and how it will be used in the RDC's processes and decision-making. Doing so will improve decision accuracy, organizational focus, and contingency planning.

Using common data practices across RDC's partner organizations will improve metric comparability and increase insight into supply and demand misalignment when associated data come from different sources.

- We recommend working with local governments to understand reporting differences across Washington and establish common standards. Use these conversations to understand local needs in the development of state-level data processes for recycling market data.
- Use engagement with supply chain stakeholders, as discussed in Recommendation 1, to understand the types of data that could most benefit supply chain participants. Several interviewees indicated MRFs may be more open to reporting than other supply chain members. As relationships with MRFs develop over time, work with them to develop reporting requirements to enable the collection of data and development of related deliverables that would benefit them as well as the RDC. For instance, publicizing feedstock availability may increase demand. Advocate for appropriate legislation and regulation that encompasses these reporting requirements.

Following stakeholder conversations, design and develop appropriate state-level data processes and databases to meet stakeholder needs and curate market data for the RDC's own use. Given the challenges with recycling rate goals discussed in Chapter 4, including inaccuracy and delays in seeing impact, metrics tailored to specific RDC objectives will be more fruitful for the organization. Additionally, creating several goals across multiple projects will allow the RDC to assess progress across several areas simultaneously.

As the RDC develops metrics and qualitative criteria, they should simultaneously develop procedures to appropriately incorporate them into their processes. Documenting limitations in these processes, measures, the data supporting them, and their intended use can enhance contingency planning. Reviewing this documentation to evaluate and evolve practices on a regular cadence will help the RDC to mature in its use of data and qualitative criteria over time.

We also encourage the RDC to engage in conversations with the EPA to influence and align with standards they develop as part of their National Recycling Strategy.

Recommendation 5: Incorporate equity into decisions

To ensure that recycling development programs work well for all residents of Washington, and to comply with the equity and environmental justice requirements of the Washington State HEAL Act, we recommend developing clear and formal equity-related processes for RDC programs. Common factors in use by interviewees include curbside and drop-off recycling accessibility, facility placement, and incorporating voices from underserved communities. We also recommend the RDC consider factors included in the World Health Organization's report Circular Economy and Health.[111] Developing these practices and measures will require specialized expertise. Given the limited staff of the RDC, we suggest making use of Ecology's Office of Equity & Environmental Justice to design processes that incorporate equity appropriately.

Appendix 1: Founding Legislation for the Washington Recycling Development Center

[RCW 70A.240.030](): Recycling development center—Creation—Purpose and duties—Report to the legislature and governor—Interagency agreement—Rules.[f]

1. The Recycling Development Center is created within the Department of Ecology.
2. The purpose of the center is to provide or facilitate basic and applied research and development, marketing, and policy analysis in furthering the development of markets and processing for recycled commodities and products. As used in this chapter, market development consists of public and private activities that are used to overcome impediments preventing full and productive use of secondary materials diverted from the waste stream, and that encourage and expand use of those materials and subsequent products. In fulfilling this mission, the center must initially direct its services to businesses that transform or remanufacture waste materials into usable or marketable materials or products for use rather than disposal.
3. The center must perform the following activities:
    a. Develop an annual work plan. The work plan must describe actions and recommendations for developing markets for commodities comprising a significant percentage of the waste stream and having potential for use as an industrial or commercial feedstock, with initial focus on mixed waste paper and plastics;
    b. Evaluate, analyze, and make recommendations on state policies that may affect markets for recyclable materials. Such recommendations must include explicit consideration of the costs and benefits of the market-effecting policies, including estimates of the anticipated: Rate impacts on solid waste utility ratepayers; impacts on the prices of consumer goods affected by the recommended policies; and impacts on rates of recycling or utilization of postconsumer materials;
    c. Work with manufacturers and producers of packaging and other potentially recyclable materials on their work to increase the ability of their products to be recycled or reduced in Washington;
    d. Initiate, conduct, or contract for studies relating to market development for recyclable materials, including but not limited to applied research, technology transfer, life-cycle analysis, and pilot demonstration projects;
    e. Obtain and disseminate information relating to market development for recyclable materials from other state and local agencies and other sources;
    f. Contract with individuals, corporations, trade associations, and research institutions for the purposes of this chapter;
    g. Provide grants or contracts to local governments, state agencies, or other public institutions to further the development or revitalization of recycling markets in accordance with applicable rules and regulations;

