COMPOSTING CONSORTIUM

CLOSED LOOP partners
CENTER FOR THE CIRCULAR ECONOMY

Unleashing the Economic and Environmental Potential for Food Waste Composting in the U.S.

A GUIDE FOR INVESTORS, POLICYMAKERS AND THE COMPOST INDUSTRY

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About the Center for the Circular Economy & the Composting Consortium

About Closed Loop Partners

Closed Loop Partners is at the forefront of building the circular economy. The company is comprised of three key business segments. Closed Loop Capital Management manages venture capital, buyout and catalytic private credit investment strategies on behalf of global corporations, financial institutions and family offices. The Center for the Circular Economy unites competitors and partners to tackle complex material challenges and implement systemic change to advance circularity. Closed Loop Builders is an operating group that incubates, builds and scales circular economy infrastructure and services. Its first company, Circular Services, employs innovative technology within reuse, recycling, remanufacturing and re-commerce solutions to improve regional economic and environmental outcomes, and build resilient systems that keep food and organics, textiles, electronics, packaging and more, in circulation and out of landfill or the natural environment. Closed Loop Partners is based in New York City and is a registered B Corp.

For more information, please visit www.closedlooppartners.com.

About the Center for the Circular Economy

The Center for the Circular Economy ('the Center') is the innovation arm of Closed Loop Partners. The Center executes research and analytics, unites organizations to tackle complex material challenges and implement systemic change that advances the circular economy. The Center for the Circular Economy's expertise spans circularity across the full lifecycle of materials, connecting upstream innovation to downstream recovery infrastructure and end markets.

About the Composting Consortium

The Composting Consortium, managed by the Center for the Circular Economy at Closed Loop Partners, is a multi-year industry collaboration on a mission to build a world where organics are kept in circulation. The Consortium advances composting infrastructure and the recovery and processing of food-contact compostable packaging and food scraps in the U.S., to reduce food waste and mitigate climate impact.

The Consortium brings together leading voices across the composting and compostable packaging value chain—from the world's leading brands to best-in-class composters running the operations on the ground. Through in-market tests, deep research and industry-wide collaboration, the Consortium is laying the groundwork for a more robust, resilient composting system that can keep food waste and food-contact compostable packaging in circulation.

Acknowledgments

The Composting Consortium would like to acknowledge the invaluable contributions of our 33 corporate, industry, composter and NGO partners who have collaborated closely since our launch in 2021. Special thanks to our colleagues within the Capital Management division at Closed Loop Partners, the US Composting Council, ReFED and our other industry partners for their contributions and guidance that have shaped this report.

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Executive Summary

The composting industry in the United States presents a powerful solution for diverting food waste from landfills, creating valuable nutrient-rich compost and promoting a circular economy. Even though composting food waste offers clear social, environmental and economic benefits, scaling up food-waste composting infrastructure faces significant challenges, especially when dealing with complex post-consumer organics streams (e.g., streams that contain compostable packaging). This report, developed with investors, policymakers and composters in mind, delves into the current state of the industry, breaks down the basics of the compost business model and offers investment recommendations to support the scale up of food waste composting infrastructure in the United States.

Food Waste Composting Infrastructure and Collections in the United States

The composting industry is on the cusp of major growth, but investment and collaboration are needed to handle complex food waste streams like post-consumer food scraps and compostable packaging. While composting infrastructure for large-scale food waste diversion is still nascent, some states have composting facilities and collection programs already. These established systems offer a promising entry point for investors due to a pre-existing flow of food waste material. Additionally, existing collection programs in states ensure a consistent feedstock for composting operations, and regulations like food waste bans can further incentivize investment. Table ES1 summarizes the tailwinds and headwinds for investment into food waste composting infrastructure.

Less than 4% of the 66 million tons of total food waste generated by Americans annually is composted in the U.S. This gap presents a critical opportunity for investors, policymakers and the composting industry.

TABLE ES1. TAILWINDS AND HEADWINDS FOR FOOD WASTE COMPOSTING IN THE U.S.

Tailwinds

Rising landfill costs and federal action on food waste are driving the shift towards more sustainable end-of-life solutions including composting.

State-wide organic bans have taken root on the east and west coast and have the potential to quickly disrupt and scale food waste composting infrastructure.

The number of U.S. households with organics collections access grew 49% between 2021 and 2023, from 10 million to just shy of 15 million households across 25 states.[1]

200 food waste compost facilities exist in the U.S. already, and another approximately 2,700 facilities that only process yard waste have the potential to be retrofitted to accept and process food waste with food-contact compostable packaging.[2]

Headwinds

Product Demand and Pricing: Compost creates an environmental benefit that is linked to climate change mitigation and healthy soils, but further work and collaboration are needed to connect the dots and scale compost end markets across the U.S. Also, the price of compost over the last few decades has not kept pace with inflation.

Permitting Restrictions: Retrofitting existing yard trimming compost facilities to accept food scraps often requires navigating complex permitting regulations (refer to Part 2 of this report).

Capital Intensity and Long Lead Times: Establishing greenfield, full-scale food waste composting facilities necessitates upfront investment with long lead times of up to five years before revenue can be generated.[3]

Lack of Support for Strategic Expansion: A significant barrier to scaling composting infrastructure lies in the lack of support for operators and developers as they transition from a single facility to multi-site operations.

Alignment to Traditional Financing: Composting developers need to secure or have visibility into securing sites, operators, permits and offtake agreements before unlocking private equity funding (infrastructure investments typically range from $20-200M).

Financing the Compost Industry to Unlock Its Full Economic and Environmental Potential

The composting industry will need to rely on blended finance to support its growth in the next decade. By leveraging this approach, the industry can secure the necessary capital for building large-scale composting facilities while nurturing the growth of smaller, established operators. Each type of funding caters to a specific need in the development cycle of a particular region and composting business.

Grants and philanthropic funding provide essential seed capital to launch composting initiatives, especially in underserved communities where traditional economic models might not be viable. However, for these funders to participate, there needs to be a clear path towards long-term financial sustainability. This might involve demonstrating cost reductions, building strong market demand for compost, and developing replicable models for wider implementation. Patient capital offers longer investment horizons and flexible terms, allowing compost businesses to navigate the initial growth phase without the immediate pressure for high returns. Patient capital providers prioritize both social and environmental impact and a trajectory towards profitability. To appeal to investors, composting businesses need to showcase efficient scaling strategies, a diversified revenue stream beyond just compost sales and a strong management team with a proven track record.

As the industry matures, private equity firms can play a crucial role in scaling composting infrastructure. Private equity investors are typically attracted to markets with consistent growth potential and a path towards larger, more efficient operations. This might involve industry consolidation, adoption of innovative technologies and a favorable regulatory environment with streamlined permitting and government incentives.

By addressing financing hurdles and fostering a supportive ecosystem through collaboration between composting businesses, municipalities and investors, the U.S. composting industry can unlock its full potential. This will not only lead to a significant reduction in food waste but also contribute to a more robust circular economy, enriching our environment and communities.

INTRODUCTION

The global circular economy has the potential to unlock $4.5 trillion dollars of additional economic output by the end of 2030, by mitigating environmental impact and creating long-term value through regenerative production and consumption.[4] Organics circularity, a key component of this approach, remains largely untapped, with vast quantities of food waste representing nearly 25% of municipal solid waste disposed of in landfills.[5]

Closed Loop Partners recognizes food waste as a complex issue with significant economic, environmental and social consequences. Landfilling food waste not only creates a substantial economic burden due to the high costs associated with transportation and disposal fees, but also contributes to climate change through methane emissions. Furthermore, this approach squanders the value of food, an important resource that has the potential to create renewable energy or nutrient-rich compost.

As more and more cities and states put into place regulations on organics diversion, pass bans on certain types of plastic packaging, and rethink their waste management strategies, a comprehensive approach is necessary to tackle the complex issue of food waste management.

Effective solutions should address the entire food value chain, focusing on three key areas: food waste prevention, recovery (i.e., upcycling into new biomaterials) and recycling (i.e., composting and anaerobic digestion). Preventive measures championed by companies like Too Good To Go and Mori play a vital role, ensuring edible food is consumed and shelf life is extended. However, a significant portion of food waste still requires end-of-life recycling solutions.

Buoyed by growing demand from regulations and consumer trends, favorable policy environments, and improving efficiency through technology and scale, food waste composting infrastructure presents a timely economic opportunity for investors seeking both social impact and financial returns.

This report by the Composting Consortium, a multi-year collaboration managed by the Center for the Circular Economy at Closed Loop Partners, dives deep into the current state of food waste composting infrastructure in the U.S., explores investment opportunities and offers policy recommendations to accelerate the scaling of this critical infrastructure. Our focus centers on commercial-scale composting facilities with the capacity to accept the most complex organics streams, including post-consumer food scraps alongside food-contact compostable packaging.

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PART 1
MARKET TRENDS, INFRASTRUCTURE AND COLLECTIONS

Macro Trends Driving Demand for Food Waste Composting Infrastructure in the U.S.

The Mounting Case Against Landfills

Traditional waste management methods like landfill and incineration have been relied upon as part of our linear economy model for decades. But the negative climate impacts of landfill emissions and incineration are placing a renewed spotlight on the importance of downstream solutions, like composting. Food scraps and organic materials make up a significant portion of landfill waste today—66 million tons annually according to the Environmental Protection Agency (EPA).[6] However, rising tipping fees and limited landfill capacity are making landfilling a less attractive option and increasing the demand for disposal alternatives like recycling, composting and anaerobic digestion. A stark example is the 11% increase in national landfill tip fees between 2021 and 2022, with the national weighted average cost reaching $60.34 per ton.[7]

Moreover, research from Industrious Labs sheds light on the concerning environmental impact of landfills. Their 2023 landfill emissions dashboard revealed that municipal solid waste (MSW) landfills are a major contributor to climate change, accounting for over 14% of U.S. methane emissions. This troubling statistic positions landfills as the third-largest source of methane in the country, surpassed only by the oil and gas and livestock sectors. The report goes even further, highlighting that landfills were the leading source of industrial methane emissions in a staggering 38 states. The environmental and economic costs associated with landfill emissions from food waste can be significantly reduced by turning to alternative downstream solutions like composting. Compost products have the ability to improve soil health and increase resiliency against climate catastrophes like drought and wildfire.

Policy Push for Food Waste Diversion

Policymakers are responding to these issues with a growing number of food waste diversion mandates. Food waste bans across 10 states and seven major U.S. cities (as of spring 2024)[8] have driven a 49% increase in residential curbside organics collection programs since 2021[9], highlighting the effectiveness of such policies and initiatives. These policies create a “push” by diverting organic materials away from landfills and towards downstream organics recycling facilities, like composters.

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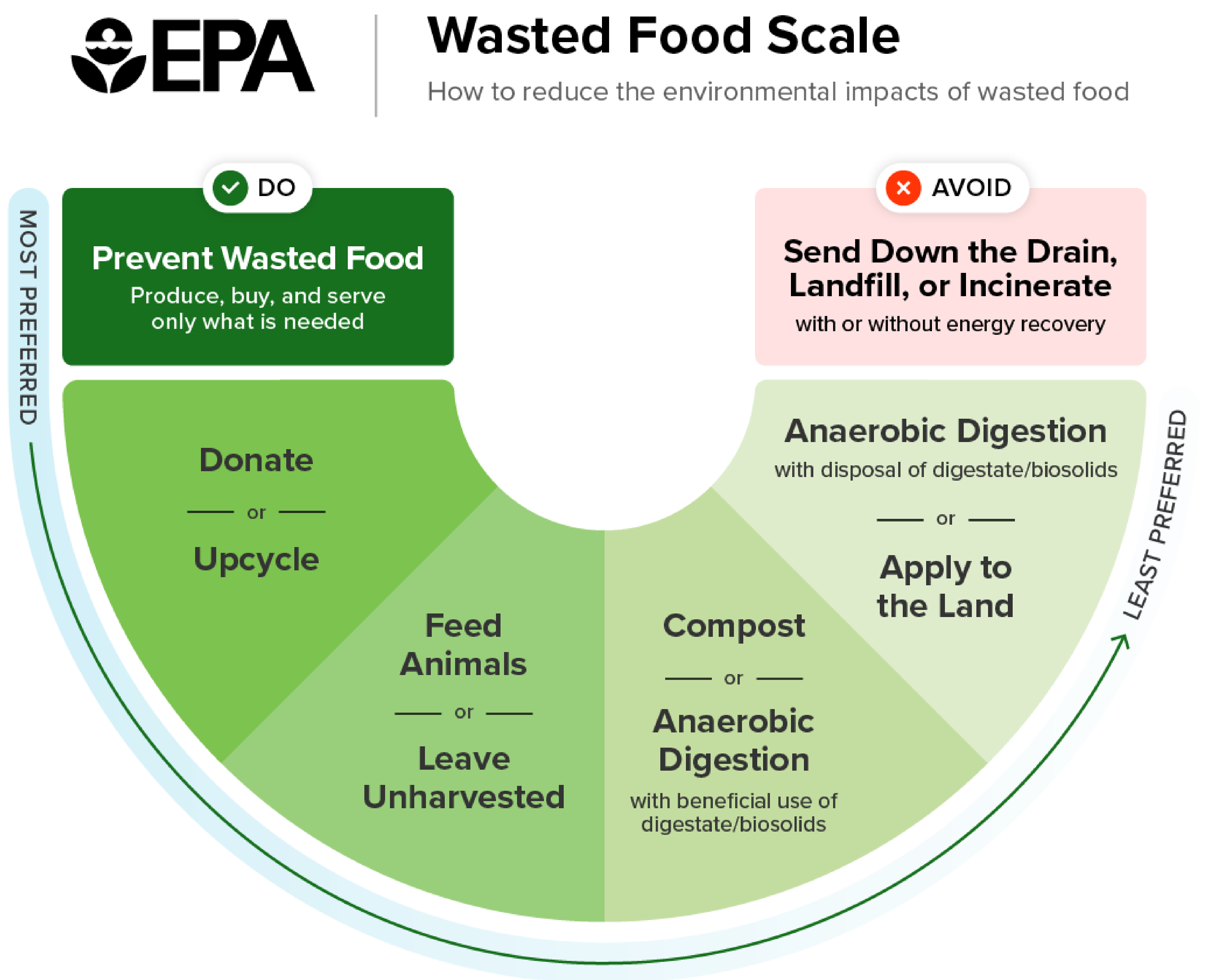
Federal Agencies Increasing Attention on Food Waste

In 2023, the EPA declared that food waste was responsible for about 58% of fugitive methane emissions from landfills and recommended diverting food waste to slash methane emissions in the landfill sector.[10] That same year, the agency released two key reports signaling federal-level attention to the growing issue of food waste and the need for solutions. Their revised Wasted Food Scale prioritizes composting as one of the preferred end-of-life options after upstream solutions like prevention and donation (see Figure 1). Additionally, the EPA's National Strategy for Reducing Food Loss and Waste and Recycling Organics focuses on reducing food waste, increasing organics recycling and mitigating greenhouse gas emissions.

This combined approach—rising landfill costs, policy mandates and federal action—is driving the shift towards more sustainable solutions to manage food waste, like composting. However, food waste composting infrastructure is only at the beginning of this transition. There's a glaring disconnect between the potential of composting food waste and what is currently composted in the U.S. **In reality, less than 4% of the 66 million tons of total food waste generated by Americans annually is composted in the U.S.**[11] This gap presents a critical opportunity for investors, policymakers and the composting industry.

FIGURE 1. MOST TO LEAST PREFERRED SOLUTIONS FOR FOOD WASTE



SOURCE: ENVIRONMENTAL PROTECTION AGENCY

Case Study: Lessons from Recycling to Scale Composting Infrastructure Through Policy

The Resource Conservation and Recovery Act (RCRA) fundamentally changed how waste is managed in the U.S. and planted the seeds for our nationwide recycling infrastructure today. We can look back to this national policy's passage in 1976 and the influence it had on scaling recycling infrastructure to glean lessons for scaling composting infrastructure.

Enacted in 1976, RCRA established a comprehensive framework for hazardous waste management and triggered the closure, and subsequent redesign, of numerous landfills in the U.S. About a decade later in the early 1990s, several states banned the landfilling of yard waste. These tailwinds led to a dramatic 3.75x increase in yard waste composting from 1990 to 2005.[12] Today, more than half of the U.S. (27 states) have banned yard waste from landfills.

The RCRA's emphasis on waste reduction, and the potential economic benefits of recycling materials, spurred state and local governments to find alternatives for materials that were once presumed to be waste. Financial incentives offered by RCRA, coupled with growing public awareness of environmental issues, further fueled the development of curbside recycling programs and materials recovery facilities (MRFs) across the country. Over time, these state and local initiatives collectively built a recycling infrastructure that continues to evolve today.

Just as the RCRA spurred recycling, so too do food waste mandates present a similar opportunity for federal and state policy to become catalysts for organic waste diversion. While momentum is gaining at both the state and federal level, more work remains to propel the composting industry forward.

Can Federal Policy Level the Playing Field Between Composting and Landfill?

