2019 Wasted Food Report

Estimates of generation and management of wasted food in the United States in 2019

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Contents

List of Tables

List of Figures

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) estimates that more food reaches landfills than any other material in municipal solid waste (MSW) in the United States, making up over 24 percent of MSW sent to landfills in 2018 (EPA, 2020b). Producing food and managing food waste uses significant resources. Wasted food contributes to a broad range of environmental impacts, including climate change, air pollutants, water scarcity, biodiversity loss, and soil and water quality degradation. In addition, communities with environmental justice concerns, by definition, bear the brunt of the adverse environmental, social, and economic consequences of waste management. By preventing food loss and waste where possible, and recycling the remainder, environmental impacts and impacts to underserved communities can be substantially reduced. To support food waste reduction strategies, identify current practices, and identify opportunities to prevent and reduce food waste, EPA publishes annual estimates of how much wasted food is generated and managed in the United States, which are detailed in this report.

Recognizing the importance of tackling food loss and waste, in 2015, EPA and USDA announced the first-ever national goal to reduce food loss and waste by 50% by the year 2030 (EPA, 2015). The same year, the United Nations announced the Sustainable Development Goal Target 12.3, which aims to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses by 2030 (UN, 2019).

The United States is not alone in its efforts to reduce wasted food. Roughly 30% of the food produced worldwide is lost or wasted each year: approximately 14 percent of the world's food, valued at $400 billion, is lost on an annual basis between harvest and the retail market (FAO, 2019) and an estimated 17% of food is wasted at the retail and consumer levels (UNEP, 2021). Food loss and waste accounts for about 7% of global greenhouse gas emissions and nearly 30% of the world's agricultural land is currently occupied to produce food that is ultimately never consumed (UN, 2022).

In 2017, the EPA set out to revise its food measurement methodology to more fully capture flows of wasted food (i.e., excess food and food waste)[1] throughout the food system, and to provide more granular annual estimates of generation and management of wasted food to the public and for purposes of tracking progress against domestic and international goals. EPA developed an enhanced methodology to calculate sector-specific estimates of wasted food generation, as well as estimates of how much wasted food was sent to each management pathway. EPA's "Wasted Food Measurement Methodology Scoping Memo" (EPA, 2020a) describes the enhanced methodology that EPA developed between 2017 and 2019, the studies used, and how EPA plans to use the enhanced methodology to calculate its annual estimates for the "Advancing Sustainable Materials Management: Facts and Figures" report (hereafter referred to as the "Facts and Figures Report").

EPA has collected and reported data on the generation and management of municipal solid waste (MSW), including wasted food, in the United States for more than 30 years. EPA historically published U.S. estimates of wasted food generation and management annually in its "Facts and Figures Report." The 2018 "Facts and

[1] The term "excess food" refers to food that is donated to feed people, while the term "food waste" refers to food and inedible parts not ultimately consumed by humans that are discarded or recycled, such as plate waste (i.e., food that has been served but not eaten), spoiled food, or peels and rinds considered inedible. The term "wasted food" is an overarching term that can be used to refer to both excess food and food waste. Section 9.1 contains a glossary of terms used throughout this report.

Figures Report" (EPA, 2020b) was the first such report that used the enhanced methodology to calculate wasted food estimates.[2]

The "2019 Wasted Food Report" serves as an update to the "2018 Wasted Food Report" (EPA, 2020c) and provides detailed estimates, by sector and management pathway, of 2019 wasted food estimates.

EPA included the following generating sectors in the enhanced methodology:

- Food and beverage manufacturing and processing;
- Residential, which is comprised of single and multi-family units;
- Food retail, which includes supermarkets, supercenters, and food wholesalers;
- Food service, which includes several hospitality categories such as restaurants, hotels, and sports venues as well as other institutions that provide food service including hospitals, nursing homes, military installations, office buildings, correctional facilities, colleges and universities, and K-12 schools; and
- Food banks.

EPA's enhanced methodology aims to capture the various methods in which wasted food is managed and to align with the "Food Loss and Waste Accounting and Reporting Standard" (or "FLW Standard"), which is a global standard that provides requirements and guidance for quantifying and reporting on the weight of food and/or associated inedible parts removed from the food supply chain (Food Loss and Waste Protocol, 2016). EPA's enhanced methodology includes the following management pathways for wasted food. All are consistent with the FLW Standard, with the addition of food donation.

- Animal feed
- Bio-based materials/biochemical processing
- Codigestion/anaerobic digestion (shorthanded to "Anaerobic digestion" in this report)
- Composting/aerobic processes (shorthanded to "Composting" in this report)
- Controlled combustion
- Donation
- Land application
- Landfill
- Sewer/wastewater treatment

EPA estimates that in 2019, 66.2 million tons of wasted food was generated in the food retail, food service, and residential sectors. Of this, 40% was from households, 40% was from food service providers, and 20% was from food retail. Most of this waste (59.8%) was landfilled. An additional 40.1 million tons of wasted food was generated by the food manufacturing and processing sectors. The biggest proportion of this food manufacturing and processing waste (42.6%) was managed by anaerobic digestion.

[2] https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/advancing-sustainable-materials-management

Wasted Food at a Glance

In 2019, EPA estimates:

- 66.2 million tons of wasted food was generated in the food retail, food service, and residential sectors.
  - Of this, 40% was from households, 40% was from food service providers, and 20% was from food retailers.
  - Most of this waste (59.8%) was landfilled.
  - 349 pounds of food waste per person was managed by anaerobic digestion, composting, controlled combustion, land application, landfilling, or sewer.
  - The United States has a goal to reduce the food waste being managed by these pathways to 164 pounds per person by 2030.
- An additional 40.1 million tons of wasted food was generated by the food manufacturing and processing sector.
  - This biggest proportion of this waste (42.6%) was managed by anaerobic digestion.

EPA's data for the food retail, food service, and residential sectors is used to inform progress toward the national goal to reduce food loss and waste by 50% by 2030 (EPA, 2015). For food waste, this goal aims to cut in half the amount of food from the retail, food service, and residential sectors that has been removed from the human food supply chain compared to a 2016 baseline of 328 pounds per person. In the three years between the baseline (2016) and the latest national data (2019), there was a slight increase of 6% (from 328 pounds to 349 pounds per person). More information on measurement for the 2030 goal can be found in Section 7.

EPA recognizes that there have been many efforts across the food system to reduce food waste, and by a variety of stakeholders, since 2019. For example, in 2021, 25 states introduced food waste-related legislation (Harvard Food Law and Policy Clinic, 2022), such as landfill bans or other mandates focused on reducing food waste going to landfills. Some of these laws have yet to be fully implemented, and therefore will continue to result in the reduction of wasted food, which is not taken into account in this report reflecting 2019 data. Private sector businesses have made strides in setting goals, measuring and reducing food waste, and communities are increasingly focused on education and awareness efforts aimed at helping their residents waste less food at home. EPA continues to support public and private sector efforts, facilitate peer learning, provide data and conduct research to help decision makers, and provide funding to support waste reduction efforts. Notably, in 2022, EPA established funding opportunities through the Solid Waste Infrastructure for Recycling Grant Program and Recycling Education and Outreach Grant Program for a total of $350 million (EPA, 2022).

Finally, there are some data limitations associated with EPA's estimates. EPA relies on existing studies and data to develop generation factors, and for some sectors, there are few existing studies. In addition, as states and cities adopt landfill bans and recycling mandates, estimates that rely heavily on studies that pre-date those laws may result in overestimation of generation, especially as these laws become more common and continue to be implemented.

On the management pathway side, composting and anaerobic digestion tonnages may be underestimated, as EPA did not extrapolate to account for states and facilities for which no data was found. Food donation may be overestimated due to EPA's approach to accounting for food being donated to food banks not in the Feeding America network. Data for food being sent down the drain to the sewer system is also lacking. Finally, while the estimates contained in this report reflect 2019 data, which is prior to the start of the COVID-19 pandemic, EPA is evaluating available information regarding the effects of the pandemic on wasted food generation and management. These findings will be incorporated into future estimates for 2020 and beyond. More detail on caveats and uncertainties can be found in Section 7.

1 BACKGROUND

Wasted food is a growing problem in our society—but also an untapped opportunity. EPA estimates that more food reaches landfills than any other material in our municipal solid waste (MSW), making up over 24 percent of MSW sent to landfills in 2018 (EPA, 2020b). Wasted food is generated by households, food service providers, food retailers, and food manufacturers and processors.

When food is wasted, it also wastes the resources – such as the land, water, energy and labor – that go into growing, storing, processing, distributing, and preparing that food. Each year, food loss and waste from farm to kitchen embodies an area of agricultural land the size of California and New York combined, enough energy to power 50 million U.S. homes for a year, and emissions (excluding landfill emissions) equal to the annual CO2 emissions of 42 coal-fired power plants (EPA, 2021). Through its Sustainable Management of Food efforts, EPA promotes ways to reduce wasted food and thereby limit its negative environmental consequences. The approach takes a life-cycle perspective, targeting waste generation at all points in the food supply chain, and promoting greater efficiency and more creative and beneficial management strategies. The benefits of such an approach are wide-ranging. Environmental benefits include resource conservation and reduction of greenhouse gas emissions. Socioeconomic benefits include improved efficiency in the food supply system, resulting in better distribution to feed people and financial savings. To support wasted food reduction strategies, identify current practices, and identify opportunities, EPA publishes annual estimates of how much wasted food is generated and managed nationally.

EPA, with support from Eastern Research Group (ERG) and Industrial Economics, Incorporated (IEc), updated its wasted food measurement methodology to build on and expand prior efforts. The enhanced methodology and resulting 2016 estimates are detailed in "Wasted Food Measurement Methodology Scoping Memo" (EPA, 2020a). The enhanced methodology was developed through a comprehensive assessment of the literature supporting the measurement of wasted food generation and management, coupled with a sector-specific data collection and characterization effort. EPA used this enhanced methodology to calculate its annual published estimates of wasted food generation and management for the first time in "Advancing Sustainable Materials Management: 2018 Fact Sheet" (EPA, 2020b) ("2018 Facts and Figures Report"). The "2018 Wasted Food Report" (EPA, 2020c) was developed to accompany the "2018 Facts and Figures Report", and provides detailed estimates by sector and management pathway, along with other relevant information about the 2018 wasted food estimates. This report serves as an update to the "2018 Wasted Food Report" and provides detailed estimates, by sector and management pathway, of 2019 wasted food estimates.