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[f]URL: https://app.leg.wa.gov/RCW/default.aspx?cite=70A.240.030

h. Provide business and marketing assistance to public and private sector entities within the state;

i. Represent the state in regional and national market development issues and work to create a regional recycling development council that will work across either state or provincial borders, or both;

j. Wherever necessary, the center must work with: Material recovery facility operators; public and private sector recycling and solid waste industries; packaging manufacturers and retailers; local governments; environmental organizations; interested colleges and universities; and state agencies, including the department of commerce and the utilities and transportation commission; and

k. Report to the legislature and the governor each even-numbered year on the progress of achieving the center's purpose and performing the center's activities, including any effects on state recycling rates or rates of utilization of postconsumer materials in manufactured products that can reasonably be attributed, at least in part, to the activities of the center.

4. In order to carry out its responsibilities under this chapter, the department must enter into an interagency agreement with the department of commerce to perform or contract for the following activities:

a. Provide targeted business assistance to recycling businesses, including:
   i. Development of business plans;
   ii. Market research and planning information;
   iii. Referral and information on market conditions; and
   iv. Information on new technology and product development;

b. Conduct outreach to negotiate voluntary agreements with manufacturers to increase the use of recycled materials in products and product development;

c. Support, promote, and identify research and development to stimulate new technologies and products using recycled materials;

d. Actively promote manufacturing with recycled commodities, as well as purchasing of recycled products by state agencies consistent with and in addition to the requirements of chapter 43.19A RCW and RCW 39.26.255, local governments, and the private sector;

e. Undertake studies on the unmet capital and other needs of reprocessing and manufacturing firms using recycled materials, such as financing and incentive programs; and

f. Conduct research to understand the waste stream supply chain and incentive strategies for retention, expansion, and attraction of innovative recycling technology businesses.

5. The department may adopt any rules necessary to implement and enforce this chapter including, but not limited to, measures for the center's performance.

Appendix 2: Key Government Agencies that Focus on Recycling in WA

This appendix describes how government agencies in Washington State influence or manage various aspects of the recycling process.

Some agencies are concerned with optimizing how recyclable materials are collected from homes and businesses (through curbside or drop-off service) and transported to a Materials Recovery Facility (MRF) to be sorted and baled. These include:

- Washington Department of Ecology (Ecology) – Solid Waste Management program
  - Provide education and outreach to the public about recycling and waste reduction
  - Collaborate with local governments to reduce contamination
  - Regulate permit-exempted MRFs and processing facilities
- City and County governments
  - Operate collection and transport services (or contract with private companies for these services)
  - Provide education and outreach to the public to reduce contamination
  - Promote recycling, reuse, and repair
  - Develop local Solid Waste and Hazardous Waste Management Plans
  - Regulate permitted MRFs and processing facilities
- Washington Utilities and Transportation Commission (UTC)
  - Regulate solid waste carriers
  - Review and approve rate changes for solid waste carriers

Some of those same agencies are also concerned with optimizing how recyclable material is processed into feedstock and used by manufacturers as raw material. These include:

- Ecology – Solid Waste Management program
  - Regulate processors of recyclable materials
- City and County governments
  - Invest in recycling market development
- **Washington Departments of Ecology & Commerce Recycling Development Center (RDC) – see details in Chapter 1**

Finally, Ecology's Solid Waste Management program conducts some activities that influence processes across recycling collection, sorting, and end markets, such as:

- Creating State Solid and Hazardous Waste Plan
- Implementing recycling-related regulations (including product-specific programs for electronics, mercury-containing lightbulbs, paint, and solar panels)
- Conducting studies and producing reports on recycling-related topics
- Providing financial assistance to local governments and non-profits