To replicate RCRA's success in the context of organic waste management, federal policy should consider a multi-pronged approach. This could include establishing national targets for food waste diversion and greenhouse gas reduction. Additionally, financial grants and technical assistance programs could be offered to states and municipalities to support the development of composting facilities and collection programs for food scraps and compostable packaging. By providing a clear national vision and tangible resources, federal policy can become a driving force in building a robust infrastructure for organics circularity in the U.S.

There are several federal legislative initiatives underway that could bolster the composting industry:

The COMPOST Act (Cultivating Organic Matter through the Promotion of Sustainable Techniques Act)
The COMPOST Act was re-introduced in January 2023. The policy aims to boost food waste composting by designating composting as a USDA conservation practice, authorizing grants and loan guarantees for projects, equipment and construction to expand infrastructure and access. Priority goes to facilities serving underserved communities, those utilizing "best management practices" and those accepting only source-separated food scraps.

Recycling and Composting Accountability Act
The Recycling and Composting Accountability Act (RCAA) is one of two companion, bipartisan bills that aims to boost recycling and composting infrastructure in communities across the U.S. The RCAA primarily focuses on data collection and reporting requirements for composting programs. The Act passed the Senate unanimously in March 2024, and currently sits in the House. If passed, the RCAA would direct the EPA to evaluate and implement a national composting strategy, and publicly report on the progress of that strategy every two years.

Inflation Reduction Act
The Inflation Reduction Act (IRA) stands as a historic investment into the U.S. economy, energy security and climate action. While not solely focused on composting infrastructure, the IRA offers a potential boon through several grants. These resources can be leveraged by states and localities to develop composting facilities as part of broader food waste reduction plans. Additionally, the IRA allocates nearly $21 billion to existing USDA conservation programs, indirectly supporting practices that utilize compost and contribute to healthier soils.

Landscape of Composting Infrastructure in the U.S.

A Brief History of the Composting Industry

Industrial scale composting in the United States emerged in the late 1980s and early 1990s, after dozens of U.S. states enacted laws that banned yard waste from entering landfills, driven by concerns from the waste industry and municipalities that yard waste would quickly overfill landfill capacity. This policy push, coupled with a growing interest in sustainability, spurred the development of private and publicly owned composting infrastructure across the country and led to the organics infrastructure we have today. Most commercial composting facilities in the U.S. today are permitted and set up to only accept yard waste—like leaves, brush and grass clippings—but an increasing number of facilities are beginning to also accept food scraps and food-associative materials, like compostable packaging.

The impetus to recycle food waste in the U.S. began to gain momentum following Vermont's 2012 passage of Act 148, its Universal Recycling Law. Since then, 10 states and several major U.S. cities have adopted various organics bans or restrictive laws on food waste disposal. However, many of these initiatives were enacted without corresponding legislation, policies or support for developing the processing infrastructure to handle the diverted organics, with the notable exception of California.

In 1986, there were three documented food waste composting facilities in the U.S.[13] Today, there are just over 200 full-scale food waste composting facilities according to BioCycle—70% of those facilities accept some form of compostable packaging (i.e., liner bag, compostable foodware).[14]

As composter feedstock has become more diversified over the last couple of decades, several issues have emerged regarding the feedstock cleanliness being sent to food waste composters. These issues have to do with contamination of source-separated organics (SSO), from seemingly benign non-compostable fruit and vegetable label stickers to more confronting "look-alike" food packaging and foodservice ware which does not belong in the organics bin (e.g., bio-based PET bottle with "Made from Plants" label). The increasing costs to mitigate contamination in the organics stream, as well as concerns and confusion around new packaging materials, have caused some compost facilities to put limitations on the types of feedstocks that they will and will not accept.

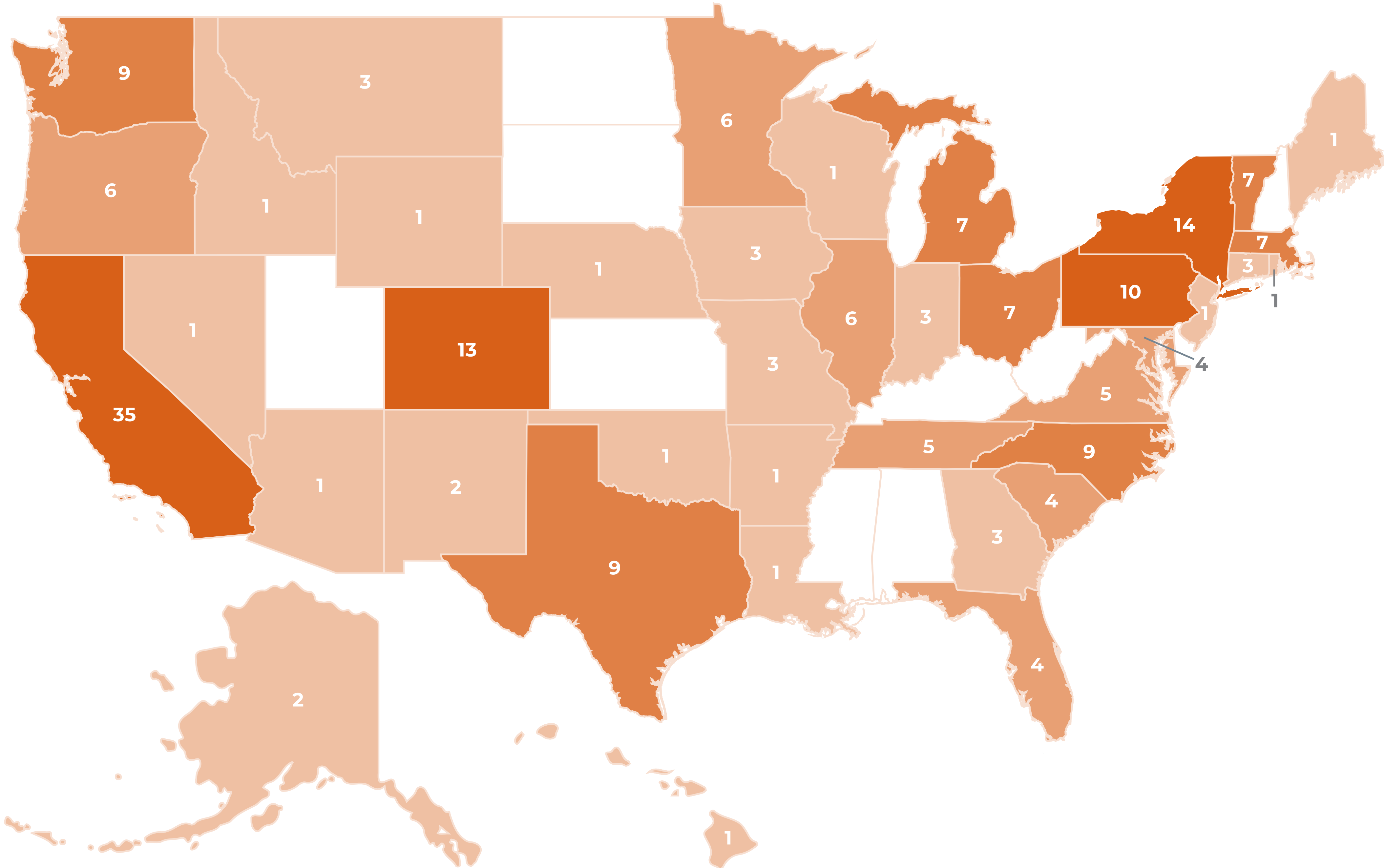
Full-Scale Food Waste Composting Infrastructure in the U.S. Today

In 2023, the Composting Consortium partnered with BioCycle Connect, LLC, publisher of BioCycle*, the Organics Recycling Authority, to conduct two national surveys:

- The first survey focused on full-scale food waste composting infrastructure in the U.S.
- The second survey focused on residential access to municipally supported food waste collection programs across the U.S.

The results of both surveys have been summarized in this report. In total, the 2023 BioCycle survey identified 200 full-scale** food waste composting facilities in 39 states (see Figure 2). Nearly 50% of all full-scale food waste composting facilities in the U.S. are located in California, New York, Colorado, Pennsylvania, Washington, Texas and North Carolina. Food waste composting deserts, defined as areas without any full-scale composting facilities, include Alabama, Delaware, Kansas, Kentucky, Mississippi, New Hampshire, North Dakota, South Dakota, Utah and West Virginia.***

FIGURE 2. NUMBER OF FULL-SCALE FOOD WASTE COMPOSTING FACILITIES IN EACH STATE



NUMBER OF FULL-SCALE FOOD WASTE COMPOSTING FACILITIES IN EACH STATE | 1-3 | 4-6 | 7-9 | 10+

* BioCycle has conducted both surveys in past years, providing data for comparisons in terms of infrastructure and program growth. The findings of these surveys were published in BioCycle CONNECT in 2023 and can be accessed via www.BioCycle.net.

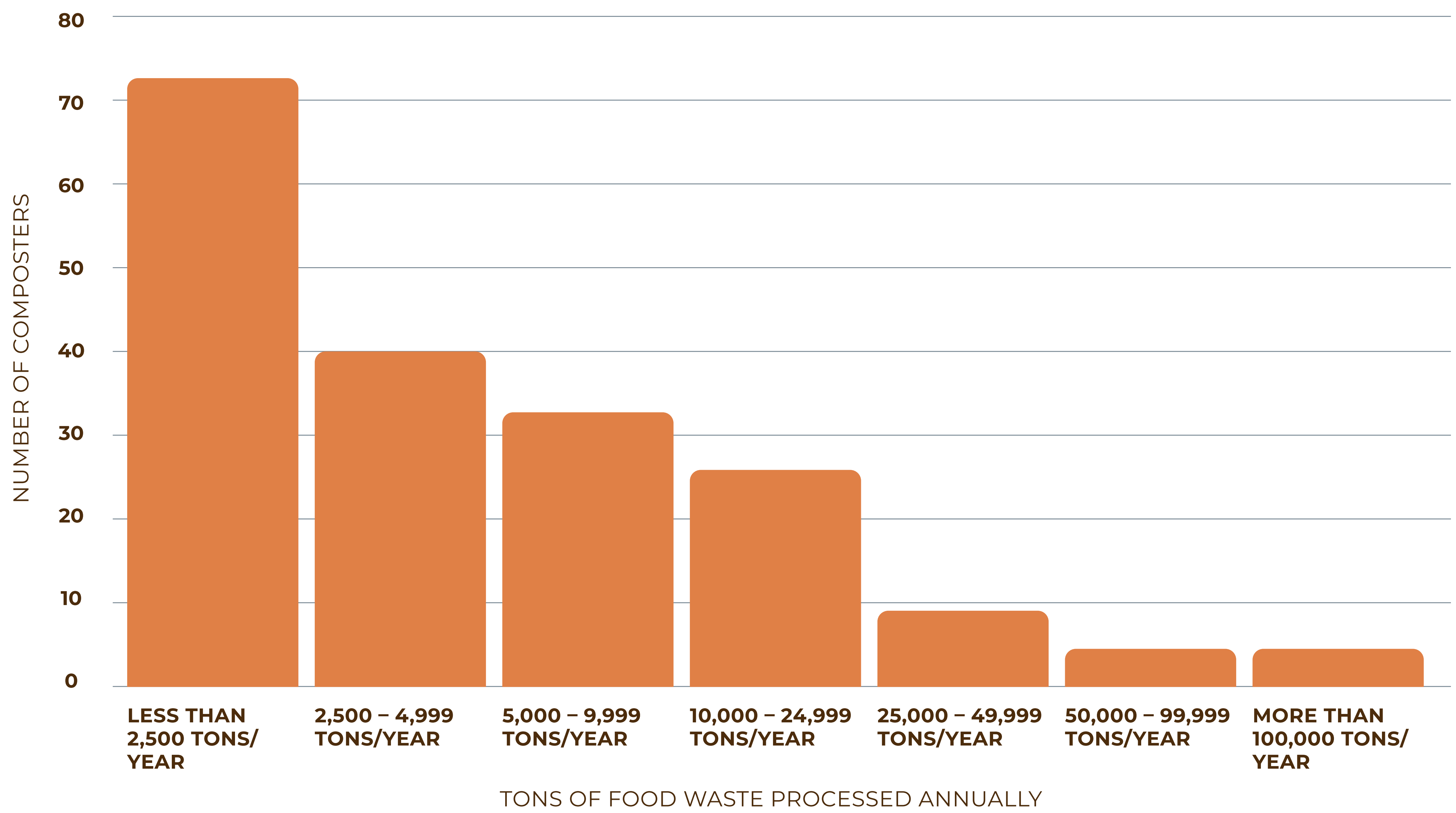
** BioCycle defines a full-scale facility as a municipal or commercial facility equipped to receive and process organic waste streams arriving by truckload volumes from generators and haulers on a year-round basis. Typically, these facilities are composting more than 2,000 tons/year of all organic waste. This contrasts with "captive" sites that normally compost their own organics and utilize the finished product on-site. There are hundreds, if not several thousand, captive composting projects in the U.S. at universities and colleges, K-12 schools, correctional facilities, resorts, health care centers and corporate campuses. Captive sites were not assessed in either survey. Community composting sites, which do accept food waste from off-site and often distribute the compost in their local jurisdictions, vary in scale. Very small, decentralized sites typically can't accommodate truckloads of food waste. Smaller-to-medium community composting operations with capacity to accept larger volumes were included in BioCycle's 2023 food waste composting infrastructure reports.

*** The survey data is reflective of data collected as of July 2023. After publication of the survey results, a handful of additional facilities have been identified.

Food waste is only one of several organic streams that composters process. As a general rule of thumb, composters need to process carbon and nitrogen-heavy feedstocks at about a 2:1 ratio, meaning there is usually twice as much yard debris processed at a compost site as there is food waste. In our survey, we found that 60% of the 200 food waste composting facilities in the U.S. process <5,000 tons of food waste per year (see Figure 3). To contextualize this, it's helpful to understand how much food waste might be expected. Using figures and assumptions from a 2017 study by the Natural Resources Defense Council,[15] we can estimate a town of 50,000 people, made up 25,000 households would generate approximately 7,000 tons of food waste annually—1.4x greater than what's processed by most full-scale compost facilities today.[16]

60% of the 200 food waste composting facilities in the U.S. process <5,000 tons of food waste per year.

FIGURE 3: ESTIMATED TONS OF FOOD WASTE COMPOSTED BY U.S. COMPOST FACILITIES



NOTES: 189 OUT OF 200 FACILITIES RESPONDED TO THE QUESTION ABOUT FOOD WASTE TONNAGE. SOME COMPOSTERS' RESPONSES HAVE BEEN ADAPTED USING A CONVERSION OF 2 CUBIC YARDS PER TON.

The BioCycle survey identified 33 food waste composting facilities that compost between 5,000 and 9,000 tons per year, and 26 that compost between 10,000 and 25,000 tons per year. Two percent of food waste compost sites in the U.S. compost between 50,000 and 100,000 tons per year and another four facilities (2%) compost more than 100,000 tons per year. Currently, there are very few "mega-sized" facilities capable of servicing major metropolitan cities, like New York City, Los Angeles and Chicago. Moving food waste long distances is not cost effective; it is a barrier that will be discussed in the following section. However, funding for facilities of all sizes is necessary to scale the industry's capacity to process food waste.

Our team estimates that the 200 full-scale food waste composting sites in the U.S. processed a minimum of 1,350,000 tons of food waste per year and a maximum of ~2,650,000 tons of food waste per year in 2022. Using the maximum tons of food waste composted, today's composting infrastructure processes up to 4% of the 66 million tons of total food waste[17] generated annually in the U.S. This opportunity gap is one that should be prioritized by municipalities, composters, regulators, policymakers and investors. Of note, most full-scale facilities indicate that they have additional capacity to handle food waste (see Figure 4), offering immense potential for further food waste capture, especially in regions where food waste has been banned from landfill. Strategic regulation and legislation paired with targeted investment can encourage the scaling of food waste composting infrastructure in the U.S.