2 SCOPE AND TERMINOLOGY

This report summarizes the 2019 wasted food estimates for the following sectors:

- Food and beverage manufacturing and processing;
- Residential, which is comprised of single and multi-family units;
- Food retail, which includes supermarkets, supercenters, and food wholesalers;
- Food service, which includes several hospitality categories such as restaurants, hotels, and sports venues as well as other institutions that provide food services including hospitals, nursing homes, military installations, office buildings, correctional facilities, colleges and universities, and K-12 schools; and
- Food banks.

This report also summarizes 2019 wasted food estimates for the following management pathways[3]:

- Anaerobic digestion
- Animal feed
- Bio-based materials/biochemical processing
- Composting
- Controlled combustion
- Donation
- Land application
- Landfill
- Sewer/wastewater treatment

EPA's scope for wasted food measurement has historically been on the food retail, food service, and residential sectors. That is also the scope of the food waste portions of the national 2030 Food Loss and Waste Reduction Goal (EPA, 2015), and Sustainable Development Goal Target 12.3. (United Nations, 2019), which both aim to reduce food loss and waste by 50% by 2030. However, the food manufacturing and processing sector is an important part of the U.S. food system, so estimates for that sector are also presented in this report. EPA's methodology does not include food loss from the agricultural sector, such as unharvested crops.

EPA's estimates do not distinguish between "food" and "inedible parts".[4] EPA's goal is to make the best use of not only food that was intended for human consumption, but also the associated inedible parts. Throughout this document, EPA uses the term "food" as a shorthand to refer to both food and inedible parts. When referring to both "excess food" (food that is donated to feed people) and "food waste" (food that is intended for human consumption but is ultimately not consumed by humans), EPA uses the overarching term "wasted food". Food waste can be managed in a variety of ways, including creation of animal feed, composting, anaerobic digestion, or sending to landfills or combustion facilities. Examples of wasted food include unsold food from retail stores; plate waste, uneaten prepared food, or kitchen trimmings from restaurants, cafeterias, and households; or by-products from food and beverage processing facilities. Section 9.1 contains a glossary of terms used throughout this report.

3 GENERATION OF WASTED FOOD

Generation estimates rely on studies conducted by state and municipal governments, industry groups, universities, and other groups that measure wasted food generated at facilities in various sectors. Estimates are correlated to facility-specific characteristics (e.g., revenue or the number of employees) to establish equations expressing generation factors (e.g., 4,080 lbs of wasted food generated/employee/year in supermarkets). There are multiple studies, and therefore multiple generation factors, available for most sectors. EPA scaled up these rates by applying national, sector-specific statistics (e.g., U.S. Census-reported store sales, number of employees in restaurants, number of patients in hospitals, number of inmates in correctional facilities), which resulted in multiple generation estimates per sector. An average annual

[3] These management pathways are consistent with the "FLW Standard" destinations (Food Loss and Waste Protocol,), with the addition of food donation. For simplicity, the term anerobic digestion is used in this report to cover both stand alone and co-digestion facilities and the term composting is used in this report to cover composting and other aerobic processing as composting is the predominant aerobic management pathway for food waste.

[4] EPA uses the definition of "food" and "inedible parts" from the FLW Standard (Food Loss and Waste Protocol). Please see section 9.1 for a glossary of terms.

generation estimate was then calculated for each sector, and these values were summed to calculate overall estimates of excess food and food waste generated nationally.

To calculate national wasted food generation estimates for 2019, EPA started with a literature search update. The literature search sought to determine whether any new articles or studies had been published since 2017 (the most recent year for which a comprehensive literature search was conducted) that offer updated generation factors or data on generation for 2019 estimates. EPA's literature search considered a variety of criteria when evaluating the usefulness and reliability of different information sources. These criteria included the following:

- the depth and level of detail provided by the data sources;
- the availability/accessibility of the data in terms of implicit and/or explicit acquisition costs;
- the reliability of the data in terms of the quality of the methods applied; and
- the scope of the data (e.g., whether the study considers wasted food generation at hospitals in one state or hospitals nationwide).

EPA did not find updated literature for 2019 estimates; all sectors retained the same generation factors as were used to calculate 2018 estimates in EPA's "2018 Wasted Food Report" (EPA, 2020c). Table 1 summarizes the generation factors applied to each sector.

Table 1. Average Wasted Food Generation Factors (2019)

SECTOR	CATEGORY	GENERATION FACTOR	UNITS
Manufacturing/ Processing	N/A	0.005	Lbs/sales $/year
Residential	N/A	337.9	Lbs/household/year
		17.0	Percent food waste (of total household waste)
Food Retail	Supermarkets	2.0	Tons/employee/year
	Supercenters	0.38	Tons/employee/year
	Supermarkets and Supercenters[1]	104.9	Tons/ establishment/year
		10.0	Lbs/thousand $ revenue/year
	Food Wholesale[2]	120.7	Tons/facility/year
		0.005	Tons/thousand $ revenue/year
Food Service	Hotels	1,137.8	Lbs/employee/year
	Restaurants (full service)	3,050.7	Lbs/employee/year
		39.1	Tons/facility/year
		33.0	Lbs/thousand $ revenue/year
	Restaurants (limited service)	2,751.3	Lbs/employee/year
		40.9	Tons/facility/year
		33.0	Lbs/thousand $ revenue/year
	Sports Venues	0.31	Lbs/visitor/year
	Hospitals	653.1	Lbs/bed/year
		0.47	Lbs/meal
	Nursing Homes	657.0	Lbs/bed/year
		0.55	Lbs/meal
	Military Installations	105.3	Lbs/person/year
	Office Buildings	169.9	Lbs/employee/year
		0.22	Tons/1000 sq ft/year
	Correctional Facilities	1.1	Lbs/inmate/day
	Colleges and Universities	0.36	Lbs/student/meal
		0.44	Lbs/student/meal
		0.01	Tons/student/year
	K-12 Schools	26.3	Lbs/student/year
		0.43	Lbs/meal
Food Banks	N/A	372.5	Tons/establishment/year

[1] The revenue total from supermarkets and supercenters includes in-person shopping from these traditional brick and mortar establishments as well as revenue from any secondary e-commerce business from these retailers.
[2] When a company has a large e-commerce segment, typically with separate warehousing facilities, the Annual Retail Trade survey considers this a separate industry from the company's brick-and-mortar NAICS classifications, and this type of e-commerce is included in the wholesale category.

EPA then updated the extrapolation sector-specific statistics to reflect 2019 data.

Table 2 summarizes the 2019 extrapolation basis value for each generation sector and category and the associated data source.

Table 2. Extrapolation Bases for Wasted Food Generation Estimates (2019)

SECTOR/CATEGORY	GENERATION FACTOR UNITS	EXTRAPOLATION BASIS VALUE	EXTRAPOLATION BASIS UNITS	SOURCE
Food Manufacturing and Processing	Lbs/sales $/year	845,096,721,000	Sales $	(United States Census Bureau, 2021a)
Residential	Lbs/household/year	128,579,000	Households	(United States Census Bureau, 2021)
	Percent food waste	149.2	Million Tons MSW	(EPA, 2020b)
Food Retail				
Supermarkets and Supercenters	Tons/employee/year (supermarkets)	2,942,271	Employees	(United States Census Bureau, 2022d)
	Tons/employee/year (supercenters)	1,782,231	Employees	(United States Census Bureau, 2022e)
	Tons/establishment/year	123,833	Establishments	(United States Census Bureau, 2022f)
	Lbs/thousand $ revenue/year	716,842,000,000	Revenue $[1]	(United States Census Bureau, 2022)
Wholesalers	Tons/facility/year	35,112	Facilities	(United States Census Bureau, 2022a)
	Tons/thousand $ revenue/year	685,095,000,000	Revenue $	(United States Census Bureau, 2022b)
	Tons/thousand $ revenue/year (E-commerce)	1,368,000,000	E-commerce Revenue $[2]	(United States Census Bureau, 2022c)
Food Service				
Hotels	Lbs/employee/year	2,102,377	Employees	(United States Census Bureau, 2022e)
Restaurants/ (full service)	Lbs/employees/year	5,860,567	Employees	(United States Census Bureau, 2022f)
	Tons/facility/year	272,689	Facilities	(United States Census Bureau, 2022f)
	Lbs/thousand $ revenue/year	300,700,000,000	Revenue $	(United States Census Bureau, 2022f)
Restaurants/ (limited service)	Lbs/employees/year	5,418,681	Employees	(United States Census Bureau, 2022g)
	Tons/facility/year	330,296	Facilities	(United States Census Bureau, 2022g)
	Lbs/thousand $ revenue/year	290,400,000,000	Revenue $	(United States Census Bureau, 2022g)
Sports Venues	Lbs/visitor/year	256,187,897	Visitors	(Ballpark Digest, 2019), (Ballparks of Baseball, 2019), (ESPN, 2019), (Inside Hoops, 2019), (NCAA, 2019a), (NCAA, 2019b), (Soccer Stadium Digest, 2019), (USCH, 2019)
Hospitals	Lbs/bed/year	919,559	Beds	(American Hospital Association, 2021)
	Lbs/meal	1,260,760,907	Meals	(Statista, 2022)
Nursing Homes	Lbs/bed/year	1,660,400	Beds	(National Center for Health Statistics (U.S.), 2019)
	Lbs/meal	1,280,931,000	Meals	(National Center for Health Statistics, 2021)
Military Installations	Lbs/person/year	1,189,842	Active-duty military in U.S.	(Defense Manpower Data Center, 2019)

SECTOR/CATEGORY	GENERATION FACTOR UNITS	EXTRAPOLATION BASIS VALUE	EXTRAPOLATION BASIS UNITS	SOURCE
Office Buildings	Lbs/employee/year	55,511,900	Employees	(U.S. Bureau of Labor Statistics, 2022)
	Tons/1000 sq ft/year	16,682,000	1,000 sq ft	(Energy Information Administration (EIA), 2019)
Correctional Facilities	Lbs/inmate/day	2,086,600	Inmates	(Minton et al., 2021)
Colleges and Universities	Lbs/student/meal	3,381,166,269	Meals	(National Center for Education Statistics, 2019b)
	Tons/student/year	20,006,901	Students	(National Center for Education Statistics, 2019b)
K-12 Schools	Lbs/student/year	56,350,000	Students	(National Center for Education Statistics, 2019a)
	Lbs/meal	9,278,062,379	Meals	(U.S. Department of Agriculture Food and Nutrition Service, 2021)
Food Banks	Tons/establishment/year	1,270	Establishments	(Hoovers, 2019)

[1] Revenue includes sales from in-person shopping as well as e-commerce from these retailers whose primary business is brick-and-mortar stores. This revenue excludes alcohol sales.
[2] Only the revenue for food and beverage sales from companies whose primary business is e-commerce (NAICS 4541) is used here. Food and beverage e-commerce sales do not breakout alcohol sales.