Appendix 3: RDC Goals and Draft Success Metrics

In July 2020 the RDC advisory board approved organizational goals and draft success metrics, which we reproduce below.[112]

Goals

- Develop local and regional markets and processing for Washington's recyclable products and materials to be transformed or remanufactured into usable or marketable products for use other than landfill disposal or incineration. This work will:
  - Encourage waste prevention and emphasize reuse before materials enter the waste stream; and
  - Initially focus on traditional recyclables, like mixed waste paper and plastics, with potential for use as industrial or commercial feedstocks; and phase into other materials that comprise a significant percentage of the waste stream; and
  - Ensure materials are marketable by looking both upstream (product design for recyclability and reduced toxic content), midstream (reduced contamination of recyclable materials), and downstream (processing that enables responsible recycling); and
  - Ensure/Encourage that products marketed in Washington incorporate post-consumer recycled content; and
  - Facilitate connections and exchange of information across all sectors of the circular economy – including research, innovation, and policy; and
  - Increase awareness of recycling's impact and a resulting thriving circular economy.
- Support equitable economic growth by attracting outside funding and analyzing, attracting, and supporting existing and new Washington-based businesses that enable reuse of products, packaging and other materials before they enter the waste stream, process recyclable waste materials into valuable commodities and products, use recycled content, and create local jobs, while ensuring that a social justice lens and a triple bottom line approach is applied throughout.
- Assess and adapt innovative technologies, such as new Material Recovery Facility (MRF) technologies, sorting processes, or new ways of addressing mixed plastics, and promote those that meet criteria acceptable to the board, including pilot-scale efforts.
- Collaborate with manufacturers and producers of packaging and other potentially reusable or recyclable materials to increase the ability of their packaging and products to be reduced, reused or recyclable.
- Evaluate, analyze and recommend state policies that positively affect markets for recyclable materials.
- Collect recycled materials end use data from material recovery facility (MRF) operators; public and private sector recycling and solid waste industries; manufacturers and retailers.
- Work in partnership with product and packaging producers and other regional partners on a pilot project that demonstrates a pathway for a specific material, showing all stages of the supply chain using a circular economy model.

Draft Success Metrics

We will know we made a difference if we have:

- Increased business use of recycled plastic or paper material – Worked with 10 new or existing businesses in Washington to manufacture products using plastic or paper recyclable materials, in five years.
- Increased business use of other recycled material and reusable products – Worked with 10 new or existing businesses in Washington to increase use of reusable or recyclable materials, in five years.
- Increased reusability/recyclability of manufactured products – Worked with 15 manufacturers (or their associations) to make their products reusable or recyclable (design changes), in five years.
- Increased purchasing of products with recycled content – Worked with 10 manufacturers, government agencies, or institutions to implement purchasing preferences for products with recycled content, in five years.
- Recommended policy changes – Supported policies to improve recycling – examples: product stewardship for specific products, bottle deposit program, improved labeling for recyclability – in five years.
- Completed a pilot project or initiative with packaging or other product producers, within five years, that demonstrates that creating sustainable markets is possible or has fostered/enhanced/built markets for mixed waste papers or plastics or has created a template for how to create more sustainable markets for this material.
- Collaborated with other recycling development centers, regional partners and other stakeholders so that our successes are amplified rather than duplicative or competitive.
- Increased total amount of material recycled locally/regionally (relative to the percentage exported) – Percentage of recyclable materials that are primary/secondary processed and responsibly recycled into new transformed or remanufactured into usable or marketable products within the state or region increased by 50 percent, in five years.
- Injected economic growth and innovative technologies into Washington and the region's recycling and processing capacity by increasing capital investment (by 50 percent) and job creation rate (by 50 percent), in five years.
- Reduced the amount of recyclable material going to the landfill by at least 50 percent in five years, relative to 2015, as measured by the State Waste Characterization reports, including reductions created both by increased recycling and decreased waste generation (e.g., reusable packaging) strategies.
- Reduced pulp and paper mill residuals using recycled products as raw material by 50 percent in five years.