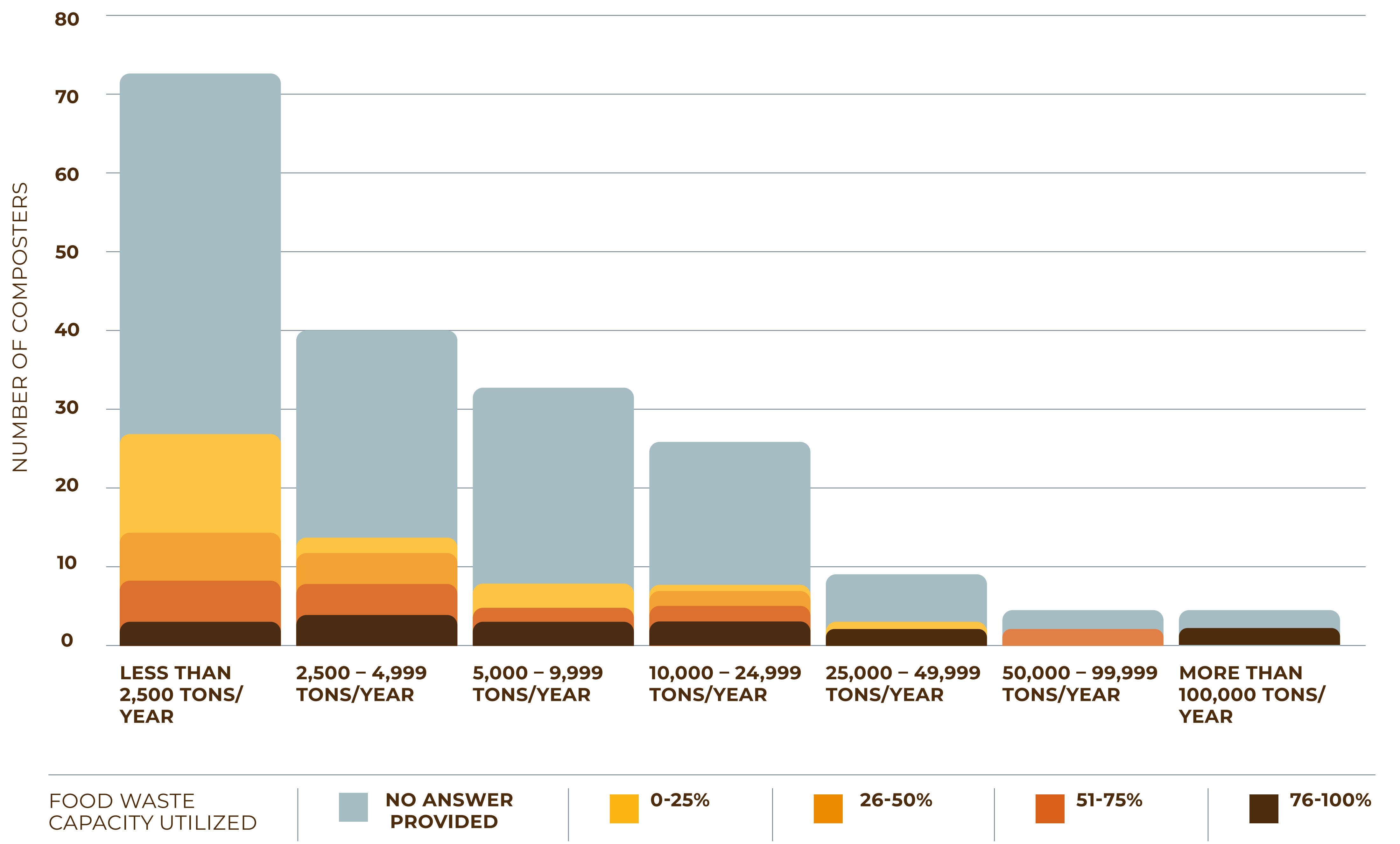
Today's composting infrastructure processes up to 4% of the 66 million tons of total food waste generated annually in the U.S. This opportunity gap is one that should be prioritized by municipalities, composters, regulators, policymakers and investors.

Four Notable Trends in Food Waste Composting Infrastructure Since 2018

1. Slow growth in food waste composting sites

There is an enthusiasm across the composting industry to close the loop on food waste and meaningfully contribute to a circular economy. However, growth of food waste composting has been tepid with the number of facilities that process food waste increasing only 8% between 2018 and 2023. Key challenges in the wide-scale adoption of organics recycling include contamination in source-separated organic streams, a lack of participation and effective incentives to produce cost-effective volumes for processing, and economies of scale, which is especially true for larger-scale composting sites and anaerobic digestion. These topics are addressed in Part 2 of this report. To address food waste at scale, the industry requires financing and other support mechanisms, including policy, to ensure composters are set up for success to process food waste and food-contact compostable packaging.

FIGURE 4. PERMITTED FOOD WASTE CAPACITY UTILIZED (TONS)



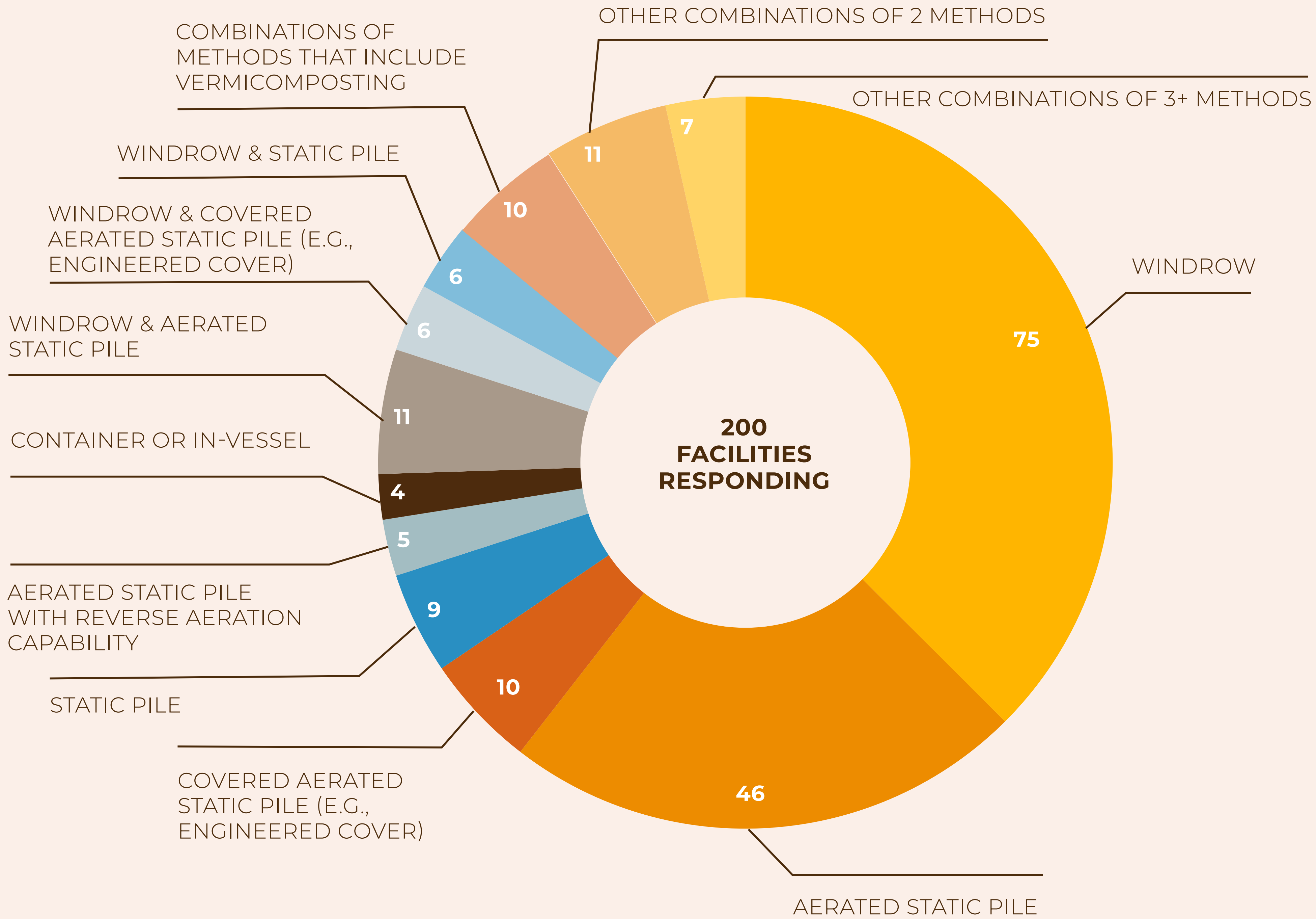
SOURCE: BIOCYCLE, 2023

2. A shift away from longer composting methods to shorter, technology-aided compost methods

In the last five years, there has been an increase in the use of aerated static pile (ASP) methods across the country. There are a few reasons for this. First, finding land to permit a full-scale windrow composting facility within proximity of food waste generators is challenging, and other composting methods, like ASP, boast faster throughput times (i.e., 45-60 day process) than traditional windrow facilities (i.e., 120-180 day process) and require a smaller footprint to operate. As of 2023, 75 facilities in the U.S. utilized windrows and 78 used ASP. In a different composting industry survey, the US Compost Council and the Environmental Research & Education Foundation (EREF) found similar results, with ASP having the greatest increase in total tonnage processed between 2016 and 2021 compared to other methods, bringing it level with windrow facilities' total tonnage processed in the U.S.[18]

BioCycle has also seen an increase in this practice of combining composting methods at food waste composting facilities. Some composters start with ASP to better control moisture, odors and temperatures, then turn to windrows for maturation, followed by static piles for curing. For an explanation on composting methods and technologies, jump to Part 2 of this report.

FIGURE 5. METHODS OF COMPOSTING UTILIZED IN FOOD WASTE COMPOST SITES (2023)



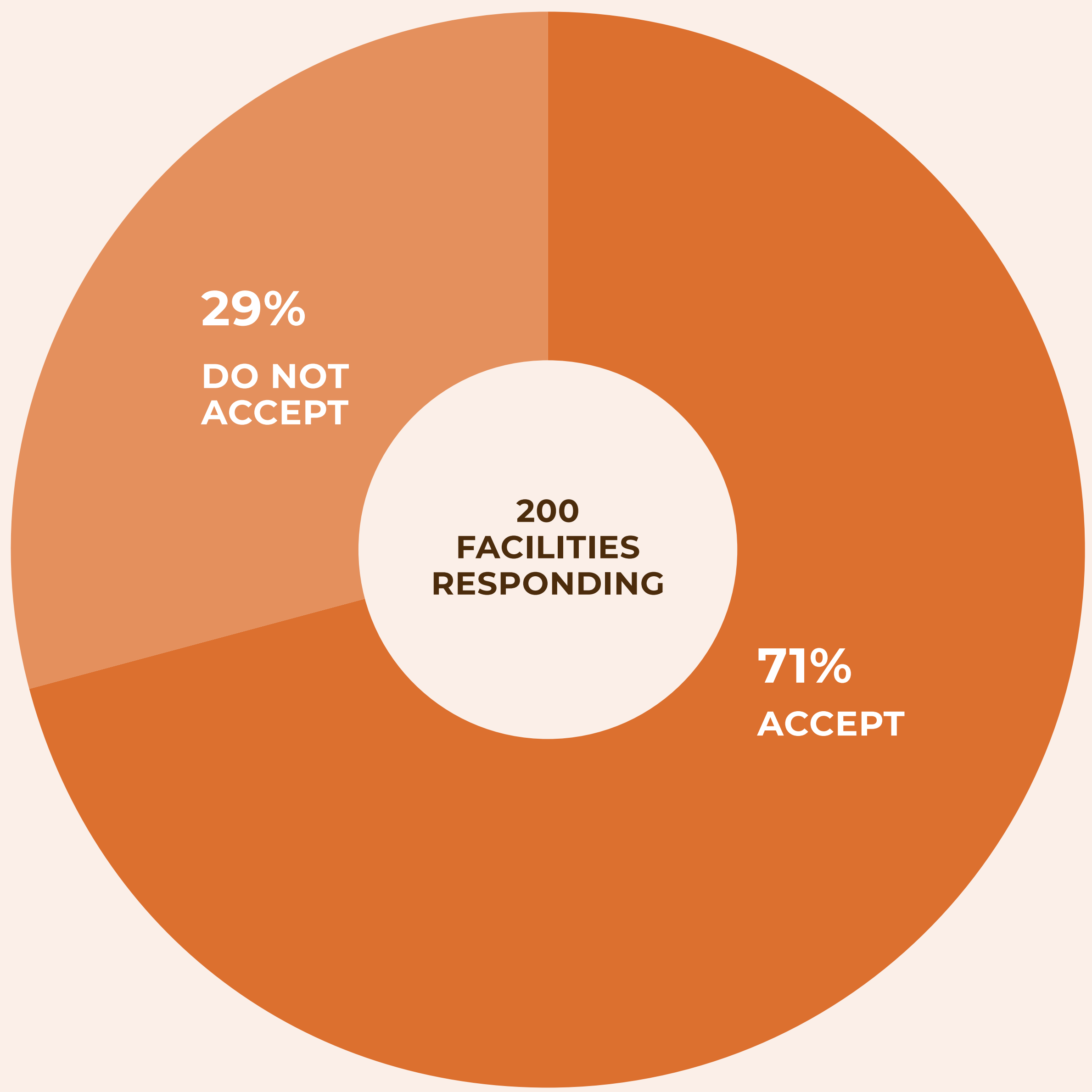
SOURCE: BIOCYCLE, 2023

3. Increase in acceptance of food-contact compostable packaging, with nuance around formats of compostable packaging accepted at the facility level

According to 2023 BioCycle data, most full-scale facilities that accept food waste also accept food-contact compostable packaging of *some* type. The U.S. has seen a 13% increase in the number of facilities that accept compostable packaging since 2018 (71% in 2023 vs. 58% in 2018).

However, it is important to note that there are varying levels of acceptance of compostable packaging across the 141 composters who reported they accept compostable packaging. Across all facilities, food-soiled paper and pizza boxes are the most common types of food-contact compostable packaging accepted (117 facilities). This precedes certified compostable liner bags (93 facilities) which are commonly used for collecting food waste and lining organics bins. Some facilities only accept certain materials (e.g., fiber packaging) which makes the acceptance landscape patchy and difficult to track across these 142 facilities and across the U.S. that do accept compostable packaging.

FIGURE 6. COMPOSTER ACCEPTANCE OF FOOD-CONTACT COMPOSTABLE PACKAGING

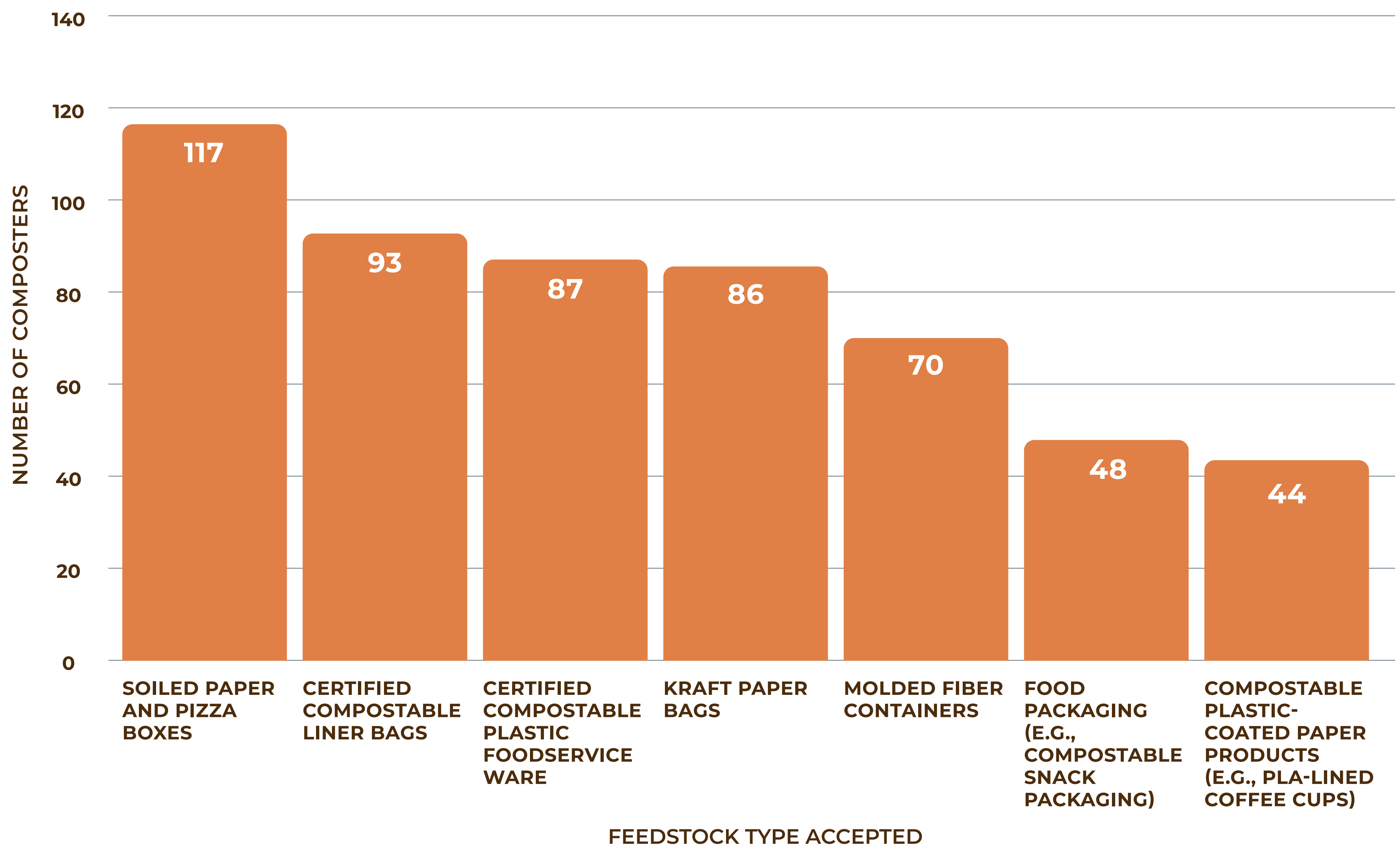


SOURCE: BIOCYCLE, 2023

The primary reason facilities do not take food-contact compostable packaging is concerns about contamination from lookalike single-use conventional plastic packaging and film plastic bags. This concern is reasonable considering that, on average, 85% of the contamination that composters receive is conventional plastic (by volume).[19] Addressing contamination requires significant amounts of time and energy and is a major hindrance and financial burden to the composting process. The Composting Consortium's *Don't Spoil the Soil* report, which summarizes a year-long study into contamination in the organics stream, found that composters receive some degree of contamination in their feedstock irrespective of whether they accept compostable packaging. Several upstream factors contribute to contamination.[20]

Composters receive some degree of contamination in their feedstock irrespective of whether they accept compostable packaging. Several upstream factors contribute to contamination.