To arrive at generation estimates for each generation sector, EPA then multiplied generation factors by the corresponding updated extrapolation basis value and averaged annual generation for sectors with multiple generation estimates.

Table 3 summarizes annual wasted food generation estimates for each of the sectors, as well as contextual information on each sector. First, for each sector, the table identifies, where appropriate, the NAICS codes used to define the sector. Second, the table lists the number of unique empirical studies on which the generation estimate is based. Finally, the table provides estimated generation in tons per year, as well as the percent of all generation that the sector represents.

EPA estimates that in 2019, 66.2 million tons of wasted food was generated in the food retail, food service, and residential sectors. An additional 40.1 million tons of wasted food was generated in the food manufacturing and processing sector.

As shown in Table 3 and Figure 1, households account for about 40% of total generation. Restaurants and supermarkets and supercenters are also major generators, followed by office buildings, food wholesalers, K-12 schools, and hotels. Most of the remaining categories have annual generation below one million tons. Table 4 quantifies the wasted food generated by food manufacturers and processors.

Table 3. Estimated Annual Wasted Food Generation for the Food Retail, Food Service and Residential Sectors (2019)

SECTOR	CATEGORY	NAICS CODES	NUMBER OF STUDIES INFORMING GENERATION RATE	ESTIMATED ANNUAL GENERATION (TONS PER YEAR) (CATEGORY)	PERCENT OF TOTAL (CATEGORY)	ESTIMATED ANNUAL GENERATION (TONS PER YEAR) (SECTOR)	PERCENT OF TOTAL (SECTOR)
Residential	N/A	N/A	12	26,502,346	40.0%	26,502,346	40.0%
Food Retail	Supermarkets and Supercenters	445110, 445120, 445210, 445220, 445230, 445291, 445292, 445299, 452311	9	8,998,443	13.6%	12,971,959	19.6%
	Food Wholesale	424410, 424420, 424430, 424440, 424450, 424460, 424470, 424480, 424490, 4541[3]	3	3,973,516	6.0%		
Food Service	Hotels	7211	4	1,196,076	1.8%	26,741,937	40.4%
	Restaurants (full and limited service)	722511, 722320, 722514, 722513, 722330, 722515	8	18,337,784	27.7%		
	Sports Venues	N/A	3	39,702	0.06%		
	Hospitals	622[1]	6	298,576	0.45%		
	Nursing Homes	6239, 6233, 6232, 6231[1]	3	415,591	0.63%		
	Military Installations	N/A	2	62,627	0.09%		
	Office Buildings	N/A	3	4,093,447	6.2%		
	Correctional Facilities	922140, 561210[1]	6	425,232	0.64%		
	Colleges and Universities	N/A	10	624,371	0.94%		
	K-12 Schools	N/A	6	1,248,532	1.9%		
N/A	Food Banks[2]	624210	1	473,027	N/A	473,027	N/A
		Total Generation		66,216,242	100%	66,216,242	100%

[1] In several instances (e.g., hospitals, nursing homes, correctional facilities), the sector has a NAICS code, but the extrapolation data are not strictly delineated by NAICS code as with Census data. For instance, nursing homes are aligned with several NAICS codes, but data on nursing home populations are compiled by CDC, not by the Census Bureau.

[2] Food waste from food banks is not added to total generation because it would represent "double counting," i.e., it is already accounted for in Total Generation, because total generation includes excess food that was donated to food banks (and some food donated to food banks inevitably is wasted).

[3] Note that in 2019, EPA added wasted food estimates from e-commerce sales (NAICS code 4541). When a company has a large e-commerce segment, typically with separate warehousing facilities, the Annual Retail Trade survey considers this a separate industry from the company's brick-and-mortar NAICS classifications. E-commerce sales that occur at brick-and-mortar locations are included in the overall revenue for the supermarkets and supercenters.

Figure 1. Percentage Distribution of Wasted Food Generation from the Food Retail, Food Service and Residential Sectors (2019)

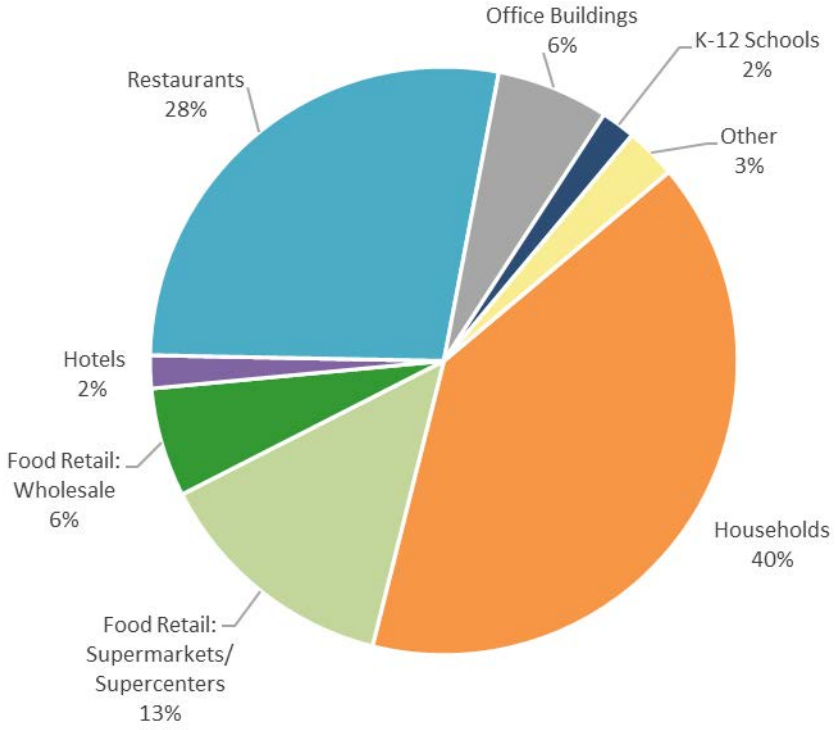


Table 4. Estimated Annual Wasted Food Generation for the Food Manufacturing and Processing Sector (2019)

SECTOR	NAICS CODES	NUMBER OF STUDIES INFORMING GENERATION RATE	ESTIMATED ANNUAL GENERATION (TONS PER YEAR)
Food Manufacturing/ Processing	311 and 3121 (excluding 311111, 311119, 312112, and 312113)	3	40,050,707

4 MANAGEMENT OF WASTED FOOD

The characterization of management pathways for wasted food involves two phases: (1) an initial characterization based on percentage distributions reported in the literature; and (2) a revised characterization based on actual tonnages for several key pathways.

EPA developed the initial management characterization for each sector as part of the generation analysis. The management pathways align with the "FLW Standard" destinations (Food Loss and Waste Protocol, 2016), with the addition of donation of excess food to food banks. EPA includes the following management pathways (please see Section 9.1 for a glossary):

- Anaerobic digestion,
- Animal feed,
- Bio-based materials/biochemical processing,
- Composting,
- Controlled combustion,
- Donation,

- Land application,
- Landfill, and
- Sewer/wastewater treatment.

The initial analysis drew on sector-specific literature that provided a percentage distribution across the management pathways (i.e., an estimate of the percent of wasted food destined for each major management pathway by generating sector).[5] These same studies were used for the 2019 update with the exception of the anaerobic digestion pathway, which was based on reported tonnages by sector to EPA's 2019 anaerobic digestion survey (EPA, 2023). The survey did not have breakdowns for food waste going to AD from nursing homes but did have reported tonnages for other sector categories included in this report (although reported tonnage for some were zero).

- **Food manufacturers, food retail, and restaurants**: Annual surveys performed by Business for Social Responsibility (BSR) in 2013 and 2014 (Business for Social Responsibility, 2013, 2014) and the Food Waste Reduction Alliance (FWRA) in 2016 (Food Waste Reduction Alliance, 2016) provided the management distribution. These three studies surveyed manufacturers, food retailers, and restaurants and provided detail on how those sectors manage their wasted food.[6] After subtracting out the amount reported to be sent to anaerobic digesters based on the EPA's 2019 anaerobic digestion survey (EPA, 2023), the remaining waste management pathways were distributed among the remaining percentage of waste generated from each sector category. EPA used the food manufacturing data for the manufacturing and processing sector, the food retail data for the food retail/wholesale sector, and the restaurant data for both full service and limited-service restaurants.

- **Residential**: EPA developed a distribution based on a variety of studies examining composting rates in different geographic locations, as well as studies on the use of household food waste disposers (e.g., in-sink disposals). EPA then assumed that the remaining food waste that was not sent to composting, sewer, or anaerobic digestion is either landfilled or combusted, with the proportion based on various literature sources.

- **Remaining sectors (food services sectors other than restaurants as well as food banks):** The initial management characterization for 2016[7] and 2018 estimates relied on the general wasted food management distribution estimated in "Advancing Sustainable Materials Management: 2017 Fact Sheet" (EPA, 2019). For the 2019 estimates, EPA made a change to the management characterization for food services sectors other than restaurants, as well as food banks. Based on similarities in operations, EPA applied the management distribution for restaurants, as derived from the BSR and FWRA surveys, to the remaining food services sectors for all management pathways except for anaerobic digestion. In addition, EPA applied the management distribution for retail, as derived from

[5] For more detailed explanation on the initial management percentage methodology and distributions, please refer to "Food Waste Measurement Methodology Scoping Memo" (EPA, 2020a).

[6] The annual surveys performed by FWRA reports a minimal amount of food waste managed by an "other" category, however, the surveys do not define "other". As a result, EPA zeroed out the "other" category and redistributed the management percentage to the other management pathways. In addition, the annual surveys report the amount of food waste managed by a combination of landfilling and controlled combustion (categorized as "disposed of"). The amount combusted on site was specified but the specific breakdown of total (on and off site) combustion and landfilling are not provided so EPA assumed a breakout of 80.4% to landfill and 19.6% to controlled combustion. This estimated breakout was derived from the Energy Recovery Council's (ERC) Directory of Waste-to-Energy facilities (Energy Recovery Council (ERC), 2018).