Appendix 4: Interview Protocol

Interview Introduction Protocol

Below we provide our introduction protocol, which includes information about our research project, disclosed difficult interview topics, requested consent to record, disclosed risks of personal identification, requested consent for distribution of results, and informs interviewees of their right to stop the interview at any time.

Spoken verbiage is in bold, with directions to the interviewer provided in plain text.

My name is [insert name] **and my colleague who will be taking notes during this interview is** [insert name]**. We are part of a student team from the Evans School of Public Policy at the University of Washington. As we have previously shared, we are working with the Washington State Department of Ecology's Recycling Development Center to study how similar organizations use metrics and other criteria to inform their work.**

We may ask follow-up questions and see where the conversation takes us, but generally we're planning to ask you the questions we sent via email. Some questions will touch on challenges your organizations have faced and how they have responded to these challenges.

As mentioned in our email, we would like to record this interview to aid in analysis. We will use voice-to-text software to create a transcript of the interview. This recording and the transcripts will be destroyed after our final report is made available. You may also ask us to delete the recording of this interview and the associated transcript at any time.

- **May we record this interview?**
- If consent to record is provided: **We have started recording. All meeting participants have consented to this recording. Any participant may ask to stop or delete the recording at any time.**

Our final report will be made publicly available through the Washington Department of Ecology publishing process. It will be shared widely across recycling market development organizations and future students. Our final report will contain narratives detailing the practices of each organization we are interviewing, as well as appendices containing information related to specific metrics and other criteria discussed. Although your name may not be included in the report, RDC knows who we are interviewing at each organization. Please let us know if there are particular pieces of information you are sharing that you would not like to appear in your organization's narrative, but that we may use in summarizing cross-organizational insights with no identifiable information for you or your organization.

- **May we include quotations from this interview in our final report and attribute them to you and/or your organization?**
- **May we include quotations from this interview in our final report if we do not attribute them to you and/or your organization?**

You may ask me questions about the interview or choose to stop the interview at any time.

Interview Questions

Below we include a generic version of our interview questions that has not been customized for a specific organization. For nonprofits and consulting organizations, we reframed these questions to ask about their observations of the governmental recycling programs they had advised, seeking cross-organizational insights.

Spoken verbiage is in bold, with directions to the interviewer provided in plain text.

1. **Tell us about your role in your organization.**
2. **What quantitative data/metrics has your organization gathered to inform its operations and priorities for market development?**
   a. For organizations with published reports, focus the discussion on metrics not included in these reports.
   b. Potential follow-up probes include:
      i. Volume: Current disposal rates of materials and potential for landfill diversion
      ii. Environmental Factors: Potential for GHG emissions reduction or toxicity reduction related to materials or activities
      iii. Economic Factors: Potential monetary value, job creation, or tax revenue related to certain materials or activities; direct, indirect, and induced economic impacts; costs associated with addressing particular material streams; regional commodity prices
3. **What qualitative factors has your organization used to inform its operations and priorities for market development?**
   a. For organizations with published reports, focus the discussion on metrics not included in these reports.
   b. Potential follow-up probes include:
      i. Feasibility of certain projects (in terms of staff time and budget required)
      ii. Level of community/commercial interest in certain materials or activities
      iii. Influence of local industries
      iv. Directives or priorities from department leadership, city leadership, state legislature, or other external entities
      v. Regional values & characteristics
      vi. Alignment with funding opportunities
      vii. Equity considerations
4. **How has your organization used the factors you provided in the first two questions to decide how to prioritize certain recyclable materials or market development activities?**
   a. **How did you weigh each factor and why?**
   b. **Which factors are a higher or lower priority for your organization, and why?**
5. **How has your organization used these metrics and factors to monitor specific market development projects, assess organizational direction, justify funding requests, or communicate with different audiences?**
6. **Have you collected any information you have not used? If so, why?**
   a. Potential follow-up probes include:
      i. Data perspective was too narrow

      ii.   Data wasn't as useful as anticipated

      iii.   Insufficient processes in place to act on data

7. **Have you made decisions that conflicted with information you collected?**
   a. **Were there other factors that outweighed information you initially thought would be the most pertinent?**
8. **What challenges and roadblocks have you faced in developing evaluative criteria and processes for your organization, and how did you overcome them?**
   a. **Is there any data you don't have that you would like to have?**
9. **Have your program goals changed since inception? If so, how?**
   a. **Has your use of data changed in response or to contribute to those changes?**
10. **What other organizations have you learned from, looked to as role models, or think we could learn from as we continue this project?**
   a. **Are there individuals at these organizations who you would recommend we reach out to?**