FIGURE 7. TYPES OF FOOD-CONTACT COMPOSTABLE PACKAGING ACCEPTED



NOTE: 141 OF 142 COMPOSTERS RESPONDED TO THIS QUESTION

SOURCE: BIOCYCLE, 2023

A belief that compostable materials don't break down is the primary reason nearly a third of food waste composters don't accept and process these materials. New research from the Composting Consortium's 18-month study of the breakdown of 23,000 units of fiber and compostable packaging shows that on average, these materials break down when specific compost pile operating metrics (i.e. moisture, temperature) are met.[21] New field research from other organizations (Compostable Field Testing Program) and entities (Eastman) reaffirms these positive results. To learn more about the disintegration of compostable plastic and fiber at composting facilities, read our report linked on the right on this page.

4. State-wide organic bans have the potential to quickly disrupt and scale food-waste composting infrastructure

From an infrastructure investment standpoint, California has seen the most activity in terms of new facilities and/or the capacity expansion of existing composting facilities to accommodate greater volumes of food waste. This is largely driven by the state's Short-Lived Climate Pollutants Law (SB 1383), which is a landmark law mandating a 75% decrease in organic waste landfilling by 2025 to combat methane emissions. This policy, which went into effect in January 2022, triggered a surge in infrastructure upgrades and investments across the state. Of note, CalRecycle, the agency overseeing implementation of SB 1383, estimated the policy could cost $20.9 billion by 2030,[22] though it was also projected to generate $17 billion in economic benefits and create thousands of new jobs.

California's ambitious organic waste law, with its hefty fines for non-compliance, is putting pressure on local governments. This has led to municipalities enacting double-digit rate hikes to fund new collection programs and infrastructure, leaving even established collection programs scrambling to meet the law's demands. Jurisdictions now face critical choices about long-term collection and processing strategies. The impact extends beyond government, significantly shaking up the waste industry. Companies are investing heavily in composting facilities and processing equipment to meet these new requirements. Recognizing this shift, some businesses have been acquired by larger players or sought new investors, while others, including out-of-state companies, are entering the California market for the first time. Despite these challenges, CalRecycle and law proponents remain optimistic. They believe California's success with this law can serve as a model for other states and national waste companies looking to expand organics recycling to its full potential.[23]

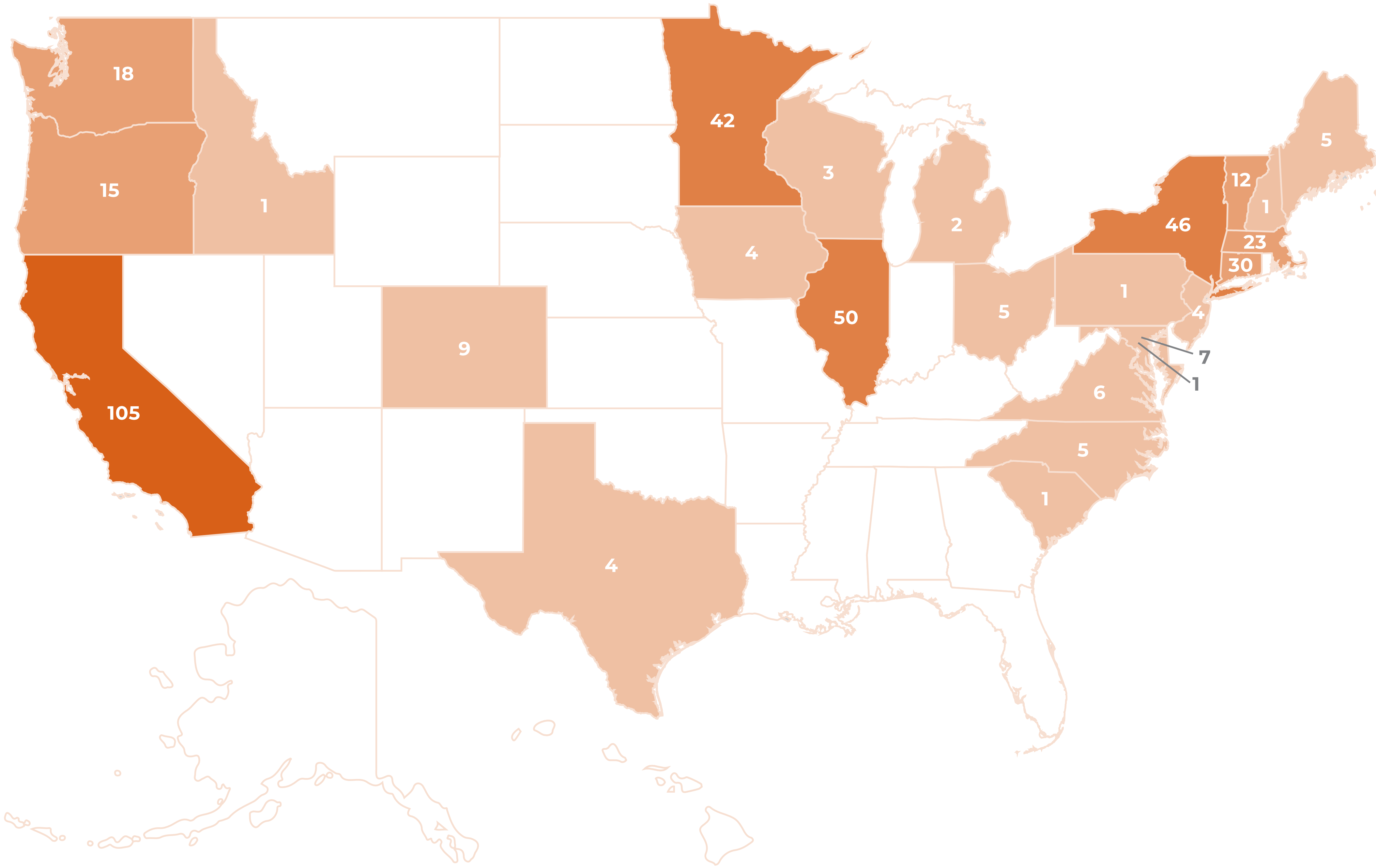
Residential Food Waste Collection Access

Over the last few years, curbside collection and residential drop-off has been growing steadily in the U.S. through municipally supported programs and private subscription services. According to BioCycle's 2023 Nationwide Survey, the number of U.S. households with organics collections access grew 49% between 2021 and 2023, from 10 million to just shy of 15 million households across 25 states. The survey identified 400 programs across 710 U.S. communities, which is not a comprehensive analysis of all programs in the U.S., but accounts for roughly 80-85% of all programs across the country.

California leads the nation in the number of programs (105), as a result of the regulations laid out by SB 1383, followed by Illinois (50), New York (46), Minnesota (42) and Connecticut (30). These five states are home to 68% of all U.S. collection access programs. The 400 access programs tracked in the 2023 BioCycle survey fall into three categories:

Curbside Only	Drop-off Only	Curbside + Drop-off
230 programs	**139** programs	**31** programs
321 communities	**357** communities	**32** communities
8.2 million households with access	**5.1 million** households with access	**1.8 million** households with access

FIGURE 8. NUMBER OF CURBSIDE AND DROP-OFF RESIDENTIAL FOOD WASTE COLLECTION PROGRAMS BY STATE



NUMBER OF CURBSIDE AND DROP-OFF RESIDENTIAL FOOD WASTE COLLECTION PROGRAMS | 10 | 11-30 | 31-50 | 100+

SOURCE: BIOCYCLE, 2023

Four Notable Trends in Food Waste Composting Infrastructure Since 2021

1. Drop-off programs are an affordable entry point

Many jurisdictions begin by establishing drop-off programs for residential food waste because they are relatively low-cost to set up (i.e., less than $5,000). These drop-off bins are frequently located at recycling centers, transfer stations and/or municipal buildings. Drop-off programs tend to attract citizens who are "enthusiasts" and "early adopters," individuals who have been seeking access and who are willing to take the time to drive to a drop-off site.

2. California aside, participation in collection programs is often voluntary

Excluding California, most curbside collection programs are voluntary, in which households are provided with a cart for source-separated food waste, which is often combined with yard waste. Alternatively, residents can opt in to receive curbside collection service. Low participation rates pose significant challenges for food waste collection programs, with variations in the number of households participating and difficulties in enforcing participation requirements if the program is mandatory. It can be difficult to engage U.S. households to participate in food waste collection programs. Several factors influence participation in composting programs, including program design, whether participation is mandatory or voluntary, and the potential for unpleasant odors when food scraps are mixed with yard trimmings and a compostable liner bag isn't available. Moreover, many households underestimate the amount of food they waste, unaware that throwing food scraps in the trash significantly contributes to greenhouse gas emissions. To address this knowledge gap, municipalities are increasingly rolling out concurrent educational campaigns with their food waste collection programs.

3. State permitting regulations impede the expansion of food waste composting infrastructure

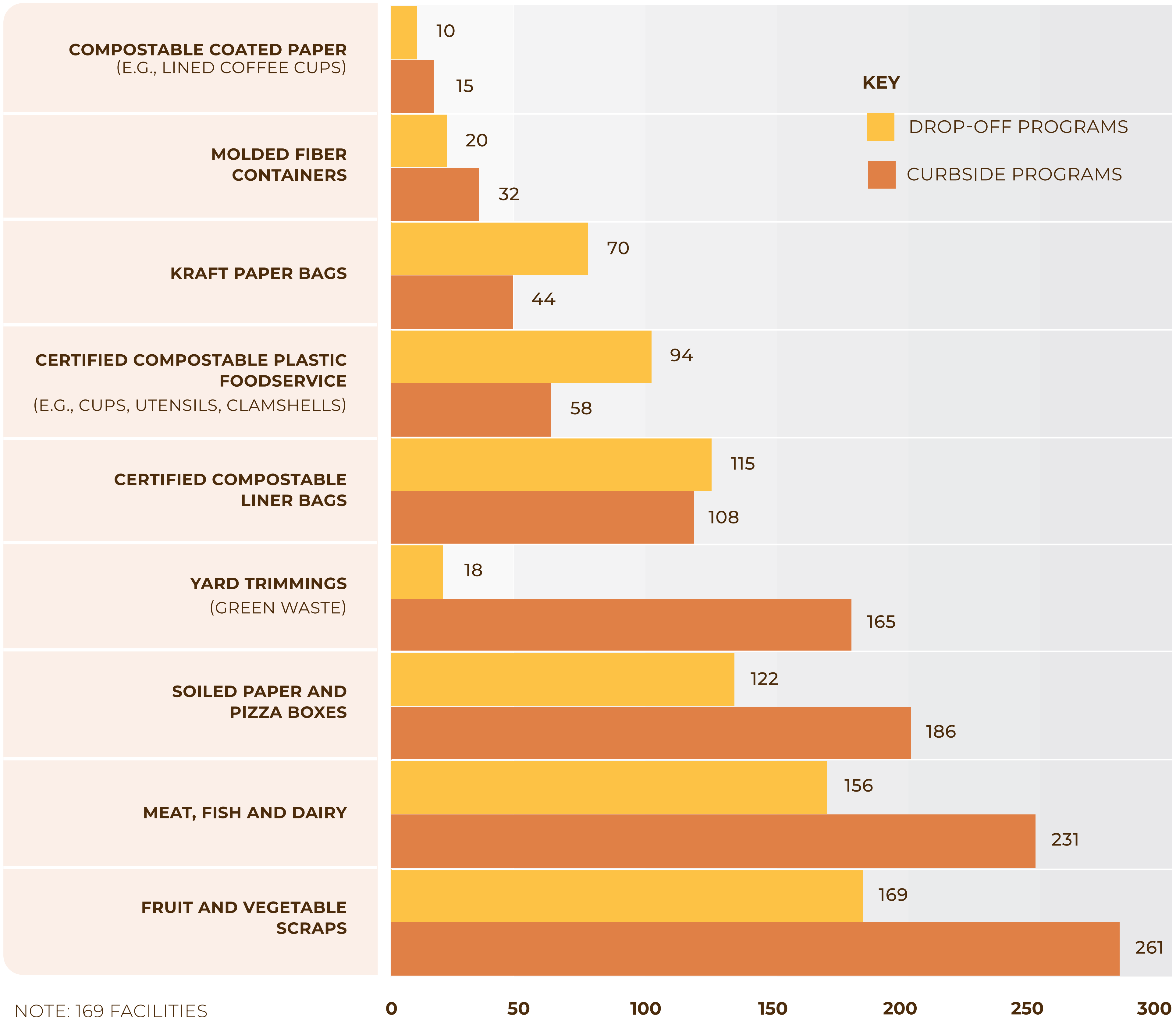
Permitting safeguards the processing of diverse organic materials in composting facilities by minimizing contamination, odor and other environmental and public health impacts. Permitting also plays a critical role in transitioning yard trimmings-only composting facilities to accept food waste as a feedstock. These regulations, which vary by state, are typically less restrictive for composting facilities that process only yard trimmings.[24] In contrast, upgrading a facility to also accept food waste can be expensive and time-consuming, with costs ranging from $500,000 to $1 million and timelines between 1-5 years to obtain the required permits.[25]

A research effort undertaken by the Composting Consortium, BioCycle and Coker Composting and Consulting found that the ability of yard trimming compost facilities to upgrade varied tremendously from state to state. More often, the permitting landscape of a particular state creates significant hurdles to scaling up food waste composting infrastructure in the U.S. The complex permitting landscape and lengthy upgrade processes often leave composting facilities in a "valley of death" where they can't operate and generate revenue. This financial strain discourages investment and limits the growth of new composting facilities. Many smaller composting businesses rely on loans or personal funds, further hindering a diverse capital base within the industry. Providing technical assistance and facilitating early engagement with regulators and local stakeholders can help streamline the permitting process and address concerns around factors like odor control and facility siting.

4. Today, less than half of all collections programs in the U.S. allow certified food-contact compostable packaging in the organics bin

Figure 9 shows the categorical breakdown of items accepted in both curbside and drop-off programs. Of note, most new curbside food waste collection programs in California (which has the most programs out of all 50 states) do not accept certified compostable plastic liner bags or other compostable packaging. However, they do allow kraft paper bags and some include food-soiled paper. Figure 10 illustrates the difference between acceptance of compostable food-contact packaging between curbside and drop-off programs. Of 261 curbside programs surveyed, 44% allow compostable food-contact packaging. Of 169 drop-off programs captured, 69% allow compostable food-contact packaging.