[7] The initial 2016 management characterization estimates are from the "Food Waste Measurement Methodology Scoping Memo" (EPA, 2020a).

the BSR and FWRA surveys, to food banks but modified the management distribution by zeroing out the "food donation" and "anaerobic digestion" category and redistributing these management percentages to the other management pathways. This change in management distribution sources was implemented so that management distributions for 2019 would be based on more sector specific information.

To develop a revised management profile, subsequent analyses incorporated more detailed data on three management pathways, leading to revised estimates of the landfill and controlled combustion pathways:

- **Composting:** EPA developed estimates of food waste composted by summarizing state-specific data available from state environmental agency websites and published reports and comparing reported values with EPA's State Data Measurement Sharing Program (SMP) (Re-TRAC, 2019)–these 2019 composting estimates are provided in Table 12. EPA did not extrapolate these data to account for activity in the remaining states, tribes, and territories for which data were not available. MSW compost, which is compost of the organic fraction of MSW, was also included in the total compost estimate and reflected production from all known sources based on published literature. Data compiled suggest that about 3.3 million tons of food waste were managed through composting in 2019. Note that these estimates do not include food waste composted from food manufacturers and processors. To estimate food waste composted by manufacturers and processors, EPA used the results of surveys conducted by BSR and the FWRA of food manufacturers around the nation as noted above.
- **Anaerobic digestion:** EPA arrived at estimates for food waste anaerobically digested using EPA's 2019 nationwide survey of anaerobic digestion facilities (EPA, 2023). In its latest "Anaerobic Digestion Facilities Processing Food Waste in the United States" report, EPA conducted a nationwide survey of anaerobic digestion facilities in the U.S. in 2021, the results of which reflect 2019 data. Of the 275 surveys distributed to anaerobic digestion facilities, 99 were returned by operational facilities, resulting in a survey response rate of 36 percent, which a significantly lower participation rate than the survey including 2018 data of 67 percent. Of the 99 facilities who responded to the survey, 89 facilities provided information about the amount of food waste they processed. The 2023 report (containing 2019 data) separates out food waste processed by anaerobic digesters by category. These category specific values are integrated into the 2019 wasted food estimates to provide more detail to category management profiles. Nursing homes were not included in the 2023 anaerobic digestion report (containing 2019 data), and two categories had no reported tonnages (military installations and correctional facilities); as a result, no food waste is allocated to anaerobic digestion in these categories. The food manufacturing and processing sector included in this report comprises the "Industrial (other)", "Manufacturing/Processing", and "Other" categories detailed in the 2023 anaerobic digestion report (containing 2019 data). The anaerobic digestion amount for "Retail/wholesale" category included in the 2023 anaerobic digestion report (containing 2019 data) was equally divided between the food retail and food wholesale categories included in the 2019 wasted food estimates. Livestock farms and food bank anaerobic digestion data are not included in the 2019 wasted food estimates as livestock farms are out of scope of this report and reported anaerobic digestion food waste from food banks was very small. Anaerobic digestion facilities reported a total of 17.60 million tons of food waste managed by anaerobic digestion annually in 2019, 17.59 million tons of which is included in the 2019 wasted food estimates.
- **Donation:** EPA's estimation method is primarily based on a 2019 annual report from Feeding America (Feeding America, 2019), the largest domestic hunger relief organization with a nationwide network

of more than 200 food banks. Feeding America secures food from corporate manufacturers, retailers, and produce suppliers nationwide; stores excess food temporarily in warehouses; and then distributes the excess food to families and individuals through food assistance agencies such as youth or senior centers, shelters, and food pantries. EPA calculated the total quantity of excess food received by Feeding America food banks (i.e., food that would have otherwise been thrown away by the establishments donating the food, but which was instead donated to Feeding America food banks), and then developed an estimate of excess food managed per Feeding America food bank. While Feeding America is the largest national network of food banks, there are hundreds more food bank establishments in the United States, so EPA multiplied excess food received per Feeding America food bank by the total number of food bank establishments nationwide to estimate total excess food managed through donation. The number of food banks in the United States is based on data available from Hoovers, a research company that provides information on companies and industries. Based on analysis and extrapolation of data from Feeding America, the food retail and food service sectors donated approximately 5.1 million tons of excess food in 2019. The food manufacturing and processing sector donated an additional estimated 2.2 million tons of excess food in 2019.

In order to integrate the composting and donation estimates into the overall analysis of management pathways and arrive at landfilling and controlled combustion figures, EPA associated the aggregate figures with specific generator categories (i.e., determined where the food waste and excess food originated). The analysis incorporated the following assumptions:

- **Composting**: The quantity of food waste allocated to composting is reduced when using the aggregate based on state data (3.9 million tons) in place of the initial estimate (5.1 million tons). The analysis retains the relative proportion of the generation sectors contributing to composting but transfers the net quantity (5.1 – 3.9= 1.2 million tons) to landfilling and controlled combustion.
- **Donation**: Relative to the initial characterization, the revised characterization points to a larger quantity of excess food being recovered for donation. The newly estimated 7.8 million tons is assumed to originate from sectors identified in the Feeding America donation profile. These 7.8 million tons reflects the total amount of food donations but some of these donations cannot be used by the food banks and are re-routed to other management pathways. EPA assumes that 3.5% of donated excess food is from food service, 28.2% from food manufacturers and processors, and 68.3% from food retail.[8] The 68.3% associated with food retail is split between supermarkets/supercenters and wholesale in proportion to their generation. The 3.5% in food service is split between each of the food service categories. In the food retail and food service sectors, the increase in excess food donation amounts is netted out of landfilling and controlled combustion because these are the two management pathways receiving the largest tonnages of food waste from those sectors. In the food manufacturing and processing sector, the increase is netted out of landfilling, controlled combustion, land application and animal feed because these all receive large amounts of wasted food from this sector.

For the food retail, food service and residential sectors together, EPA estimates that 59.8% of wasted food is sent to landfill, 14.6% is managed by sewer/wastewater treatment, 7.8% is managed by donation, 6.0% is managed by controlled combustion, and smaller amounts are managed by other management pathways. For food the food manufacturing and processing sector, EPA estimates that 42.3% of wasted food is managed by

[8] These percentages are based on a 2019 annual report from Feeding America (Feeding America, 2019).

anaerobic digestion, 34.2% is used to create animal feed, 12.9% goes to land application, and 5.5% is managed by food donation. Table 5 and Table 6 present the revised profile of wasted food management, and Figure 2 and Figure 3 depict the percentage distribution to each management pathway. It is important to note that the estimates for donation in Table 5 exclude the small share of excess food that is donated but which food banks cannot distribute (i.e., 473,027 tons) and therefore becomes food waste that is routed to other management pathways. This tonnage is included in the other management pathways where that food waste is sent.

Table 5. Quantity of Wasted Food Managed by the Food Retail, Food Service, and Residential Sectors Based on Revised Management Profile (2019)

MANAGEMENT PATHWAY	QUANTITY MANAGED (TONS)	PERCENTAGE MANAGED
Donation[1]	5,135,293	7.76%
Animal Feed	1,516,771	2.29%
Bio-based Materials/Biochemical Processing	2,335,988	3.53%
Anaerobic digestion	538,539	0.81%
Composting	3,304,764	4.99%
Land Application	141,371	0.21%
Controlled Combustion	9,646,263	14.57%
Landfill	39,621,902	59.84%
Sewer/Wastewater Treatment	3,975,352	6.00%
TOTAL	66,216,242	100.00%

[1] This estimate excludes the small share of excess food (473,027 tons) that food banks cannot distribute and is therefore food waste that is routed to other management pathways.

Table 6. Quantity of Wasted Food Managed by the Manufacturing and Processing Sector Based on Revised Management Profile (2019)

MANAGEMENT PATHWAY	QUANTITY MANAGED (TONS)	PERCENTAGE MANAGED
Donation[1]	2,205,990	5.51%
Animal Feed	13,709,339	34.23%
Bio-based Materials/Biochemical Processing	64,737	0.16%
Anaerobic digestion	17,055,531	42.58%
Composting	583,305	1.46%
Land Application	5,183,851	12.94%
Controlled Combustion	330,326	0.82%
Landfill	917,630	2.29%
Sewer/Wastewater Treatment	0	0.00%
TOTAL	40,050,707	100.00%

[1] These figures exclude the small share of excess food (473,027 tons) that food banks cannot distribute and is therefore food waste that is routed to other management pathways.

Figure 2. Percentage Distribution of Wasted Food Managed by the Food Retail, Food Service, and Residential Sectors (2019)

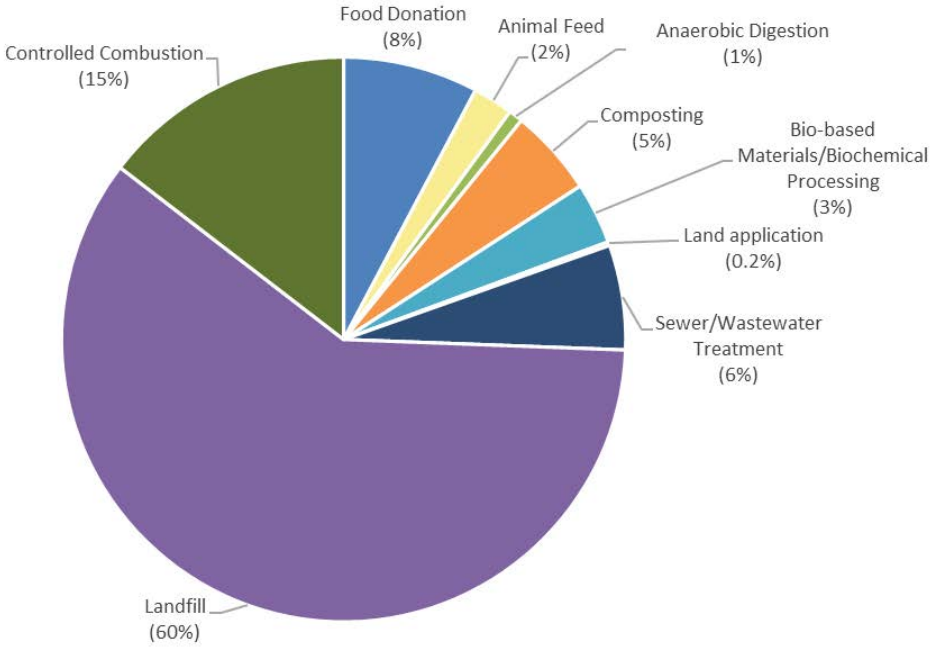
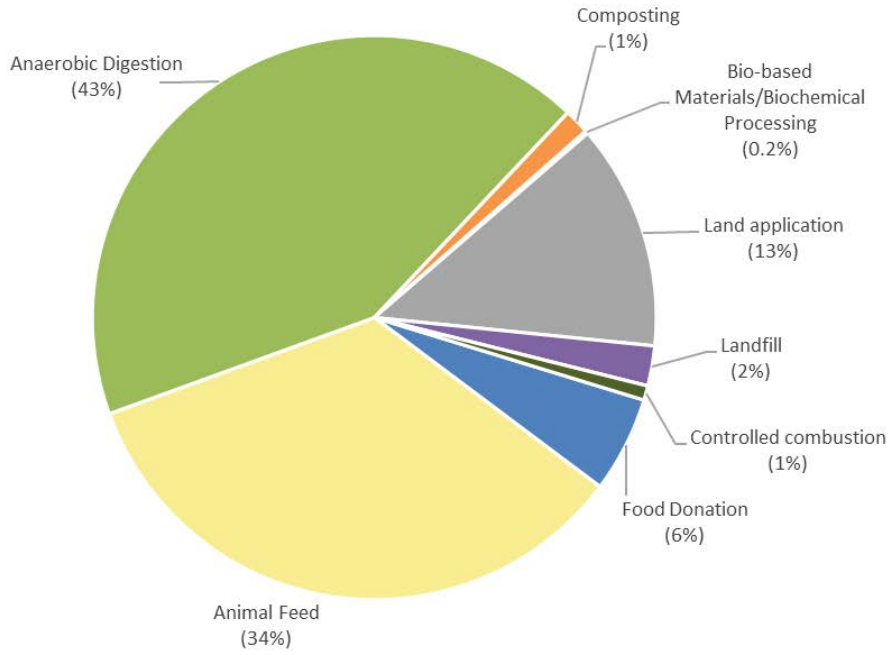