Interview Closing Protocol

Below we provide our closing protocol, which includes expressions of gratitude, a reminder of the interviewee's rights to the content of their interview, and an explanation of next steps in our engagement with the interviewee's organization.

Spoken verbiage is in bold, with directions to the interviewer provided in plain text.

Thank you for meeting with us – we appreciate it! If you have any questions or if you'd like to change or remove any of your responses, feel free to contact us.

For centers:

- **We are going to reflect on the information you shared today and then send you a follow-up survey. The main purpose of the survey is to find out what data sources you used to generate various quantitative metrics, but we may also include a few other follow-up questions.**

For other organizations:

- **We may send you a follow-up survey.**

In the meantime, if you think of anything else we didn't cover today, please don't hesitate to email us. Thank you again for speaking with us today and sharing your insights on recycling market development and related decision-making processes.

Appendix 5: Themes and Codes
Used for Interview Analysis

- Theme: Actions, Activities, and Decisions
  - Definition: Types of organizational activities, actions, and decisions.
  - Associated Codes:
    - Advocacy and Legislative Engagement
      - Definition: References to advocating for a particular policy, deciding policies to advocate for, and legislative lobbying or testimony.
      - Examples: Meeting with legislators, policy prioritization
    - Capital Investment Decisions
      - Definition: References to capital investment decisions.
      - Examples: Choosing to build a state-owned facility, land purchases or sales
    - Geographical Prioritization
      - Definition: References to prioritizing particular geographic areas for market development, program focus, or other engagement.
      - Examples: Programs for rural versus urban areas, focus on particular municipalities or counties
    - Grant Recipient Selection
      - Definition: References to selecting recipients of organizational grants or other monetary awards.
      - Examples: Grant award processes, business commendations
    - Material Prioritization
      - Definition: References to prioritizing certain types of materials in market development, program design, or similar.
      - Examples: Need for programs for particular materials, expansion of programs to particular materials
    - Program Provisioning Decisions
      - Definition: References to prioritizing provision of particular programs or program components. Excludes such decisions that fall under other codes in this theme.
      - Examples: Providing technical assistance instead of developing a grant program, enhancing educational materials instead of developing a business directory.
    - Progress and Accountability
      - Definition: References to evaluating and reporting on progress within teams or to oversight entities.
      - Sub-codes:
        - External

- Definition: Reporting on progress to an external oversight entity. Excludes general progress reports to the public or sharing progress with partners.
- Examples: Annual legislative progress reports, monthly advisory board check-ins
  - ○ Internal
    - Definition: References to evaluating progress within the organization.
    - Examples: Quarterly project assessments, annual reviews
- Public Relations
  - Definition: References to efforts by the organization to influence or engage with external entities.
  - Sub-Codes:
    - ○ Demonstrate Impact
      - Definition: References to public relations efforts to demonstrate organizational impact or progress over time. Excludes formal accountability and progress reporting to oversight entities.
      - Examples: Advertising campaign about improved diversion rates or new jobs attracted to the state.
    - ○ Education
      - Definition: References to educational activities targeting general recycling knowledge or behavioral change.
      - Examples: Flyers about correct sorting behaviors, seminars on the importance of recycling
    - ○ Influence a Stakeholder, Non-Advocacy
      - Definition: References to efforts to influence the behavior of a stakeholder. Excludes advocacy efforts. Excludes purely educational efforts.
      - Examples: Recruit a new business to a state
    - ○ General
      - Definition: General discussions of public relations and optics or references to specific public relations activities not covered in the above categories.
      - Examples: How a program will make the organization appear, efforts to make an organization appear more business-friendly
- Supply Chain Prioritization