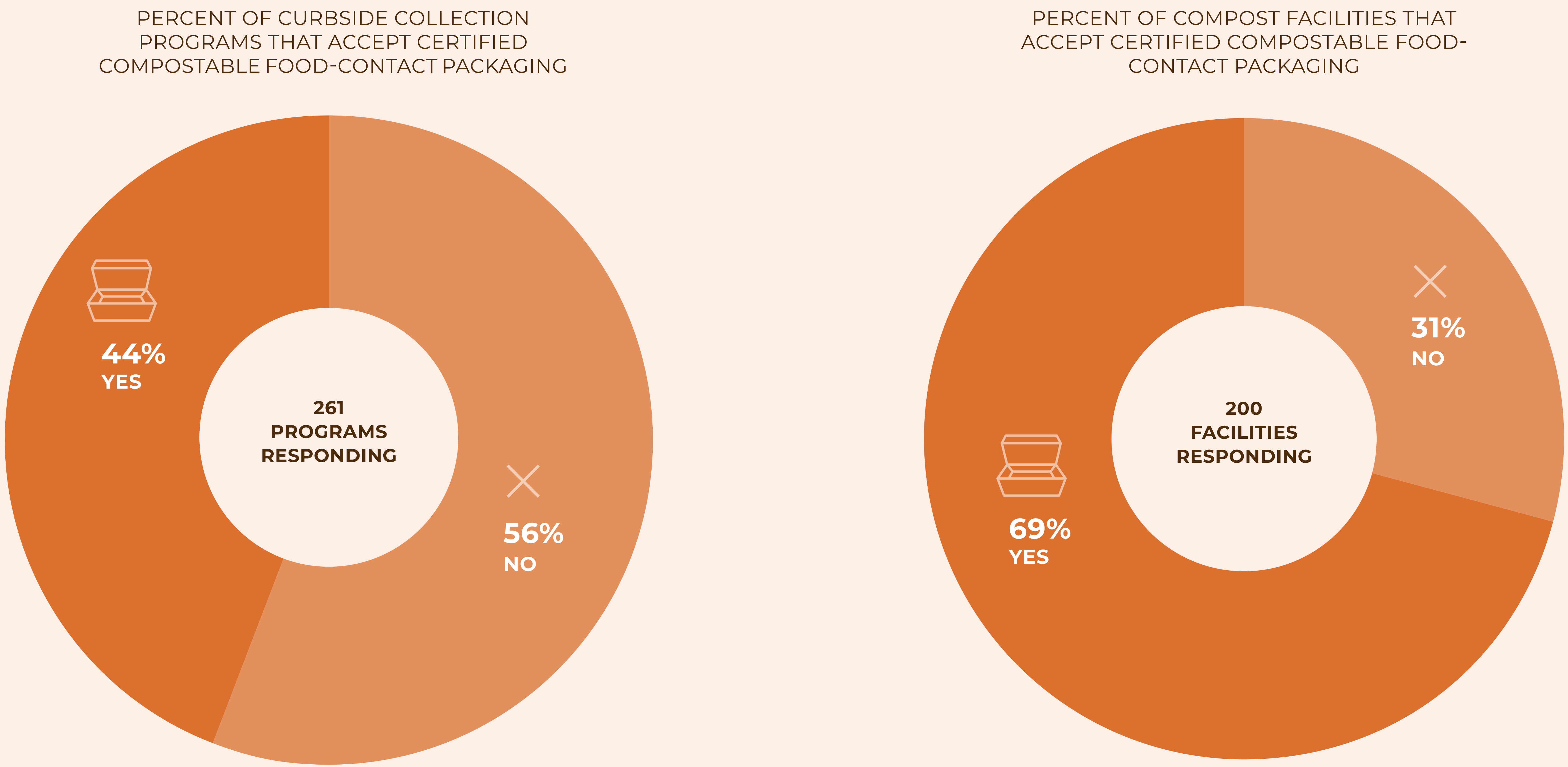
FIGURE 9. ACCEPTED ITEMS IN CURBSIDE AND DROP-OFF PROGRAMS



NOTE: 169 FACILITIES RESPONDING

SOURCE: BIOCYCLE, 2023

FIGURE 10. CERTIFIED COMPOSTABLE FOOD-CONTACT PACKAGING ACCEPTED IN CURBSIDE AND DROP-OFF PROGRAMS



SOURCE: BIOCYCLE, 2023

Key Takeaways from the Composting Infrastructure and Collections Analysis

1. The composting industry is at an inflection point in its development, and to meaningfully address food waste, the industry needs to spur investment and industry action. This can help establish food waste compost manufacturing as a viable solution for recovering complex food waste at scale (i.e., post-consumer organic streams with compostable packaging). The infrastructure transition is in its early stages, with 23 U.S. states currently having both full-scale food waste composting facilities and residential collections programs to facilitate material flow from food waste generators to composters.

2. States with existing food waste composting infrastructure and collection systems may present a more approachable entry point for investors, since the groundwork for material flow has already been laid. Additionally, long-established collections programs are more likely to ensure a consistent source of feedstock (i.e., food waste) for composting operations, potentially leading to more predictable outcomes. Food waste bans and evolving regulations can influence the feasibility of this approach. For example, states with food waste bans may be more receptive to infrastructure investment because they require end markets to process their organic waste.

3. Retrofitting yard-waste facilities to accept food waste is one approach to infrastructure expansion. States with complex and costly regulatory requirements might signal that retrofitting strategies are not the most efficient approach, which could prompt the exploration of other investment opportunities. Table 1 summarizes the regulatory tailwinds and permitting landscape to facilitate the setup of community compost and full-scale compost sites.

These are just merely factors that exemplify the broader macroeconomic considerations that investors, composters, policymakers and regulators should be aware of. There are diverse strategies for food waste composting infrastructure expansion, and the table below examines only one approach to inform investment decisions.

Findings from BioCycle's nationwide surveys indicate that the U.S. is at the beginning of its transition to accepting food waste via composting infrastructure, and far from reaching a saturation point of materials recovery when it comes to processing infrastructure and collection. This presents untapped market opportunities to expand organics collections and infrastructure throughout the U.S. To succeed, it's critical that investors, regulators and policymakers wholly understand the compost business model to advance opportunities that strengthen composting infrastructure.

"Findings from BioCycle's nationwide surveys indicate that the U.S. is at the beginning of its transition to accepting food waste via composting infrastructure, and far from reaching a saturation point of materials recovery when it comes to processing infrastructure and collection. This presents untapped market opportunities to expand organics collections and infrastructure throughout the U.S."

TABLE 1: STATE ANALYSIS WHERE FULL-SCALE FOOD WASTE COMPOSTING INFRASTRUCTURE AND COLLECTION PROGRAMS EXIST

✓ POLICY EXISTS

✗ NO POLICY EXISTS

— POLICY EXISTS ON STATE LEVEL WHICH OVERRIDES MUNICIPAL LEVEL

States with Full-Scale Food Waste Composting Facility and Households with Curbside and/or Drop Off Access	State Food Waste Ban and/or Organics Diversion Law	Municipal Food Waste Ban and/or Organics Diversion Law[26,27]	Infrastructure Retrofit Score*	Barrier to Entry for Small-Scale Food Waste Operations**
New York	✓	✓ New York City	A	A
Idaho	✗	✗	B	B
Massachusetts	✓	—	B	A
Ohio	✗	✗	B	A
Virginia	✗	✗	B	B
Maine	✓	—	C	A
Maryland	✓	—	C	B
North Carolina	✗	✗	C	C
Oregon	✗	✓ Portland	C	B
South Carolina	✗	✗	C	C
Texas	✗	✓ Austin	C	D
Vermont	✓	—	C	C
Washington	✓	✓ Seattle	C	C
Wisconsin	✗	✗	C	B
Connecticut	✓	—	D	B
Iowa	✗	✗	D	B
Michigan	✗	✗	D	D
Minnesota	✗	✓ Hennepin County, Duluth	D	D
Pennsylvania	✗	✗	D	B
California	✓	✓ San Francisco	F	C
Colorado	✗	✓ Boulder	F	D
Illinois	✗	✗	F	C
New Jersey	✓	—	F	F

***Infrastructure Retrofit Score:** Grade Scaling: A – F with A = best, F = worst.

Each of the 50 U.S. states have been given a score on the ease of setting up a food waste facility. The retrofit score gauges the degree of difficulty and cost of upgrading existing yard-waste only composting facilities to process food waste as of July 2023. Grades are assigned based on scores across five factors, including ease of permitting process, permitting tiers, cost to upgrade, time needed to upgrade and the existence of state food waste bans. All factors are considered equally, without weighting one factor over another. States with lower scores reflect considerations of length of time needed, cost and overall ease. States with staffing shortfalls that lengthened permit processing times scored lower than more well-staffed states.

****Barrier to Entry for Small-Scale Food Waste Operations:** Grading Scale: A to F, with A being the lowest barrier to entry and F being the greatest barrier.

In several states, the permitting and regulatory landscape enables small-scale facilities to be set up much more easily than commercial-scale food waste composting sites. These small-scale sites allow municipalities to 'test the waters' or set up a small-footprint site that suits community needs. Grades were assigned qualitatively based on regulation inclusion of small-scale carve out and the following factors:

- Exemption from permit or registration tier designation for composting source separated food waste, typically based on quantity allowed (annually or at any one time) and type of food waste, e.g., vegetative, all pre- and post-consumer food waste.
- Allowance of all food waste types (i.e., meat, fish, dairy) vs. vegetative only.
- If time-limited or pilot status only vs. a tier with no time limitation.
- If model for other states to utilize.

PART 2
COMPOSTING 101

The Compost Business Model

The composting process has been likened to baking a cake.[28] Just like there are many recipes to make a cake, there are many ways to set up compost facilities to produce high-quality finished compost. The compost industry does not have a standardized facility set up, but there are general commonalities about the inputs, processes and outputs that connect this diverse sector. Understanding these general operating models, along with potential system-specific variations, is crucial for investors, policymakers, regulators and municipalities. This section will explore these generalities and provide illustrative examples.

How Does the Composting Process Work?

Although an exact count is not known, it is believed that there are about 5,000 operating composting facilities in the U.S.[29] This includes full-scale facilities, on-farm compost sites, smaller community composting operations and seasonal yard waste locations. Each of these facilities make compost, which is "the product manufactured through the controlled aerobic, biological decomposition of biodegradable materials."[30]

First, incoming feedstocks enter the facility and can include yard trimmings, food waste, food-contact compostable packaging, industrial food processing residuals, land-clearing vegetation, agricultural residues, animal manure, animal mortalities, human sanitary waste and even human mortalities. There are compost operating facilities in the U.S. handling each of these feedstocks at various scales. Food waste composters accept and process materials other than food waste, as they need carbon-rich amendments for the composting recipe and to ensure adequate structural porosity (i.e., oxygen) in a composting pile. Carbon-rich amendments include wood chips, sawdust, hay, straw, yard trimmings and compostable paper.

As the feedstock breaks down, the compost pile undergoes both mesophilic and thermophilic temperatures (i.e., hot and hotter temperatures), which significantly reduce the viability of pathogens and weed seeds in the feedstock and stabilize the carbon to be beneficial to plant growth. Finished compost products are typically used as a soil amendment but may also contribute to plant nutrients. The compost products are usually screened to reduce their particle size, which improves soil incorporation.[31] Since compost sales are very seasonal, many composters now make compost-amended engineered soils to meet other market demands.

The Diversity of Composting Business Models

Composting is a manufacturing process that produces a bulk commodity, usually at a modest price point typically ranging between $10 to $70 per cubic yard, which is costly to transport long distances due to its weight.[32] Compost production is focused on manufacturing a consistent finished product that has local demand, and as such, involves expenses common in other manufacturing industries such as processing, product quality control, labor, health and safety and environmental protection.

Compost manufacturing business models exist in several configurations. At the highest level, there are two types of composters:

Processors

Those who own and operate a facility and receive inbound feedstock from external haulers/sources.

Hauler-Processors

Those who are vertically integrated—meaning they collect feedstocks, transport the feedstock to their facility and process those materials into compost.

Compost manufacturers can be municipally owned and operated, municipally owned and privately operated, or privately owned and operated. Out of the 200 food waste compost facilities surveyed by BioCycle in 2023, 151 of those facilities were privately held companies; 43 were municipal sites (some managed privately); 4 were non-profit operations; and 2 sites were employee-owned. These facilities operate at various scales, varying from on-site facilities for dedicated users, such as universities or industrial facilities; to small community-scale operations tied in with local community-sponsored agriculture; to large regional facilities that take in feedstocks from numerous sources in a 75- to 100-mile radius (and sometimes farther). Their reasons for existence vary. For example, a compost facility may exist to solve a municipal waste management problem (e.g., yard waste processing), be adjunct operations on an animal agriculture farm, be a stand-alone merchant facility or be part of wastewater treatment plant infrastructure.

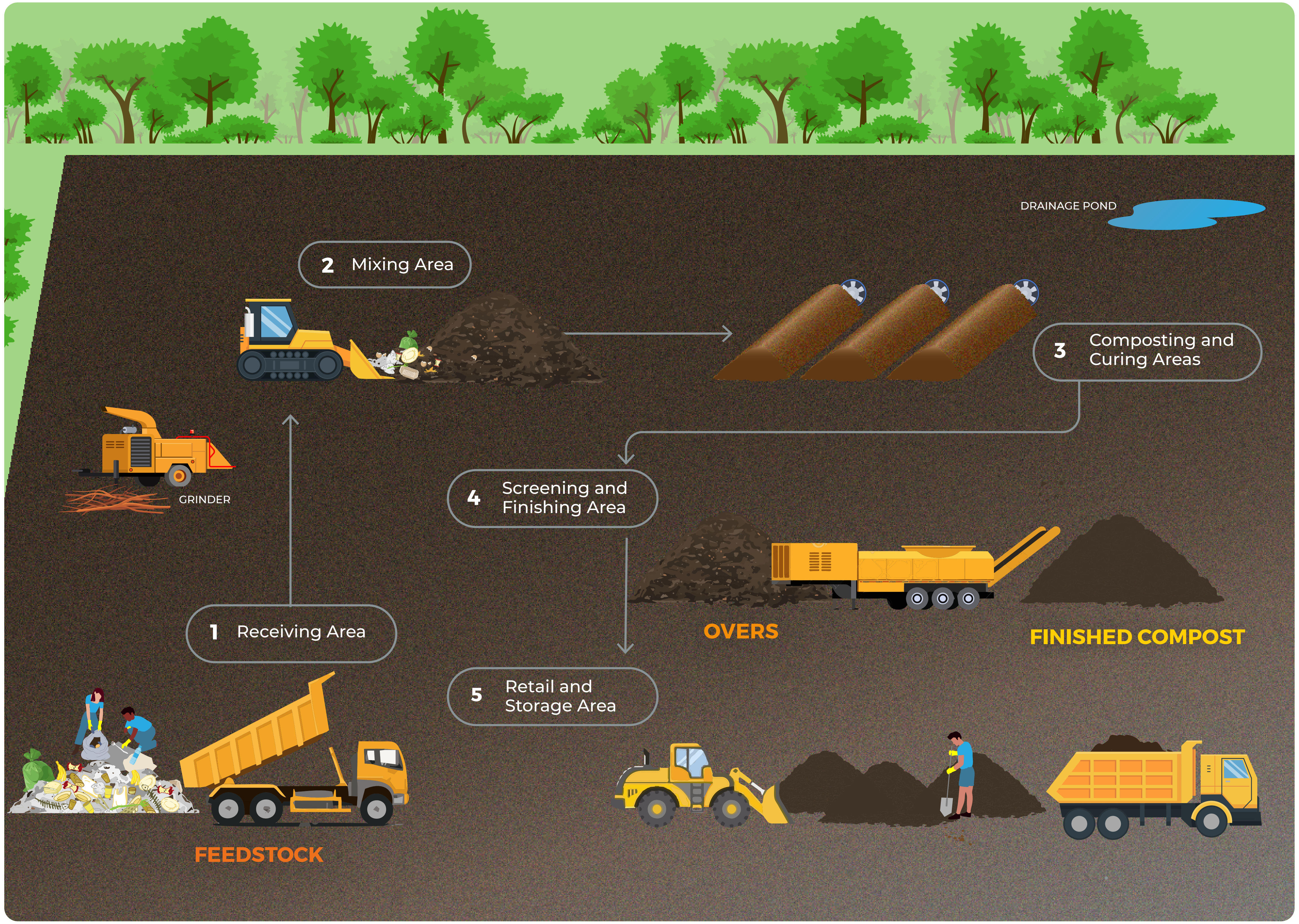
Composting Technologies and Methods

There are three primary methods of composting food scraps and food-contact compostable packaging—turned windrow, aerated static pile (ASP) and in-vessel systems. Turned windrow and ASP systems tend to be scalable, whereas in-vessel systems have, for the most part, finite capacity and a smaller footprint requirement (see Table 3). Composters are focused first and foremost on product quality, but they are also driven to maximize throughput of material through their facility, which is one reason for the industry shift to more ASP systems, which have faster throughput times than traditional windrow facilities.

Turned Windrow

Turned windrows are the most common method of composting but are not always advisable for food waste composting due to the potential for attracting vectors (i.e., flies, birds, small mammals) and for the need for continual housekeeping (Figure 12). Housekeeping may require a continuous walk-through and audit of the pile to ensure that no feedstock (e.g., food waste) has fallen out of the pile. The picture on the next page shows an example of an immature windrow pile that has just been turned, in which some food items (e.g., apples, oranges, etc.) have accidentally rolled out of the pile.

FIGURE 11. EXAMPLE COMPOST MANUFACTURING PROCESS FLOW DIAGRAM



Aerated Static Pile (ASP)

This additional operational housekeeping, plus a greater emphasis on managing stormwater runoff at windrow facilities, has increased the use of ASP compost systems to process food waste. ASP composting was developed by the U.S. Department of Agriculture in the mid-1970s to help wastewater treatment plants develop beneficial reuse systems for sewage sludges. ASP composting introduces forced aeration into a compost pile, either by pushing it up from under the pile (positive aeration) or pulling it down into the pile (negative aeration). ASP systems are often constructed out of concrete for longevity (Figure 13) and to provide “push walls” for materials handling equipment (e.g., tractors or front-end loaders).

In-Vessel

In-vessel systems, being of fixed capacity, are often better-suited for installations where the amount of food waste is known and not likely to increase much. There are several technology systems available globally; Figure 14 shows two systems.

FIGURE 12. WINDROW HOUSEKEEPING WITH FOOD WASTE

SOURCE: COKER COMPOSTING & CONSULTING

FIGURE 13. ASP COMPOSTING

SOURCE: ONONDAGA RESOURCE RECOVERY AUTHORITY, SYRACUSE NY

FIGURE 14. TWO TYPES OF IN-VESSEL COMPOSTING SYSTEMS

THE ROCKET COMPOSTER

SOURCE: FOOD WASTE EXPERTS, NYC

GREEN MOUNTAIN TECHNOLOGIES EARTH-FLOW

SOURCE: GREEN MOUNTAIN TECHNOLOGIES, THE FOODBANK, DAYTON

Site Footprint

As BioCycle survey data reinforces, most food waste diversion programs in the U.S. are voluntary sign-up programs, for both curbside collection and drop-off programs, so volumes collected tend to grow over time. Scalability in composting facility design, construction and operation is important in settings where future quantities of feedstocks may be hard to predict in the absence of legislation banning the landfilling of food waste. As volumes increase, there is a need for increased automation and larger machinery to handle the volumes. A complication arises in communities that rely on third-party haulers to collect food waste to bring to a composter. The number of households and businesses signing up for a diversion program are unlikely to produce enough "route density" (at least initially) to make collection profitable for private-sector haulers.