Figure 3. Percentage Distribution of Wasted Food Managed by the Manufacturing and Processing Sector (2019)

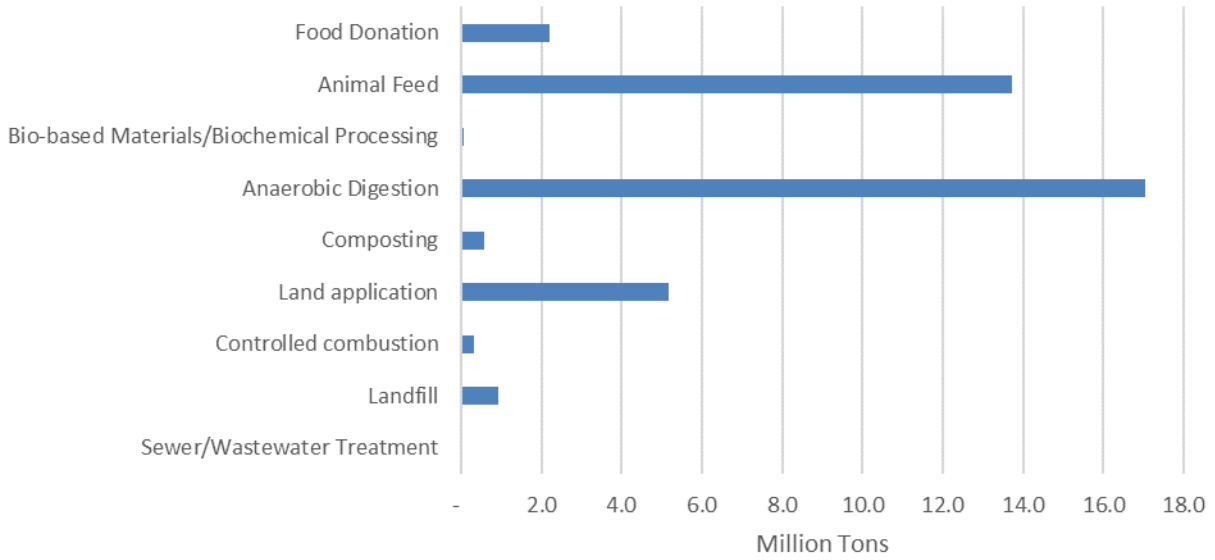


4.1 SECTOR-BY-SECTOR SUMMARY

4.1.1 Food Manufacturing and Processing Sector

Food and beverage manufacturers and processors generated an estimated 40.1 million tons of wasted food in 2019. The majority (42.6%) of this sector's wasted food was managed by anaerobic digestion, 34.2% animal feed, 12.9% by land application, with smaller proportions managed by other methods. Food and beverage manufacturing/processing industries are unique from the other sectors EPA analyzed in the methods they use to manage their wasted food (i.e., a much higher percentage going to anaerobic digestion, animal feed and land application, and a lower percentage going to landfill, than the food retail, food service, and residential sectors). Figure 4 depicts the proportion of the food and beverage manufacturing and processing sector's wasted food managed by each pathway.

Figure 4. Food Manufacturing and Processing Sector Wasted Food Management Profile (2019)

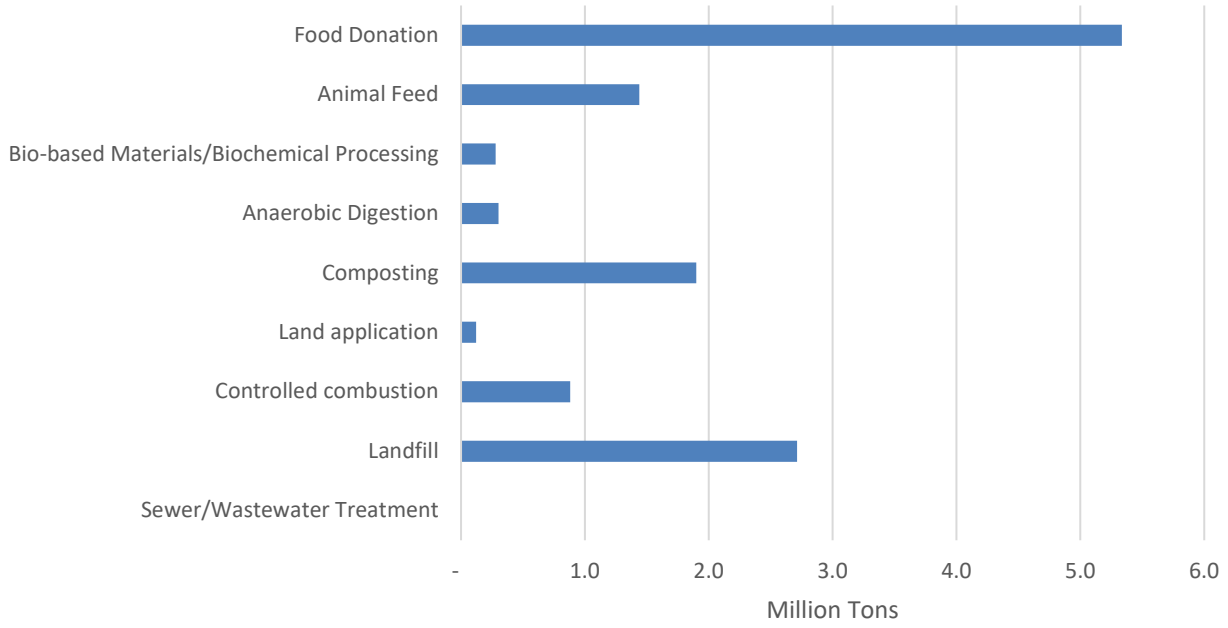


4.1.2 Food Retail Sector

The food retail sector includes supermarkets, supercenters, and food wholesalers.[9] The food retail sector was estimated to generate 13.0 million tons of wasted food (9.0 million tons from supermarkets and supercenters, and 4.0 million tons from food wholesale). About 41.1% of the food retail sector's wasted food was donated, 20.9% was landfilled, 14.6% was sent to composting, 11.1% was sent to animal feed, 6.8% was combusted, and smaller proportions were managed by other methods. Figure 5 depicts the proportion of the food retail sector's wasted food managed by each pathway.

[9] Food wholesale includes food waste resulting from e-commerce under NAICS code 4541. Online grocery shopping done through brick-and-mortar supermarkets or supercenters are included in the revenue from those stores under food retail.

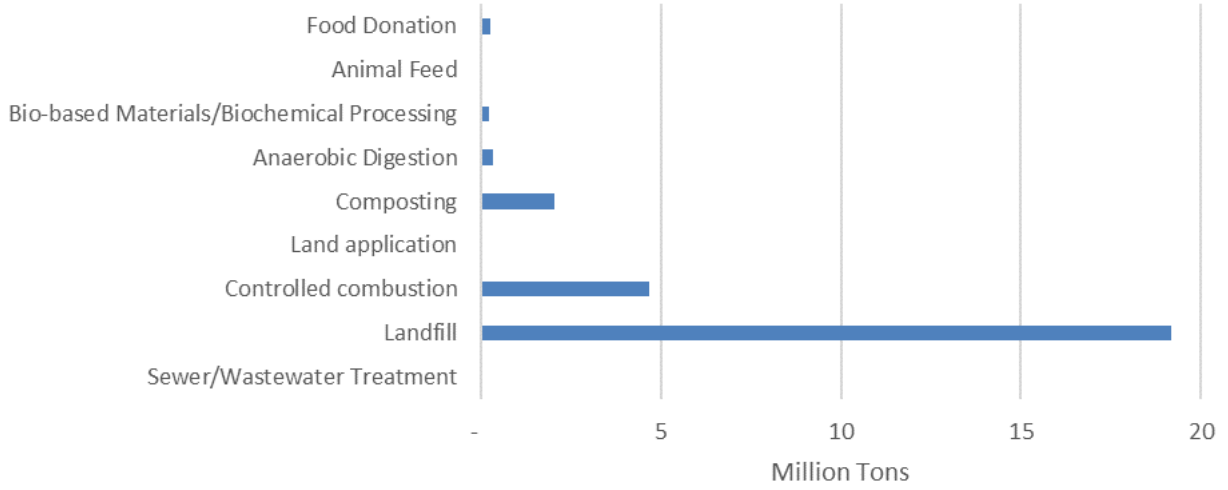
Figure 5. Food Retail Sector Wasted Food Management Profile (2019)



4.1.3 Food Service Sector

The food service sector includes hospitality categories (restaurants, hotels, and sports venues) and various types of institutions serving food (hospitals, nursing homes, military institutions, office buildings, correctional facilities, colleges and universities, and K-12 schools). The food service sector was estimated to generate 26.7 million tons of wasted food, with the majority (over 73%) coming from the hospitality categories. Almost three quarters (72%) of the wasted food generated from the food service sector was landfilled, 17% was managed by controlled combustion, and 8% was composted, with smaller proportions managed by other methods. Figure 6 depicts the proportion of the food service sector's wasted food managed by each pathway.