- Definition: References to prioritizing engagement or program development with a certain portion of the supply chain.
- Examples: Choosing to prioritize a program because of its involvement with consumers, MRFs, other processors, product manufacturers, transportation firms, etc.
  - Technological and Process Innovation
    - Definition: References to developing or implementing new processes or technologies.
    - Examples: Installing better sorting technology in hauling trucks, processing enhancements
  - Other
    - Definition: References to organizational activities, priorities, or decisions not covered in the above codes.
- Theme: Data and Factor Difficulties
  - Definition: Challenges organizations face with quantitative or qualitative factors.
  - Associated Codes:
    - Comparison Challenges
      - Definition: References to metrics used to compare a given phenomenon being difficult to compare with each other.
      - Examples: Measurements are inconsistent, multiple ways to measure similar attributes, use of different time frames, noisy or volatile data, changing needs and definitions over time
    - Data Privacy
      - Definition: References to concerns about data privacy.
      - Examples: Ensuring individual data is deidentified, ensuring confidentiality, tension between reporting requirements and privacy desired by providers
    - Inaccurate Data
      - Definition: References to collected data being inaccurate. Excludes references to incomplete data.
      - Examples: Data is double counted, data is not trustworthy, accuracy verification is difficult
    - Incomplete Data
      - Definition: References to collected data being incomplete or to data being difficult to collect.
      - Examples: No requirements to report data; missing data from certain entities, timeframes, or areas; another entity does not collect or will not share data
    - Logistical Challenges

- Definition: References to implementation challenges with data collection and maintenance of data stores.
- Examples: tracking replies, current events introducing constraints to methodological design, extensive time necessary for data management, long periods between repeat collections
  - Tension Between Quantitative and Qualitative Factors
    - Definition: References to qualitative and quantitative factors coming into conflict when used in the context of organizational activities and decisions.
    - Examples: Economic metrics suggest a different path forward from past organizational experience.
  - Quantitative Fluency
    - Definition: References to stakeholder or staff difficulty in understanding quantitative analyses, metrics, or other uses of numbers.
    - Examples: Confusing averages with actuals, stakeholders not reading quantitative analyses
  - Other
    - Definition: References to data related challenges not falling into the other codes in this theme.
- Theme: Data and Factor Presentation
  - Definition: Ways in which data and factors are presented or shared.
  - Associated Codes:
    - Formal Report or White Paper
      - Definition: References to formal reports or white papers.
      - Examples: Agency publications, commissioned studies, academic publications, white papers
    - Narratives and Case Studies
      - Definition: References to use of narratives or case studies. Excludes specific examples or anecdotes interviewees provide.
      - Examples: case studies of similar programs to ones under consideration, use of narratives in stakeholder engagement
    - General
      - Definition: Mentions of other data and factor presentation mechanisms not mentioned above.
      - Examples: Visualizations, tables
- Theme: Factors and Metrics
  - Definition: Quantitative metrics and qualitative factors that interviewed organizations discussed. Includes such items that organizations mentioned in the context of their own practices and their clients' practices. Excludes mentions of related areas when

not being discussed as a contributing factor to organizational actions, priorities, or evaluation.