Compost facility planning usually requires the preparation of a Feedstock Capture Plan, which is a five to 10 year projection of potential feedstocks whose generators are willing to pay the processing fee. This forms the basis for the composting recipe and for a compost facility's footprint analysis which is an evaluation of the areas needed for each step in the compost manufacturing process. Table 3 is an example footprint analysis, for a proposed 10,600 ton/year composting facility exploring different composting methods. The footprint analysis just examines processing needs; there is also the need for office and equipment maintenance functions, employee and visitor parking, stormwater management and adequate vegetated buffer zones. The total area needed for this proposed facility would be about 15-20 acres.

As proposed facilities get bigger, it is much more difficult to find suitable greenfield sites that do not face substantial public opposition. Sites with greater proximity to "sensitive receptors"—broadly defined as anywhere the public gathers, works or lives—will need greater infrastructure to ensure the facility is a good neighbor (e.g., enclosed buildings, active odor control systems, storm water runoff management). Because composting facilities do not create as many jobs as other waste sectors (i.e., recycling), economic development officials are not willing to present their graded, prepared industrial lots for consideration. This has led to several municipal public-private partnerships where the private sector enters a long-term (e.g., more than 20 years) lease of municipal land and constructs a facility under a Design-Build-Own-Operate (DBOO) model. Often the municipal land is already associated with solid waste management activities like a landfill or a transfer station or is part of a wastewater treatment complex.

TABLE 3. FOOTPRINT ANALYSIS EXAMPLE

	Windrow Composting Area (sq. ft.)	ASP Composting Area (sq. ft.)	In-Vessel Unit Composting Area (sq. ft.)
Feedstock Receipt	1,600	1,600	1,600
Feedstock Storage			
Food Waste	400	400	400
Old Corrugated Cardboard	400	400	400
Leaves	19,900	19,900	19,900
Wood Chips	8,400	8,400	8,400
Yard Waste	6,000	6,000	6,000
Overs from Screen	750	750	750
Composting Area	87,500	26,250	24,000
Curing Area	75,000	95,625	115,500
Screening Area	4,500	4,500	4,500
Product Storage Area	24,000	24,000	24,000
Retail Sales Area	6,400	6,400	6,400
Subtotal	234,850	194,225	216,650
Equipment Storage, etc. @ 25%	58,713	48,556	54,163
Total Square Feet Needed	**293,563**	**242,781**	**270,812**
Total Acreage Needed	**6.7**	**5.8**	**6.2**

SOURCE: COKER COMPOSTING AND CONSULTING, 2023

The Economics of Running a Compost Operation

Composting Facility Costs: Capital Expenditures

The cost of developing a composting operation is considered “front-end loaded.” The entire facility has to be planned, permitted, designed, built and in operation for approximately six months before the first sale of finished product is possible. Gate fee revenues (i.e., tip fee revenues) can help offset some of the initial cost of operations, but only after the facility starts operation.

Compost facility financing is largely done through savings, friends and family contributions, angel investors and debt financing.[33] There has been some private equity interest in composting facilities, but notable investments are limited to a handful of announced deals and merger and acquisition activity (i.e., Atlas Organics[34], WM and Republic M&A[35]). As noted above, debt is serviced by free cash flow. There are limited government subsidies for composting, but some grant programs are being expanded by Federal and State governments, and some of those state-level grants can go to private-sector companies.

The initial cost of enterprise development can include business plan research and development, professional service fees for attorneys, accountants and consultants, financing fees, permit application preparation, and government permit and approval fees. If the enterprise is planning on accepting gate fee materials, the time and effort needed to secure firm contracts for those wastes is considerable. The extent of permitting documentation and regulatory approvals needed is often directly correlated to the types and sources of feedstock to be composted. Farm-generated feedstock have the least regulatory oversight. Biosolids, food and solid feedstock have more oversight.[36] A larger-scale composting operation taking in off-site solid wastes may have $125,000 to $250,000, or more, in up-front engineering and permit application costs and fees alone.[37]

Composting facilities are subject to local government approvals for planning and zoning (and sometimes for inclusion in solid waste management plans), which are public procedures that can take multiple months to complete.

Then the facility owner(s) must apply for State environmental permits for waste management, storm water discharge, and, increasingly, air emissions. Facilities are normally built, then inspected by state regulators for consistency with the approved plans, following which they get permission to begin operations. Facilities with air pollution permits will have to prove the pollutant removal efficiency of any air pollutant control device (e.g., a biofilter). It is not unusual for the entire up-front approvals processes to take 18 months to three years to complete.

Construction activities can be defined as site development activities and compost technology construction. A simple turned windrow facility can require as little as a graded parking lot with a storm water pond. ASP and in-vessel systems require extending power to the site, and as larger blowers need three-phase power, extending power can be expensive. Sites in proximity to sensitive receptors and in-vessel systems not suitable for outdoor environments may also have building costs. Compost technology costs depend on whether a technology provider is hired. These technology providers usually include all physical infrastructure for their technology, including process control instrumentation and software, and operator training.

While capital costs are very site-specific, planning-level estimates of capital expenditures would be $75-$100 per ton of throughput capacity for turned windrows, $150-$200 per ton for ASPs (which require a much smaller footprint than windrows), and $200+ per ton for in-vessel systems. Table 4 provides a range of equipment costs. Composting facilities use a lot of mobile equipment for materials handling. Under normal supply chain conditions, most equipment has a 14-16-week lead time but in some cases, lead times have expanded to more than one year. These pieces of equipment have a 7-10-year lifespan. The cost variations in the table reflect differences in processing capacity, degree of automation and manufacturing quality.

TABLE 4. RANGES FOR COMMON COMPOSTING EQUIPMENT COSTS

Equipment	Range of Costs ($)
Slow-Speed Shredders	$500K – $1M
High-Speed Grinders	$350K – $1.25M
Depackagers	$250K – $750K
Mixers	$150K – $350K
Front-End Loaders	$150K – $500K+
Windrow Turners	$350K – $1M+
ASP Systems (Vendor-Supplied)	$1.5M – $4M
In-Vessel Composting Systems	$300K – $6M
Screens	$250K – $500K
Bagging Equipment	$150K – $1.5M+

SOURCE: COKER COMPOSTING AND CONSULTING

DOLLAR AMOUNT RANGES FOR EACH TYPE OF COMPOSTING EQUIPMENT

FIGURE 15. THE SCOTT EQUIPMENT MEGA THOR

NOTE: THIS DEPACKAGING UNIT HAS SWING HAMMERS THAT HELP SEPARATE FOOD WASTE FROM ITS PACKAGING. THE ORGANICS PASS THROUGH PUNCH PLATE SCREENS THAT LINE THE BOTTOM OF THE UNIT. ALL PACKAGING IS CONVEYED TO A COMPACTOR.

SOURCE: SCOTT EQUIPMENT COMPANY.

There is also a cost for distributing compost and compost-based soil products. These costs include marketing and sales expenses, delivery costs (usually reimbursed by the buyer) and, if offered, application expenses (e.g., soil testing costs, compost spreading equipment, etc.). The radius of waste capture and compost sales varies from 50 miles to 100 miles depending on the quality of the road network (i.e., interstate highway access allowing for longer delivery distances).

Facilities that become permitted and regulated by environmental agencies are sometimes required to maintain financial assurance to cover closure costs if the facility is abandoned. Financial assurance is a regulatory program designed to assure regulators that a composting facility has the means to finance the closure of the facility, should that become necessary. This type of program originated in the solid waste landfill industry so that public tax dollars would not have to be spent to clean up privately owned, but abandoned, landfills. Financial assurance mechanisms acceptable to most government agencies include certificates of deposit, irrevocable letters of credit, trust funds, surety bonds and insurance policies. Financial assurance mechanisms can be a significant cost to a composting facility.

Composting Facility Costs: Operational Expenditures

Composting is a volumetric materials handling manufacturing process, so every time feedstocks, raw compost (i.e., immature compost) or finished compost are handled, additional costs are incurred, with limited ability to recover those cost increases with price adjustments for processing fees or compost product prices. Optimal compost production is linear with the fewest materials handling steps.

Operational costs include labor, fuel, maintenance, electricity and, if needed, costs to acquire carbon-rich amendments. Labor costs are the largest component of cost of goods sold (COGS). Labor is needed to prepare and mix feedstocks, build and monitor compost piles, move compost to curing, and to screen and prepare the final product for market. Cost of labor can range from $4.00 to $12.00 per ton of feedstock handled, depending on composting method, equipment available and regional labor rates.[38] Fuel costs are often the second-largest cost, as most equipment used to handle the materials of composting is diesel fuel-driven, and transport is often needed to bring feedstocks to the composting facility. Transportation is almost always needed to take the product to market. Equipment maintenance is a frequent, and sometimes unexpected cost of composting operations. Electrical power costs can be on the order of $1.05 to $1.50 per ton of feedstock handled in the U.S., depending on availability of three-phase power and electric utility rates.[39]

Compost production expenses are labor, fuel, debt service on improvements or equipment, feedstock amendments (if purchased), business development (both securing feedstocks and marketing and selling products), and management and administrative costs. Some of these expenses are direct expenses (e.g., costs of goods sold) and some are indirect expenses (e.g., overhead). Compost utilization expenses are the costs to apply the compost and costs to get compost to customers.[40] Composting facility overhead include the following components: advertising, debt, bank charges, donations, drug testing costs, education, internet, janitorial, licenses/permits, life insurance, medical, memberships, office supplies, postage & delivery, professional fees, subscriptions, telephone, travel, utilities, payroll expenses and retirement funding.

Net profit margins vary, but a net margin of 6-8% is not unrealistic. Composters with high processing fee contracts (e.g., biosolids composters) may get 10-12% net profit margins. One of the drivers of cash "burn" is unanticipated maintenance expenses. Facility planning budgets anticipate 5% of the capital cost of equipment will be consumed by maintenance each year. If a facility must rely on outside service contractors for equipment repairs, the costs escalate greatly.

Lastly, there are significant costs associated with contamination removal. Findings from the Composting Consortium's contamination report, Don't Spoil the Soil: The Challenge of Contamination at Composting Sites, indicate that composters spend an average of 21% of their operating expenses on removing contaminants.[41] Efficient material throughput is crucial to composter profitability; the faster composters can move material through their system, the more product they can sell. While tip fees help offset costs, they may not cover the entirety of expenses spent on sorting and removing contaminants. This highlights the importance of setting an appropriate value for the finished compost on the backend.

Material Management Costs

How materials are moved around inside the composting facility can greatly influence operating costs. Most composters use rubber-tired front-end loaders to move feedstocks, bulking agents and compost through the manufacturing process (smaller-scale and on-farm operations rely more on tractors). With a front-end loader, bucket capacity can make a large difference in materials handling costs. Table 2 compares two loaders, moving 100 cubic yards (CY) of compost 1,000 feet to a curing pile daily at assumed hourly operating costs (labor + fuel + maintenance).

TABLE 2. IMPACT OF BUCKET SIZE ON COMPOSTING OPERATIONAL COSTS

Parameter	Loader A	Loader B
Bucket Capacity	3 Cubic Yards	8 Cubic Yards
Number of Bucket Movements Needed	33.3 Per Day (5-day week)	12.5 Per Day (5-day week)
Time Needed to Move Compost (round-trip)	5 Minutes	5 Minutes
Operating Cost Per Hour	$50.00	$65.00
Annual Operating Cost	$36,075 ($1.38 per cubic yard)	$17,602 ($0.68 per cubic yard)

SOURCE: COKER COMPOSTING AND CONSULTING

Composter Revenue Sources

Composting facilities usually charge a processing fee, or a "tip fee," for incoming feedstocks, which, ideally, will cover the cost of compost production with a margin to spare. As municipal solid waste landfills are the primary competition to composting facilities, the processing fee is limited to what the landfill charges as a tip fee, except in those states and jurisdictions where landfilling food wastes have been limited or banned. Composters in this competitive environment must create an "economic magnet" to pull in source-separated organics at a processing fee less than the landfill tipping fee. Larger-scale composters often have weigh scales, so they will charge processing fees on a "per ton" basis. Smaller facilities without scales will likely charge on a volume basis (e.g., per cubic yard), although some will charge a fixed-price for a certain size load.

Tip Fees: Most of a composter's annual revenue is often made on the front end, on the tip fee. Tip fees, or fees charged for accepting organic waste, are assessed either by weight (e.g., $45 per ton) or by volume (e.g., $15 per cubic yard or $25 per 6' x 12' trailer). The published rate is usually slightly below the tip fee at a nearby landfill in order to create demand that pulls waste away from the landfill and to the composter, especially in states that do not have an organics recycling mandate. In states that do have mandates, tip fees can be less, since the composting facility is more assured of customer flow. A 2021 study by the US Composting Council and the EREF revealed a significant disparity in revenue streams between larger and smaller composting facilities. Tip fees constitute over 80% of the average revenue for larger facilities. These tip fees typically remain below $75 per ton, with the exception of private household food waste collection. Conversely, micro-facilities generate only around 25% of their revenue from tip fees.[42]

Product Sales: Composting facilities also generate revenue from product sales. It is the combination of processing fees and sales revenues that create the cash flow for funding operations and retiring debt. The ratio between the two revenue sources varies with the extent of competition, but ideally, ~75% of the revenue comes from tip fees and ~25% from product sales, so that processing fees cover the cost of production. This ratio can change over time as competition increases for the feedstocks (i.e., from other composters, anaerobic digestion facilities or waste upcycling operations), putting more pressure on the compost, soils, and/or mulch sales and marketing efforts.

Contracts: Contract terms and conditions vary but most private-sector waste management contracts have 3 to 5 year terms, with one or two renewal periods. Municipal contracts can be annual (often used on woody waste grinding contracts), short-term with one to two renewals (often used on food scraps drop-off collection contracts) or longer terms of 20 years if the municipality is seeking a public-private partnership to develop an organics recycling facility.

Compost End Markets

As noted in Part 1 of this report, the 200 food waste composters in the U.S. process between 1,350,000 and 2,650,000 tons of food waste annually. Food waste compost products have higher nutrient contents than yard waste compost products, but lesser nutrients than biosolids composts or some composts made from livestock manures (e.g., poultry litter compost). Food waste compost products that are derived from feedstocks that include compostable packaging are currently not approved for use in organic agriculture as defined by the U.S. Department of Agriculture's National Organic Program.

Three Primary Reasons for the Exclusion of Compostable Packaging from Collections Programs

In some instances, composting facilities that sell compost to certified organic growers do not accept compostable packaging because they are not allowed as an input into organic compost according to definitions set by the USDA. The National Organic Standards Board (NOSB) held its first hearing to update the national compost definition in spring 2024, prompted by a petition led by the Biodegradable Products Institute (BPI). The decision-making process is ongoing and will resume in fall 2024. Click here for more information on the petition and the National List of Allowed and Prohibited Substances. Other concerns for not allowing compostable packaging include concerns around physical and chemical contamination. Without clear product labeling that is easy for composters to distinguish, composters risk single-use plastics entering their process and final products. Not all compostable products in the market are also certified, increasing the risk that some packaging may have per- and polyfluoroalkyl substance (PFAS), a class of manmade chemicals added to thousands of different consumer products from cookware to makeup to increase a product's resistance to oil, water and heat. It is widely understood that PFAS can be toxic at low levels and are extremely difficult to break down. Certifying compostable packaging is important because the certification organizations serve as checks and balances to ensure that the products are PFAS-free and safe for use.

Barriers to Compost Market Development

Barriers to compost market development can be classified as physical/chemical, economic and societal, and are described below. Aspects of these barriers as they influence markets are presented in Table 5.