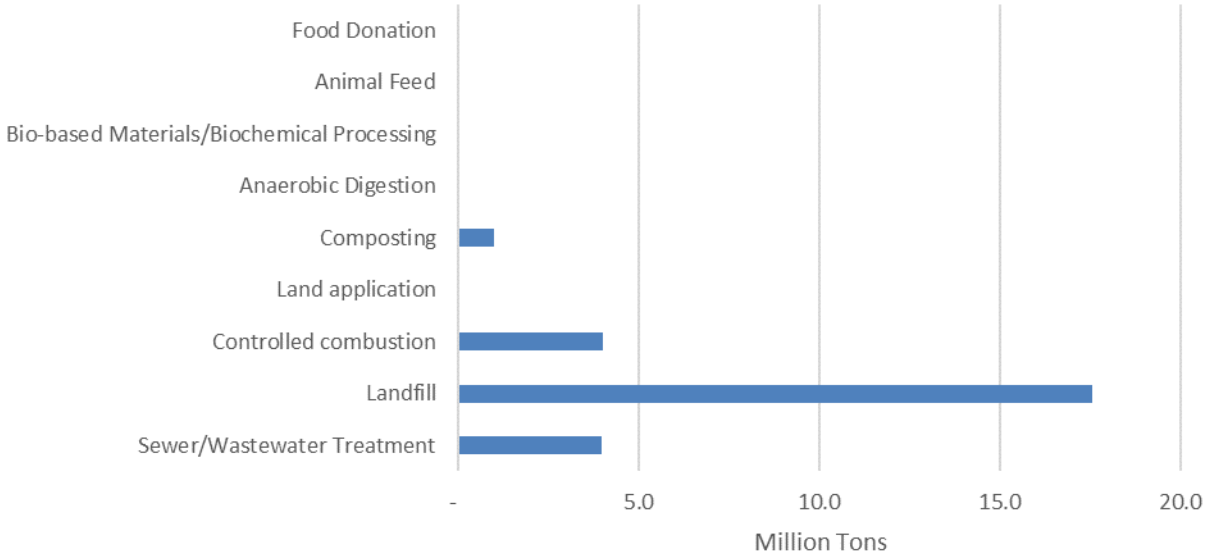
Figure 6. Food Service Sector Wasted Food Management Profile (2019)



4.1.4 Residential Sector

The residential sector, which includes single family and multi-family dwellings, was estimated to generate 26.5 million tons of wasted food. The majority (66.2%) of residential wasted food was landfilled; 15.1% was combusted, and 15.0% was sent to sewer/wastewater treatment. Only 3.7% was composted. Figure 7 depicts the proportion of residential wasted food managed by each pathway.

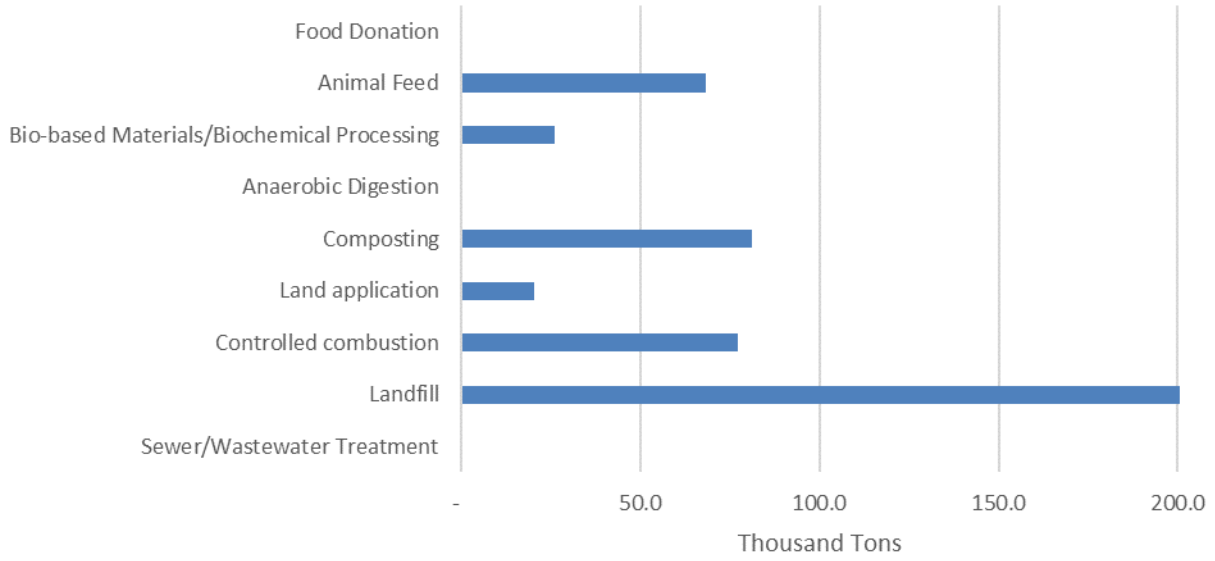
Figure 7. Residential Sector Wasted Food Management Profile (2019)



4.1.5 Food Banks

Food banks are also a minor generator of food waste, because they receive a small amount (6.1%) of excess food that is unfit for distribution due to damage, spoiling, and other reasons. Food banks were estimated to generate 473,027 tons of food waste. Note that this tonnage is already accounted for in the estimates of wasted food generated in the food manufacturing and processing, food retail, food service, and residential sectors, because establishments in those sectors donate excess food to the food banks (i.e., 473,027 tons of the excess food that is donated from these sectors to food banks cannot be distributed and ends up becoming food waste). Approximately 42.4% of the food waste generated in food banks was landfilled, 17.1% was composted, 16.3% was combusted, 14.4% was managed by animal feed, and smaller proportions were managed by other methods. Figure 8 depicts the proportion of food banks' food waste managed by each pathway.

Figure 8. Food Bank Food Waste Management Profile (2019)



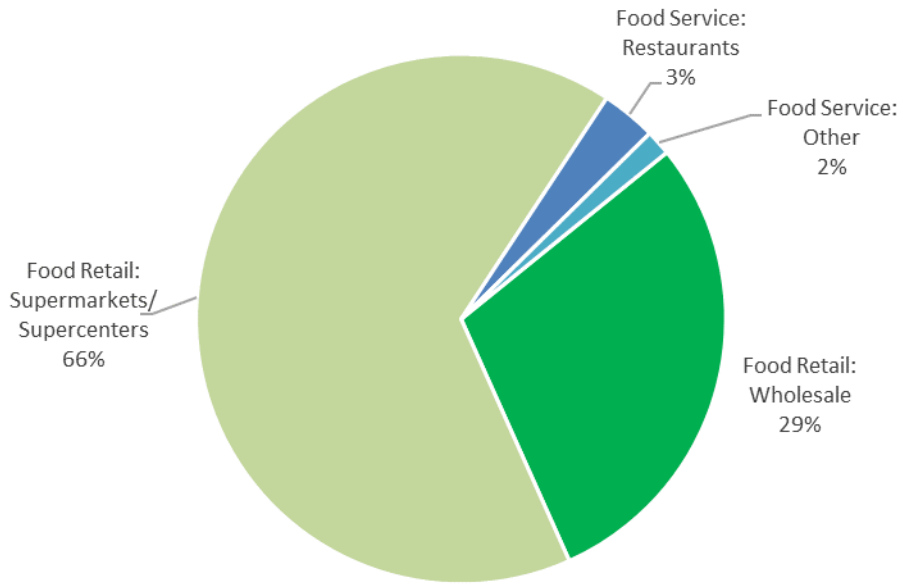
4.2 PATHWAY-BY-PATHWAY SUMMARY

4.2.1 Food Donation

In 2019, 7.8%, or 5.1 million tons, of wasted food from food retail, food service, and residential sectors was managed by food donation. This percentage reflects the net amount donated after subtracting out the wasted food (473,027) that could not be used by food banks. Most of this excess food was donated by the supermarket and supercenter retailers and wholesalers. EPA does not have data on food managed by donation from the residential sector.

Figure 9 depicts the proportion of food donated by each of the categories in the food retail, food service, and residential sectors for which EPA had data. In addition, in 2019, 2.2 million tons of wasted food from the food manufacturing and processing sector was managed by food donation.

Figure 9. Food Donation Sources (Food Retail, Food Service, and Residential Sectors) (2019)

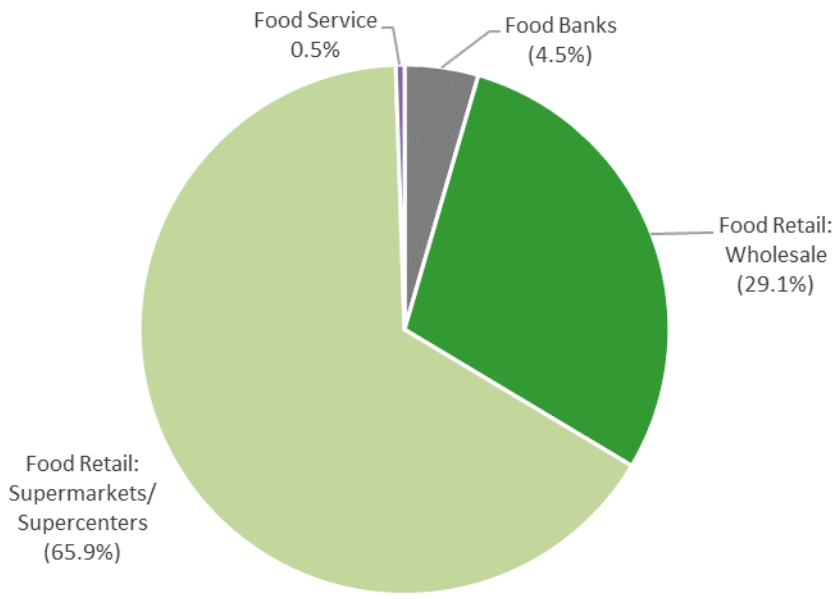


4.2.2 Animal Feed

In 2019, 2.3%, or 1.5 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by animal feed. Most of this wasted food managed by animal feed was generated by the supermarket and supercenter retailers and wholesalers. EPA does not have data on food sent to animal feed by the residential sector.