- o Associated Codes:
  - ▪ Comprehensive Evidence:
    - • Definition: References to experimental results or other forms of comprehensive evidence.
    - • Examples: Pilot programs, commissioned studies.
  - ▪ Contamination
    - • Definition: References to waste stream contamination and related metrics. Includes cross-contamination of trash, recycling, and organics streams, as well as contamination of specific recyclable waste streams by other recyclables. Includes contamination of a given recyclable waste stream by refuse that is not recyclable.
    - • Examples: Contamination rate, cross-stream contamination rate.
  - ▪ Cost
    - • Definition: References to cost of particular investments or programs without direct references to funding availability or source.
    - • Examples: Relative cost of material processing, relative cost of different program alternatives, cost of collection.
  - ▪ Economic
    - • Definition: Economic related metrics and factors, excluding material pricing.
    - • Examples: Direct, indirect, and induced jobs; business creation; overall economic impact; State Gross Product; supply and demand ratios; tax revenue
  - ▪ Environmental
    - • Definition: References to associated environmental benefits or costs.
    - • Examples: Energy savings, emission reductions, litter reductions, air quality changes, toxics produced, material transport related emissions.
  - ▪ Equity and Environmental Justice
    - • Definition: References to equity and environmental justice. Includes both specific factors and unspecific references to broad ideas.
    - • Examples: Race of business owners, relative job creation by income bracket, environmental justice assessments.
  - ▪ Funding
    - • Definition: References to funding related factors.
    - • Examples: Funding source, amount of funding available, grant directives, newly available funding, funding already used.
  - ▪ Gut Instinct

- Definition: References to a perceived belief that program, initiative, or decision will result in the desired outcome.
- Examples: Knowledge from past experience, believability, perceived likelihood of success.
  - Internal Logistics and Feasibility
    - Definition: References to logistical factors and feasibility internal to recycling development centers, excluding references to funding.
    - Sub-codes:
      - General
        - Definition: References to logistical factors and feasibility, excluding references to funding and staffing.
        - Examples: Sorting and processing complexity, necessity of repeating actions multiple times, actions easily facilitated by existing programs.
      - Staffing
        - Definition: References to the impact of staffing considerations.
        - Examples: Staff expertise, staff time, staffing level
  - Landscape and Lifecycle Analysis
    - Definition: References to aspects of the recycling market landscape and supply chain.
    - Sub-codes:
      - Location of Businesses and Markets
        - Definition: References to the presence of local, state, regional, and larger markets and businesses that may impact the supply chain post recyclable collection. Includes references to entities outside the jurisdiction of the organization, including in bordering states and municipalities. Includes discussions of types and capacities of such processors. Includes references to gaps in current processing.
        - Examples: Where textile manufacturers are located, maps of all businesses using recycled materials in a given area
      - Other Contributing Factors
        - Definition: References to other factors contributing to the geographic and supply chain landscape of recycling markets. Includes references to the availability of land, labor markets, and appropriate material transport.

- Examples: Material stockpiling, rail access, trucks available, road quality, land cost, transport distance.
- Material Prices
    - Definition: Factors pertaining to the price of recycled and recyclable materials.
    - Examples: Material price, comparison of virgin and recycled material prices, price volatility, negative pricing
- Network Factors
    - Definition: References to relationships and connections between entities. Excludes explicit inward influence as included in the Stakeholder Influence sub-codes, below. Includes references to opportune connections and relationships.
    - Examples: Making use of programs provided by other entities, ability to engage with new partners or businesses, opportunity for positive positioning with related entities, making connections at conferences
- Obligatory Directives
    - Definition: References to directives the organization is mandated to follow.
    - Sub-codes
        - Mandate
            - Definition: Directives originating in law, regulation, or contract terms. Excludes restrictions due to funding source, for example, references to rate-payer funding, tax-payer funding, donations, etc.
            - Examples: Founding legislation, regulation, state laws or code, landfill bans, jurisdiction, governing legislative body decisions
        - Mission or Goal, General or from Unspecified Source
            - Definition: References to organizational mission or goals, without specifying a source for these goals.
            - Examples: Project targets, engagement goals
        - Organizational Hierarchy, Structure, and Plans
            - References to organizational hierarchy or directives arising due to organizational structure and planning processes.
            - Examples: Mandatory advisory board directives, agency directives, general references to management, references to comprehensive or agency plans.
- Performance of Related Initiatives