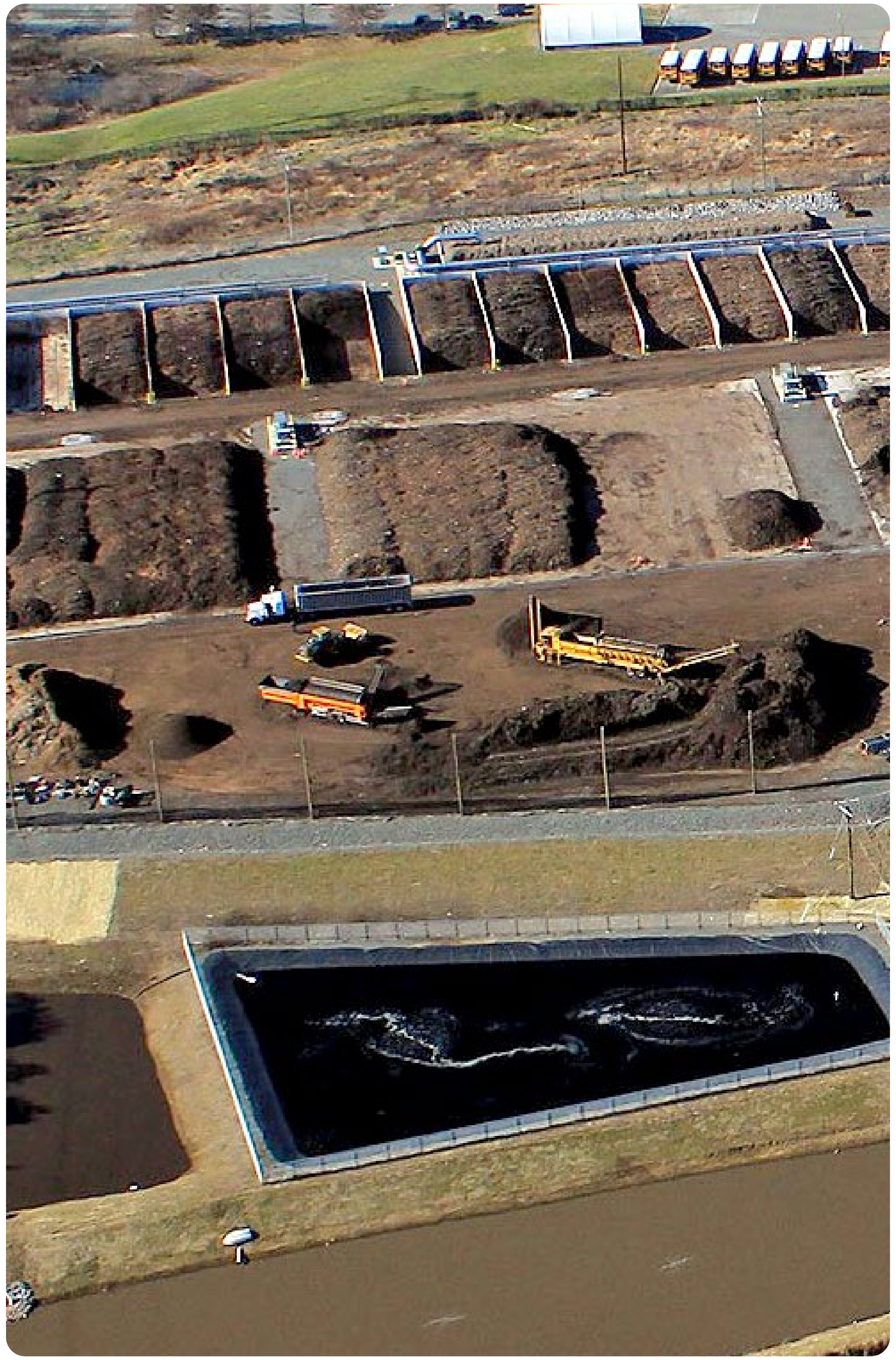


TABLE 5: BARRIERS TO COMPOST MARKET DEVELOPMENT

BARRIERS		COMPOST MARKETS															
		Landscaping	Turfgrass	Agriculture (conventional)	Agriculture (organic)	Containerized Horticulture	Engineered Soils	Storm water	Sports Turf	Urban Trees	Sediment/Erosion Control	Land Restoration	Landfill Closure/ ADC	Carbon Sequestration	Development Soil Organic Matter	Soil Profile Rebuilding	Biochar
Physical/ Chemical	Contamination – physical	Major	Major	Minor	Medium	Major	Medium	Medium	Major	Medium	Medium	Minor	Minor	Minor	Medium	Minor	Major
	Contamination – chemical	Major	Major	Major	Major	Major	Medium	Major	Major	Major	Medium	Medium	Minor	Minor	Medium	Minor	Major
	Soluble salts	Medium	Medium	Major	Major	Major	Minor	Medium	Medium	Medium	Minor	Minor	Minor	Minor	Medium	Minor	Major
	National Organic Product Standards	Minor	Minor	Minor	Major	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Economic	Cost of product(s)	Major	Major	Major	Medium	Major	Medium	Minor	Major	Medium	Major	Minor	Medium	Minor	Minor	Minor	Major
	Transportation/application costs	Medium	Medium	Major	Major	Medium	Medium	Medium	Major	Medium	Major	Medium	Medium	Minor	Minor	Minor	Major
	Alternative products	Minor	Minor	Major	Minor	Major	Minor	Minor	Minor	Minor	Major	Minor	Major	Minor	Minor	Minor	Minor
	Certified products	Major	Major	Medium	Major	Major	Major	Major	Major	Major	Minor	Minor	Minor	Minor	Medium	Minor	Medium
Societal	Perceptions of product quality	Major	Major	Major	Major	Major	Medium	Major	Major	Major	Medium	Minor	Minor	Minor	Medium	Minor	Minor
	Lack of user education	Medium	Medium	Medium	Medium	Major	Medium	Medium	Medium	Medium	Major	Medium	Medium	Major	Major	Major	Minor
	Emerging pollutants of concern	Medium	Medium	Major	Major	Major	Medium	Medium	Medium	Medium	Medium	Minor	Minor	Minor	Medium	Minor	Major

MINOR – NO SUBSTANTIVE OBSTACLE TO COMPOST USE IN THAT MARKET SECTOR

MEDIUM – SOME CONSTRAINTS ON COMPOST USE IN THAT MARKET SECTOR

MAJOR – SIGNIFICANT ISSUES WITH COMPOST USE IN THAT MARKET SECTOR

Notes:

Alternative products could include pre-seeded erosion control matting and fabric silt fence

Certified products refer to the need for high-quality certified products to protect large-volume customers (Alexander, 2017)

Lack of user education: there is a pressing need to educate engineers and architects as to compost benefits in certain markets (Alexander, 2023)

Emerging pollutants of concern not yet regulated include pharmaceuticals, PFAS and microplastics.

SOURCE: COKER COMPOSTING AND CONSULTING, 2023

There are numerous potential customers in each market as outlined in Table 6.

TABLE 6: CUSTOMER TYPES ACROSS VARIOUS COMPOST END MARKETS

	Customer						
Market	Residential	Commercial/ Industrial	Farmers	Landscapers	Construction	Municipal	DOTs
Landscaping	●	●		●	●	●	●
Turfgrass	●	●		●	●	●	●
Agriculture – Conventional			●				
Agriculture – Organic			●				
Containerized Horticulture		●					
Engineered Soils		●		●	●	●	●
Stormwater Quality Management		●		●	●	●	●
Sports Turf		●		●		●	
Urban Tree Growth Media						●	
Sediment/Erosion Control		●		●	●	●	●
Landfill Closure/ADC		●			●		
Land Restoration		●			●	●	●
Carbon Sequestration	●	●	●			●	●
Development O.M. Spec.		●		●	●	●	
Soil Profile Rebuilding	●	●	●	●	●	●	
Biochar – Amended Soils	●	●	●	●		●	

SOURCE: COKER COMPOSTING AND CONSULTING, 2023

Compost-Based Soil Blends

Another trend that has evolved in recent years is the production of compost-based soil blends. This is driven by composters' need to diversify markets and reduce the seasonality of compost sales. Compost-based soil blends (usually blends of sands and/or sandy loam soils and composts) are made and marketed to consumers as topsoils, specialized plant soil amendments (e.g., Kellogg Garden Products Palm, Cactus and Citrus all-purpose indoor and outdoor mix), and to contractors and professional consumers ("prosumers") for athletic field turfgrass growth and maintenance media, stormwater management, vegetative growth media, golf course rootzone mix, etc.). Any type of compost (e.g., biosolids, manure, yard waste, food waste, compostable packaging + food waste) can be used to make blends.

Compost, compost-amended soils and mulches are all sold in the landscape supply market, which has both retail and wholesale participants. The retail market serves both end-users (usually residents) and contractors working for residents and businesses. Contractor sales are usually at some discount from retail, often 10-15% off. Wholesale participants for bulk sales include garden centers, construction contractors, agriculture and institutional users (such as Departments of Transportation), while bagged product sales include garden centers and big-box stores. Bulk wholesalers normally buy products at 50% of their retail price point and bagged product wholesalers seek discounts of 50%–70%.

Market Segment Types

Market segments for compost and compost-based soil products can be classified as traditional markets and emerging markets. They also can be classified as "dollar" markets and "volume" markets.[43] Market segments are summarized in Figure 16. Prices for compost products vary with distribution mode (bulk vs. bagged) and model (wholesale vs. retail), compost feedstocks (manure composts tend to be higher priced than yard waste composts), and with the extent of competition in a particular area.

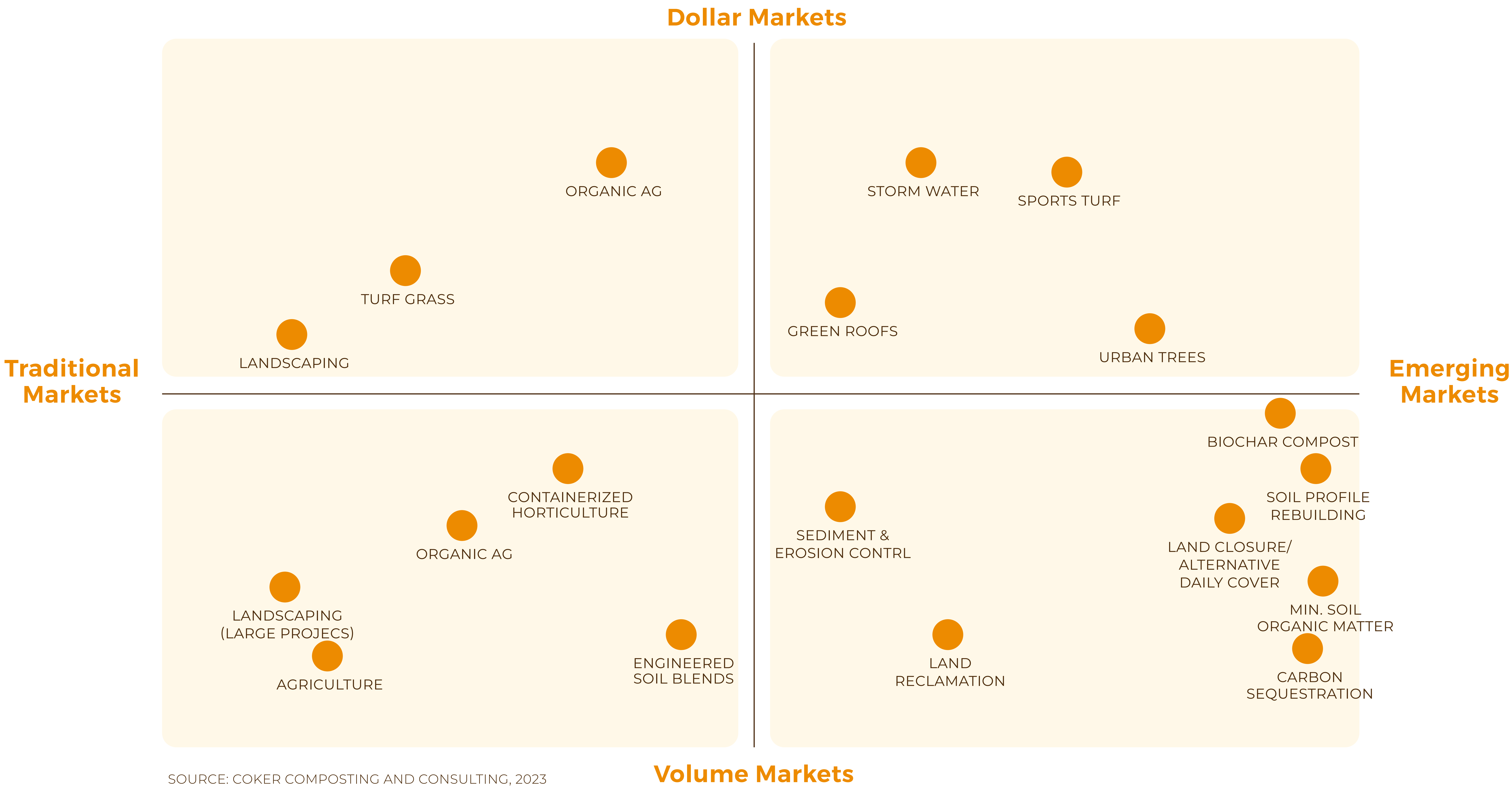
Traditional markets are those in which a product is considered well-defined and has customers with well-developed buying patterns and established customer loyalty. The local residential and commercial landscaping markets would be considered traditional markets.

Emerging markets are those in which the benefits of a product are still being defined. The use of compost-amended growth media in non-point source water quality management is an example of an emerging market in the Northeast and Mid-Atlantic. Emerging new compost and soils markets with high potential are in non-point source water quality management (i.e., rain gardens), sediment filtration and erosion prevention, low-impact development infrastructure and in carbon sequestration/climate action plans.

Dollar markets can be described as those with higher unit price potential, but lower volume sales expectations. An example of a potential dollar market for compost would be residential landscaping and gardening.

Conversely, **volume markets** are those with the capacity to support large product volumes but exhibit a lower unit cost and willingness-to-pay. Examples of volume markets for compost would be agricultural use or land reclamation/remediation. Similar distinctions are possible for compost-based soil products. Manufactured topsoil would also be an example of a potential volume market, while sports turf growth media would be a potential dollar market. The distinctions between volume and dollar markets are not definitive, and potential compost markets can fluctuate between both dollar and volume markets depending on project size. For example, a small commercial landscaping job might be considered a dollar market but landscaping the grounds of a new shopping mall would be considered a volume market.

FIGURE 16. CLASSIFICATION OF COMPOST END MARKETS



SOURCE: COKER COMPOSTING AND CONSULTING, 2023

PART 3
FINANCING THE FUTURE COMPOSTING INDUSTRY

The Future of U.S. Composting

The composting industry in the U.S. stands at an interesting juncture. Its potential for social, environmental and economic benefits is well-established, and individual food-waste compost manufacturers have stood up successful businesses. However, scaled operations, particularly for large-scale food waste composting facilities, remain hindered by hyper-localized logistics, variable municipal engagement and lack of financing tailored to the business model's dynamics (i.e., relatively small-scale, variable offtake agreements)

Challenges of the Current Composting Financing Landscape

The 2023 BioCycle data notes that current composting infrastructure has relied heavily on bootstrapping, personal savings, friends and family contributions, grants, angel investors and debt financing.[44] These funding sources, while crucial in the initial stages, fall short when it comes to scaling infrastructure to meet the nation's growing need to divert food waste and food-contact compostable packaging.

Addressing Challenges in Food Waste Composting

Despite strong interest from experienced operators, scaling food waste composting operations faces several key challenges:

1. Permitting Restrictions: Retrofitting existing yard trimming compost facilities to accept food scraps often requires navigating complex permitting regulations (refer to Part 2 of this report).

2. Capital Intensity: Establishing greenfield, full-scale food waste composting facilities necessitates upfront investment, ranging from $1 million to $20 million with long lead times of up to five years before revenue can be generated.[45] This encompasses securing land, acquiring equipment, developing infrastructure and navigating permitting processes. Financing this capital expenditure requires a multifaceted approach, potentially combining low-cost equipment financing with traditional debt financing and equity or cash injections.

3. Offtake Agreements: The lowest-cost financing options are typically reserved for operators who have secured long-term purchases for finished compost ("offtake agreements"). Long-term offtake agreements are less common in the compost industry compared to the recycling industry.

4. Lack of Support for Strategic Expansion: A significant barrier to scaling composting infrastructure lies in the lack of support for operators and developers as they transition from a single facility to multi-site operations. This is crucial because demonstrating a successful track record of scaling their business is essential to attracting larger, more traditional financing options.

5. Portfolio Visibility: Available project financing is typically looking for project portfolios that can absorb at least $20-$200 million. This means that many composting developers need to secure or have visibility into securing sites, operators, permits and offtake agreements for a portfolio of this size before unlocking larger sources of capital—a practice that is atypical outside of a handful of multi-site operators, such as WM or Republic Services.

Through our analysis, we have found that a blended financing framework can help to catalyze scale in existing composting infrastructure and bring traditional capital sources to the table.

The Role of Financing Instruments

Within the blended capital framework, various instruments play a crucial role:

1. Grants and Philanthropic Funding

These funds—typically not requiring repayment—provide essential seed capital to launch composting initiatives, especially in underserved communities or regions where the economics of composting may not pencil out (i.e., rural areas where route density is low or end markets are far away). They can also support research and development of innovative technologies that solve contamination challenges or advancements in business model innovation (i.e., large scale anaerobic with composting co-located).

Grant and philanthropic funders are primarily interested in projects addressing social or environmental issues, but they also need to see a sustainable future for the initiative. In the case of composting in underserved communities, this might involve creating a robust market for compost in these areas or developing a replicable model in an underserved area that can be more widely implemented, attracting further grant funding.