Figure 10 depicts the proportion of food sent to animal feed by each of the categories in the food retail, food service, residential, and food bank sectors for which EPA had data. In addition, 13.7 million tons of wasted food generated from the food manufacturing and processing sector was managed by animal feed.

Figure 10. Animal Feed Sources (Food Retail, Food Service, Residential, and Food Bank Sectors) (2019)

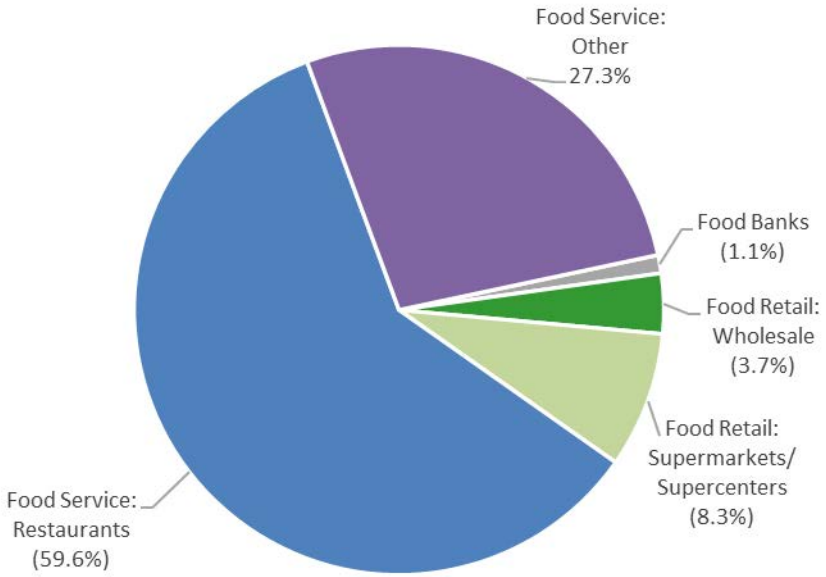


4.2.3 Bio-based Materials/Biochemical Processing

In 2019, approximately 3.5%, or 2.3 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by bio-based materials/biochemical processing (i.e., converting material into industrial products). Most of this wasted food managed by bio-based materials/biochemical processing was from restaurants, other food service providers and supermarket and supercenter retailers. EPA does not have data on food managed by bio-based materials/biochemical processing by the residential sector.

Figure 11 depicts the proportion of food managed by bio-based materials/biochemical processing from each of the categories in the food retail, food service, residential, and food bank sectors for which EPA had data. In addition, approximately 64,737 tons of wasted food generated from the food manufacturing and processing sector was managed by bio-based materials/biochemical processing.

Figure 11. Bio-based Materials/Biochemical Processing Sources (Food Retail, Food Service, Residential, and Food Bank Sectors) (2019)

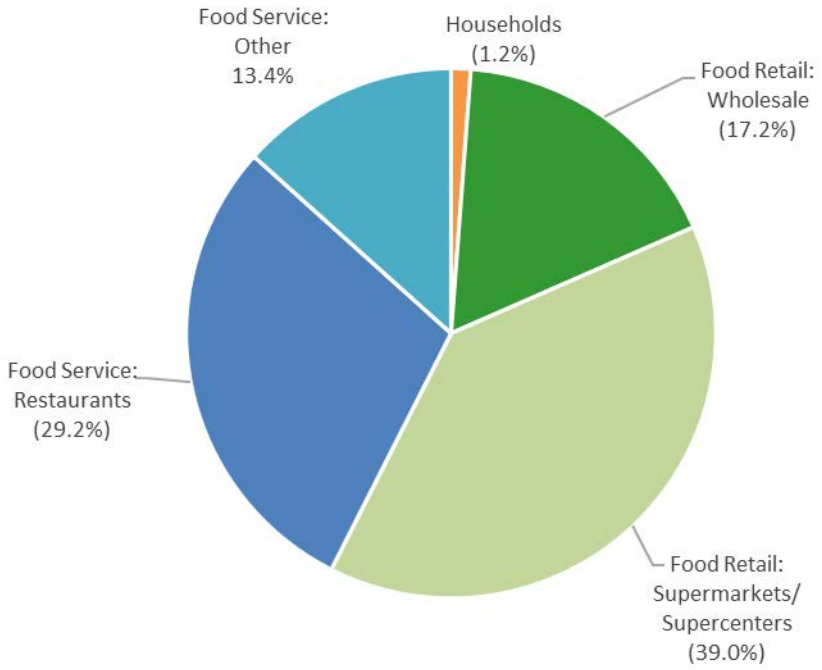


4.2.4 Anaerobic Digestion

In 2019, less than 1.0%, or approximately 538,539 tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by anaerobic digestion. Most of this wasted food managed by anaerobic digestion was from supermarket and supercenter retailers, restaurants, and wholesalers. The amount of food waste managed by anaerobic digestion by food banks was very small and has been excluded.

Figure 12 depicts the proportion of food managed by anaerobic digestion from each of the categories in the food retail, food service, residential and food bank sectors for which EPA had data. In addition, approximately 17.1 million tons of wasted food generated from the food manufacturing and processing sector was managed by anaerobic digestion.

Figure 12. Anaerobic Digestion Sources (Food Retail, Food Service, Residential, and Food Bank Sectors) (2019)

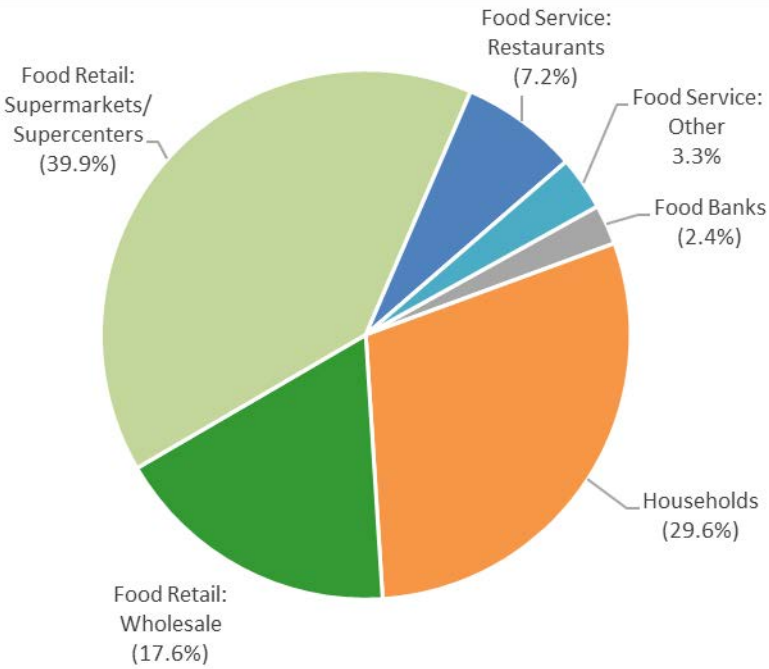


4.2.5 Composting

In 2019, 5%, or 3.3 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was composted. Most of this wasted food managed by composting was from supermarket and supercenter retailers, households, and wholesalers.

Figure 13 depicts the proportion of food managed by composting from each of the categories in the food retail, food service, residential, and food bank sectors. In addition, approximately 583,305 tons of wasted food generated from the food manufacturing and processing sector was managed by composting.

Figure 13. Composting Sources (Food Retail, Food Service, Residential, and Food Bank Sectors) (2019)

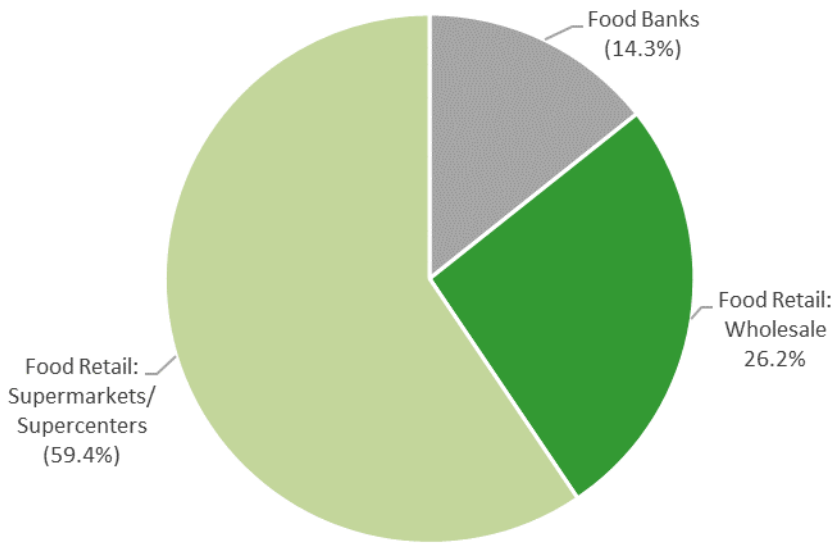


4.2.6 Land Application

In 2019, 0.21%, or 141,371 tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by land application. All wasted food managed by land application was from supermarket and supercenter retailers, wholesalers, and food banks. EPA does not have data on food managed by land application by the food service or residential sectors.

Figure 14 depicts the proportion of food managed by land application from each of the categories in the food retail, food service, residential, and food bank sectors for which EPA had data. In addition, approximately 5.2 million tons of wasted food generated from the food manufacturing and processing sector was managed by land application.