- Definition: References to how initiatives similar to those under consideration have performed.
- Sub-Codes:
  - Outside Organization
    - Definition: How related initiatives have performed when instituted by another organization.
    - Examples: Case studies of other organizations, opportunity to learn from other organizations, comparison to another organization.
  - Within Organization
    - Definition: How related activities have performed when instituted by the organization. Excludes pilot programs.
    - Examples: Expansion of program based on past successes, expanding to a new material, explicit references to past internal initiatives.
- Policy Windows and Timing
  - Definition: References to timing for a particular initiative or engagement. Includes references to opportune or inopportune alignment of organizational and external factors.
  - Examples: Budget and planning cycles, changing federal leadership, current events, legislative momentum.
- Program Participation
  - Definition: Participation level in a program by the target group or other groups.
  - Examples: Number of businesses using agency provided directories, number of residents participating in curbside recycling, number of attendees at educational programs
- Recycling Volume
  - Definition: References to volume, weight, or amount of recyclables or other waste streams. Includes references to metrics dependent on waste stream amounts, including total sales and penetration into target markets for specific recycled materials. Includes different data slices and aggregates, for instance total, per capita, per geographic area, per material, reductions, increases, etc. Includes references to diversion.
  - Examples: Diversion, collection, processing, tonnage.
- Stakeholder Influence
  - Definition
  - Sub-codes:
    - Business or Community Group

- Definition: References to influence from trade organizations, business associations, community groups, or similar.
- Examples: Community group advocacy, industry organization influence on center direction
  - General Public
    - Definition: References to members of the general public influencing agency actions.
    - Examples: Focus groups, listening sessions, public comment periods, citizen commissions.
  - Related Government Entity
    - Definition: References to influence from other government entities or participants.
    - Examples: Feedback from county-level officials, cross-agency goal alignment, optional advisory board suggestions.
  - Supply Chain or Related Business, Single
    - Definition: References to influence from supply chain entities or recycling related businesses.
    - Examples: Phone calls, aligning goals with business partners, interest in certain materials from processors.
  - Other
    - Definition: Influence from stakeholders not fitting into above categories. Includes general references to stakeholder influence.
- Other
  - Definition: References to factors not included in the above categories.
- Theme: Other Challenges
  - Definition: Challenges organizations face that are not directly related to data
  - Associated Codes:
    - Conflicting Goals in a Highly Political Environment
      - Definition: References to related entities having goals at odds with each other when there is pressure to appear aligned.
      - Examples: Differing approaches at state and county level, differing political positions of state population and population of a major municipality
    - New Insight Changes Direction
      - Definition: New information leads to changes in decisions or programs after initial decision-making. Excludes results of pilot programs.
      - Examples: Implementation challenges, new study released

- Planning Tool Support
  - Definition: References to inadequate support for tools provided for organizational planning, programming or decision-making or such tools being challenging to use.
  - Examples: Equity or environmental assessments not sufficiently explained to planning teams
- Other
  - Definition: References to organizational challenges not included in above codes.
- Theme: Process Components
  - Definition: Organizational processes and subprocesses related to decision-making, program design, or similar
  - Associated Codes:
    - Collaborative Forum
      - Definition: References to facilitated forums for engagement with specific stakeholders.
      - Examples: Industry round tables, inter-governmental conferences
    - Formalized Ranking System
      - Definition: References to processes designed to rank alternatives according to a points-based or other mathematical system.
      - Examples: Grant rubrics
    - No or Limited Processes
      - Definition: Explicit references to absence of formal processes for decision-making, program design, or similar.
      - Example: Lack of an environmental justice review, statement that decisions happen on the fly
    - Planning Process and Documents
      - Definition: References to formal planning processes and related documents
      - Example: Development of agency comprehensive or strategic plans, quarterly reviews
    - General
      - Definition: References to processes that do not fit into the above codes.
- Additional Codes Used:
  - Data Desired
    - Definition: References to a type of data or a specific metric being desired by the organization either generally or for a specific use.
  - Explicit Example
    - Definition: Places where the interviewee supplied an anecdote or specific example.

- o Explicit Goal
    - Definition: Reference to an organizational or client goal.
- o Is Quantitative
    - Definition: Reference to a quantitative metric or factor.
- o Not Effective
    - Definition: References to a specific metric, factor, process, or practice being ineffective in a specific instance or generally.
- o Not Used
    - Definition: References to a specific metric, factor, process, or practice not being used in a specific instance or generally.

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