2. Patient and Flexible Capital Providers

It offers longer investment horizons and flexible terms, allowing businesses to navigate the initial growth phase without the immediate pressure of generating high returns. Patient capital providers may be more flexible with repayment schedules, interest rates and potential conversion of debt to equity if needed. This type of financing provides a critical pathway for composting facilities to manage cash flow, adapt to changing market conditions and achieve financial stability. Examples of patient capital providers include:

- Impact Investors: These investors prioritize social and environmental impact alongside financial returns. For example, since 2014, Closed Loop Partners' Infrastructure Group has deployed below market rate, flexible loans to support the scale up of recycling infrastructure across North America. Project based financing supports municipalities, non-profit organizations and private enterprises operating across the recycling value chain and at various stages of growth. The financing structures are designed to match the bespoke cash flow needs of the borrowers.
- Community Development Financial Institutions (CDFIs): These institutions specialize in providing financial products and services to underserved communities. Similar to how CDFIs support small businesses in renewable energy, they can empower businesses throughout the composting value chain. This includes financing for hauling companies that collect food scraps, equipment manufacturers developing innovative composting technologies, and even community gardens or urban farms that compost food waste on-site. By strengthening these interconnected businesses, CDFIs can contribute to the overall growth and infrastructure of the composting industry.
- Government Programs: Some government initiatives provide funding for composting and food waste diversion. For example, the U.S. Department of Agriculture (USDA) will award $11.5 million to 38 projects between 2024-2026 focused on innovative composting and food waste reduction strategies. This initiative aims to divert food waste from landfills and is part of the USDA's broader support for urban agriculture.[46]

Patient capital providers are willing to wait for financial returns, but they still need to see a clear path to profitability. For composting businesses, this might involve building a strong management team with a proven track record of success in scaling businesses; scaling operations without incurring excessive costs through optimizing facilities, logistics and staffing; and diversifying revenue streams.

3. Private Equity (venture, growth, buyout)

As the industry demonstrates growth opportunities, private markets can play a vital role in scaling composting infrastructure and backing ambitious and excellent operators. Their expertise and access to larger pools of capital can fuel significant expansion through several strategies:

- Backing novel technology in composting: Private equity can support the development and deployment of innovative technologies that improve composting efficiency, reduce costs or address specific challenges (e.g., automated sorting systems).
- Roll-up strategies for existing facilities: Private equity investors can invest in acquiring and consolidating existing composting sites to create larger, more efficient operations.
- Pre-funding developers to secure sites and contracts: By providing capital upfront, private equity can help developers move faster in securing optimal locations and offtake agreements, accelerating project timelines.
- Structuring the lowest-cost capital stacks: Private equity firms can leverage their financial expertise to help developers build optimal financing structures that combine various instruments like debt, equity and government grants.

Private equity firms are focused on maximizing returns for their investors, which requires significant growth potential. In the composting industry, this might involve market consolidation, technological advancements and a favorable regulatory environment. Notably, not all composting facility operators will want to grow at the pace and scale required by traditional private markets, which is why we suggest a blended approach to scaling composting infrastructure.

Blended Capital: A Catalyst for Infrastructure Growth

Blended capital offers a promising solution by strategically combining public and private capital, bringing together financing partners with different risk tolerances and return expectations. Here's how it can bridge the financing gap and propel composting infrastructure development:

Signaling Market Demand: Public funds in blended finance act as a beacon for private investors, signaling strong market demand for composting infrastructure. Government investment shows a clear commitment to composting, boosting investor confidence. Pilot projects funded through blended finance validate the market by demonstrating successful composting operations in specific regions. Additionally, data collected from these projects provides valuable insights into tip fees, costs and compost demand, which can be shared with potential investors, further strengthening the case for composting infrastructure investment. By acting as a market demand signal, blended finance with public involvement can unlock the flow of private capital and accelerate composting infrastructure growth across the U.S.

De-risking Investments: Public funds or guarantees can act as a buffer, making composting facilities more attractive to private investors. This is particularly critical for projects in regions with uncertain tip fees, stricter environmental regulations or limited access to consistent feedstock. By mitigating risk, blended finance can unlock the flow of much-needed private capital into the composting sector.

Unlocking New Markets: Blended finance can be used to pilot innovative composting technologies or collection programs in new regions. Initial investments from public or philanthropic sources can demonstrate the feasibility of these projects, proving their economic and environmental benefits. This can pave the way for larger-scale private investment and unlock new markets for composting infrastructure.

Supporting Viable Unit Economics in Composting: Blended finance can subsidize the upfront costs of composting facilities, making them more accessible to communities with limited resources. This could be achieved through grants, concessional loans or results-based financing tied to achieving specific composting goals. By making composting more affordable, blended finance can expand access to this critical waste diversion strategy across the U.S.

Addressing Bottlenecks Across the Composting Value Chain With the “Right” Type of Capital

There is tremendous power in matching the various types of capital to the specific needs in the composting value chain. Philanthropic capital addresses critical bottlenecks hindering food waste composting’s growth, while private capital can help scale projects that work economically. Here’s how various types of finance can be applied to each value chain node:

1 Collections: Bridging the Organics Gap Challenge

Challenge: Establishing efficient and widespread organic waste collection programs, particularly in residential areas, remains a significant hurdle. The upfront costs of collection vehicles, infrastructure (bins, drop-off sites), and public education campaigns can be substantial.

Financing Opportunity: Public grants and subsidies can be used to offset the initial costs of collection infrastructure and educational initiatives. Tax equity or other incentives can galvanize private waste haulers to invest in organic waste collection. Outcome-linked municipal bonds can provide low-cost financing to haulers, while aligning the incentives of collecting high-quality organics tonnage and reducing the waste hauling fees of the municipality. Investors (public and private) seeking social and environmental returns can find opportunities in purchasing these bonds to support composting programs while meeting balanced portfolio goals.

2 Infrastructure Build: Financing the Future of Composting Facilities

Challenge: As discussed earlier, the capital needs of the first through fifth facility is a barrier for some current operators. Traditional lenders are often hesitant due to the long payback periods associated with composting projects.

Financing Opportunity: Public or private loan guarantees can de-risk composting projects, making them more attractive to private investors. Place-based investors see a unique opportunity to support the growth of a critical local industry while generating attractive financial returns. These investors, with a vested interest in the long-term health and sustainability of their communities, are well-positioned to provide patient capital for composting facilities. Blended finance can also be used to incentivize the adoption of innovative technologies with lower operating costs or faster processing times.

3 Innovation: Fostering the Next Generation of Composting Technologies

Challenge: The composting industry can benefit from advancements in areas like in-vessel composting, removing contamination, rapid and low-cost de-packaging technology. However, research and development (R&D) for these technologies often requires significant upfront investment by the operator, and innovation is needed to solve some key challenges (i.e., sorting contamination in feedstock).

Financing Opportunity: Public and philanthropic funding of university research labs can support early-stage R&D and traditional venture capital can support startups developing innovative advancements for the composting industry.

4 End Market Development: Expanding the Demand for Compost

Challenge: Creating a robust and stable market for the finished compost product is crucial for the long-term sustainability of the composting industry. Fluctuations in compost prices and limited awareness among potential users about the economic benefits of compost can hinder market development.[47]

Financing Opportunity: Public awareness campaigns funded through grants or public-private partnerships can educate consumers and businesses about the value of compost as a soil amendment. Local government can incentivize the use of locally produced compost by businesses, farmers, landscapers and homeowners through local sales tax abatements. Blended capital can also support the development of new compost applications, such as piloting new compost applications by potential offtakes and customers.

By strategically deploying different types of capital across these key nodes of the composting value chain, we can create a sustainable ecosystem for food waste diversion. The combined impact of improved collections, infrastructure, technological advancements and a thriving end market will propel the composting industry towards a future where it plays a central role in a circular economy.

Across the funding scenario above, policy can play a critical role in influencing market conditions, inclusive of but not limited to facilitating permitting processes, providing secure offtake agreements, proposing RFPs, providing tax incentives and more, to attract investment into composting infrastructure and scale end markets.

Beyond Blended Capital: Supporting Infrastructure Development Through Policy

While blended capital offers a powerful tool to scale infrastructure, additional mechanisms can further support the industry's growth:

Standardized Permitting Regulations

Currently, composting regulations vary significantly across states and municipalities. Standardizing permitting processes and compost quality standards can create a more predictable operating environment for investors.

Public Procurement

Government agencies at the federal, state and local levels can give a significant boost to composting by prioritizing the purchase and application of finished compost for various uses—whether it's state Department of Transportation projects, public parks or stormwater remediation.

Federal and State Policy

Federal and state funding can accelerate organics circularity by strategically directing investments toward composting facilities that process both food scraps and compostable packaging.

Federal Level Funding Opportunities

The U.S. Environmental Protection Agency (EPA) and the USDA both offer federal grants to fund food waste composting infrastructure development. A non-exhaustive list of these grants is provided below:

EPA Solid Waste Infrastructure for Recycling (SWIFR) Grants: The EPA SWIFR grant program distributed more than $44 million to 33 projects related to organics recycling, composting and anaerobic digestion in 2023.[48] Similarly, the USDA's Composting and Food Waste Reduction grants have been used to fund smaller-scale composting operations at the local and municipal level.

EPA Recycling Education and Outreach Grants: The EPA's Recycling Education and Outreach Grant Program offers funding to educate communities about recycling and composting options. These grants aim to increase participation and reduce contamination in residential and community programs, ultimately boosting national recycling and composting rates.

USDA Rural Development Fertilizer Production Expansion Program (FPEP): In 2023, the USDA made $500 million in grants available to increase American-made fertilizer production to spur competition and combat price hikes on U.S. farmers. FPEP awarded $29 million in grant funding to eight independent businesses across the country last year; two of those businesses were compost manufacturing facilities.[49] The funding supports activities like equipment upgrades, climate-smart agriculture practices and new production plant construction.

USDA Sustainable Agriculture Research and Education (SARE) grant program: SARE is a federal grant initiative supported by the USDA National Institute of Food and Agriculture. Since 2016, the SARE program has provided $51 million in funding to more than 1,000 compost-related projects.

National Strategy for Reducing Food Loss and Waste and Recycling Organics: In June 2024, the USDA and EPA released a comprehensive national strategy aimed at reducing food waste and supporting the organics recycling industry in the U.S. The Strategy proposes four key objectives—including a goal to increase the recycling rate for all organic waste in the U.S.—along with specific funding opportunities and strategic actions to support the composting industry.

State Funding Opportunities

Organics diversion mandates are continuing to proliferate throughout the U.S., redirecting food waste towards valuable end-of-life outcomes, like composting. New York State,[50] which has proposed expanding its Food Donation and Food Scraps Recycling law as part of a broader effort to reduce landfill methane emissions, is one such example. New York State's Climate Action Council estimates that food waste makes up 18% of the MSW stream in New York.[51] The law, which went into effect in 2019, requires business and institutions generating an average of two tons of food waste per week to donate the surplus edible food and recycle the rest. Currently, generators are only obligated to recycle their organics if they're situated within 25 miles of the nearest organics recycling facility. The proposed changes would remove that distance exemption, and lower the tonnage threshold in stages, starting with one ton per week effective January 2026, and half a ton per week effective January 2028. These types of policy shifts are expected to significantly enhance the attractiveness of investments in food waste infrastructure across New York State.

Demand for finished compost, however, has not kept pace with this growth in organics diversion. The growing focus of U.S. policy on soil health could be the catalyst to ignite demand for finished compost, while also building resilient and healthier communities. As of May 2024, there are 27 states with health programs or policies in place. These states make up 57% of the nation's farmland and 63% of the total population.[52] Soil health policies commonly focus on agriculture, land conservation and water quality—yet it's uncommon for these policies to connect soil health to compost use. Meeting the ambitious goals of these types of policies and programs will require us to address soil health quickly and at scale, and compost can provide a solution to achieve those goals.[53] State healthy soils programs like the Washington State Agriculture Incentive Program and California Healthy Soils Program can be looked to as models and examples for other states to follow.

Washington State's Compost Reimbursement Program, part of the Agricultural Incentive Program, encourages on-farm use of commercial compost. For eligible farms, the program will pay up to 50% of the cost to obtain, transport and spread compost. The California Healthy Soils Program has funded 1,600 projects since 2017, reducing 1.1 million metric tons CO2 and improved soil health on over 170,000 acres of land (as of March 2023). Similarly, state grants that prioritize organics infrastructure and collection, like those in California and Colorado, provide crucial financial resources for building and upgrading composting infrastructure. Grants can also be used to educate potential compost users (i.e., municipalities, farmers, landscapers, etc.) and promote domestic compost production.

State-level organics management plans can also be powerful tools for directing funding towards the composting industry. The [New York State Solid Waste Management Plan] and [Colorado's Statewide Organics Management Plan] serve as prime examples. New York State's plan provides a list of action items and implementation timelines, and identifies which stakeholders are best suited to lead each task—whether it's legislators or state agencies, like the New York State Department of Environmental Conservation (DEC). Action items related to food waste composting include operator training programs to support food waste operators, technical assistance and guidance on starting a compost operation for source-separated organics, and financial assistance to municipalities to expand food scraps collections programs.[54]

Similarly, Colorado's plan offers new research, projections and recommendations to guide policymakers, municipalities and composting facilities in building and scaling organics recycling infrastructure. The framework establishes goals tailored to local and regional needs focused on the efficient capture and diversion of organic waste and sufficient capacity for its end use. Notably, the plan identifies several potential funding sources from various Colorado departments, including Public Health and Environment, Agriculture, Local Affairs, Economic Development and the Energy Office.[55] This points to the critical role that various state agencies can play in boosting compost production and application.

Extended Producer Responsibility (EPR)

New waste management policies like Extended Producer Responsibility (EPR) are emerging in different states across the country. As of May 2024, five states—California, Colorado, Minnesota, Maine and Oregon—have established EPR. Only two include compostable packaging and composting in their EPR program. Several others, including New York, Illinois and Maryland, are preparing for the possibility of EPR by conducting statewide needs assessments.[56] EPR for packaging places the financial and operational responsibility for collection, recycling and disposal on the producer, incentivizing them to design sustainable packaging and ensure responsible end-of-life management. This incentivizes companies to design packaging that is easier to recycle, process and reuse—whether it be paper, plastics, metals or glass—to reduce waste and create a more circular economy.

EPR programs promise new funding opportunities for collection and downstream infrastructure at a scale that the U.S. has not yet seen. When designed thoughtfully, EPR policy provides tailwinds for composting infrastructure—but requires a thoughtful approach and strategic implementation to ensure viable outcomes for the composting industry.

Limited data of the composting business model and misunderstandings around compostable packaging performance in the field could stall the development of well-informed EPR programs, creating potential delays in scaling infrastructure. The setup of these systems and funding disbursement details are not finalized, nor are they guaranteed. How EPR programs are developed over the next few years will determine future outcomes for sustainable single-use packaging alternatives, like compostable packaging. If executed thoughtfully, EPR could unlock a major shift for composting facilities that process compostable packaging. Several realities still need to be met to ensure composting operations are set up for success within EPR.

First, it is essential that the groups responsible for implementing and managing the EPR plan—policymakers, regulators and Producer Responsibility Organizations—understand the diversity of composter business models, technologies and operations that exist in their state. During the needs assessment process, it's important to catalog the time and money that composters spend processing compostable packaging, which typically corresponds with the amount of time spent processing food waste. Equally important is understanding the costs associated with addressing contamination. EPR funding can be a vital assurance to help composters address and offset the costs of contamination. The Composting Consortium's 18-month study on contamination found that, on average, 21% of composter operating costs are spent on contamination mitigation. Having this level of understanding equips decision-makers to design programs that support a thriving composting industry, which can be difficult to do when compostable packaging still makes up a relatively small percentage of the packaging market.

To address food waste at scale, the composting industry needs a diversified funding toolbox. Federal and state support for processing complex feedstocks, whether in the form of grants, legislation or other programs, is key to unlocking large-scale solutions.

Conclusion

The future of food waste composting in the U.S. hinges on securing various forms of capital to address bottlenecks throughout the composting supply chain. By strategically combining public and private capital, along with catalytic funding and traditional financing instruments, the industry can unlock its full potential for diverting organic waste and creating a more sustainable future.

Philanthropic, public, private capital and traditional equipment lenders offer a powerful toolbox to address critical bottlenecks across the entire composting value chain—from establishing efficient collection programs to fostering the development of next-generation technologies and expanding the demand for compost.

Food waste continues to be a significant environmental and economic burden. As the urgency of climate action intensifies, composting presents a readily available solution for reducing greenhouse gas emissions and enriching our soils. This report serves as a call to action for a diverse set of stakeholders.

Through a collective effort, we can unlock the immense potential of composting to create a more circular economy, reduce our environmental footprint and build a more sustainable future for generations to come.

Calls to Action for Different Stakeholders

The Composting Industry
Continued collaboration and knowledge sharing are essential to further improve operational efficiencies, advocate for supportive policies and pursue the most appropriate types of capital. Embracing innovation and exploring new market opportunities, such as compost utilization for renewable natural gas production, will be crucial for long-term success.

Investors
The composting industry presents a compelling opportunity to generate positive social and environmental impact alongside financial returns. By deploying well-placed private investments, investors can play a pivotal role in scaling the industry and creating a lasting positive financial and impact return.

Policymakers
Federal and state governments can play a critical role in enabling the widespread adoption of composting by enacting food waste diversion mandates, providing financial incentives for composting infrastructure and collection programs, and supporting research and development of innovative technologies.

Consumers
By participating in composting programs and choosing products with compostable packaging, consumers can send a powerful signal to the market and drive demand for composting solutions.

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