Figure 14. Land Application Sources (Food Retail, Food Service, Residential, and Food Bank Sectors) (2019)

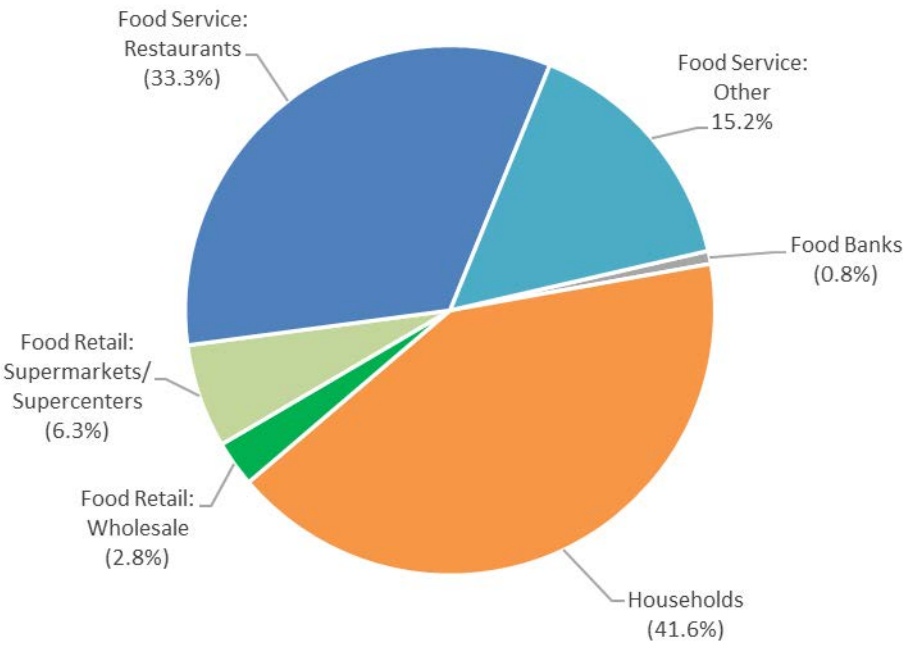


4.2.7 Controlled Combustion

In 2019, 14.6%, or 9.6 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by controlled combustion. Most of this wasted food managed by controlled combustion was from households, restaurants, and other food service providers.

Figure 15 depicts the proportion of food managed by controlled combustion from each of the categories in the food retail, food service, residential, and food bank sectors. In addition, approximately 330,326 tons of wasted food generated from the food manufacturing and processing sectors was managed by controlled combustion.

Figure 15. Controlled Combustion Sources (Food Retail, Food Service, Residential, and Food Bank Sectors) (2019)

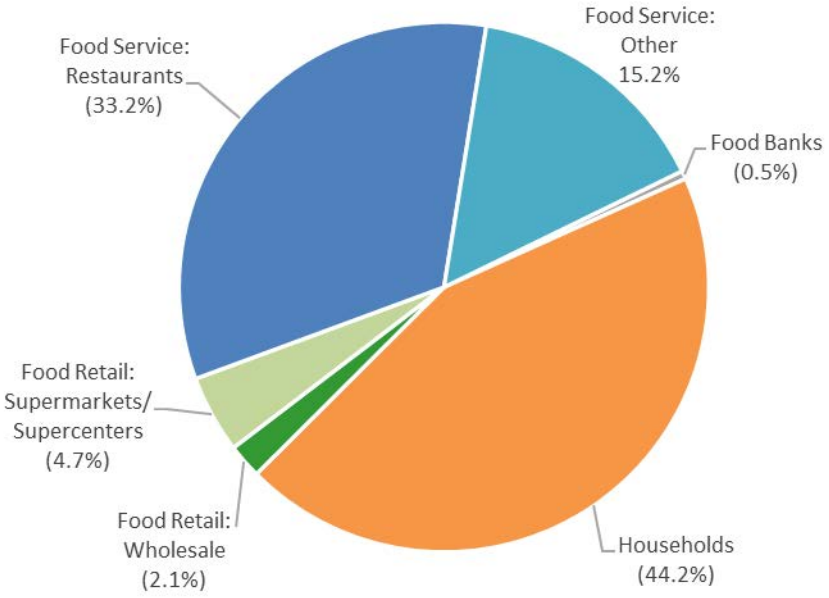


4.2.8 Landfill

In 2019, 59.8%, or 39.6 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by landfilling. Most of this wasted food managed by landfilling was from households, restaurants, and other food service providers.

Figure 16 depicts the proportion of food managed by landfilling from each of the categories in the food retail, food service, residential, and food bank sectors. In addition, approximately 917,630 tons of wasted food generated from the food manufacturing and processing sector was managed by landfilling.

Figure 16. Landfilling Sources (Food Retail, Food Service, Residential, and Food Bank Sectors) (2019)



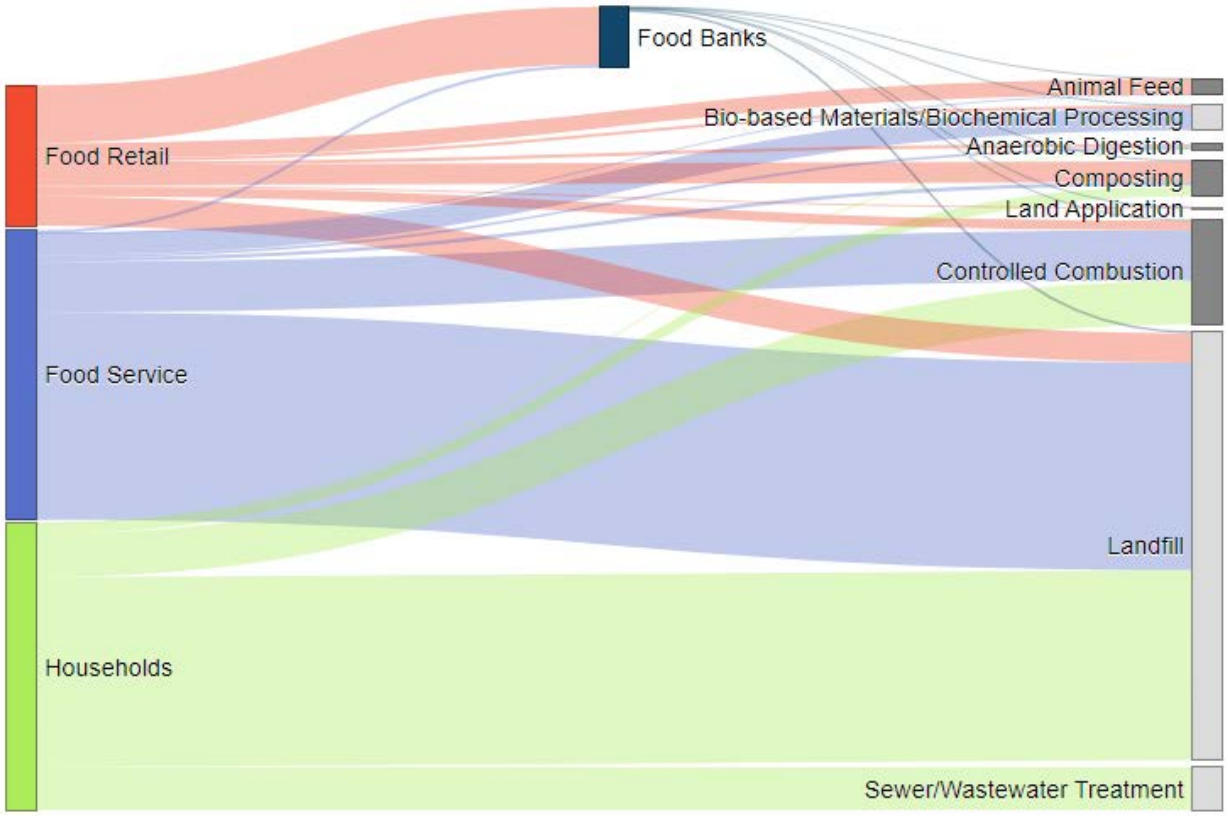
4.2.9 Sewer/Wastewater Treatment

In 2019, 14.6%, or 4.0 million tons, of wasted food from the food retail, food service, residential, and food bank sectors was managed by sewer/wastewater treatment. All this wasted food managed by sewer/wastewater treatment was from households. EPA does not have data on wasted food managed by sewer/wastewater treatment by any other sectors, including food retail, food service, food bank, and food manufacturing and processing.

4.3 OVERALL SUMMARY OF GENERATION AND MANAGEMENT OF WASTED FOOD

The generation and management characterizations can be combined in an overall diagram of the food system. The Sankey diagram in Figure 17 show the origination and ultimate destination of wasted food, depicting larger flows with broader connective arrows.

Figure 17. Summary of Wasted Food Generation and Management Flows (Food Retail, Food Service, and Residential Sectors) (2019)



5 PROGRESS TOWARD THE U.S. 2030 FOOD LOSS AND WASTE REDUCTION GOAL

In 2015, EPA and USDA announced the first-ever national goal to reduce food loss and waste by 50% by the year 2030. While the goal aims to reduce food loss, neither EPA nor USDA have baseline data for food loss, which includes food that goes uneaten in the agricultural sector, such as unharvested crops. The goal also aims to reduce food waste by 50% from the food retail, food service, and residential sectors. In 2021, EPA updated the baseline and goal for the food waste part of the national goal to align with the food waste scope for Sustainable Development Goal Target 12.3 (United Nations, 2019), which aims to cut in half the amount of food from the food retail, food service, and residential sectors that has been removed from the human food supply chain (i.e., food waste that is being sent to: anaerobic digestion; composting; land application; controlled combustion; landfill; sewer/wastewater; and litter, discards and refuse). Note that EPA does not have data on how much food waste is going to litter, discards and refuse. Using this updated interpretation, the baseline for the national goal for food waste is 328 pounds per person, because in 2016, 328 pounds of food waste per person was sent to anaerobic digestion, composting, land application, controlled combustion, landfill, and sewer/wastewater from the food retail, food service, and residential sectors. The 2030 goal aims to reduce this food waste by 50 percent to 164 pounds per person. In 2018, 335 lbs/person was sent to those six management pathways, and in 2019, 349 lbs/person was sent to those six pathways. In the three years between the baseline year (2016) and the latest estimates (2019), there was a 6% increase in per capita food leaving the human food supply chain from the food retail, food service, and residential sectors (i.e., food waste going to those six management pathways). The U.S. has a long way to go to meet this goal.

Table 7. Progress Toward the 2030 Goal Compared to 2016 Baseline

	2016	2018	2019
Total Generation (tons)	62,231,998	63,132,123	66,216,242
Total Food Waste to Food Management Pathways of Interest[1] (tons)	52,946,283	54,688,348	57,228,191
Per Capita Food Waste to Food Management Pathways of Interest[1,2] (lbs/capita)	328	335	349
% Change since 2016 baseline per capita food waste managed in pathways of interest	n/a	2%	6%

[1]Management Pathways of Interest include landfill, controlled combustion, sewer/wastewater treatment, anaerobic digestion, composting, and land application from the food retail, food service, and residential sectors.
[2]Cutting the 2016 baseline of 328 lbs/person by 50% would be 164 lbs/person. (EPA, 2015)

6 COMPARISON WITH 2018 METHODOLOGY AND ESTIMATES

There were several methodological changes between the 2018 and 2019 analyses that impacted the estimates.

For wasted food generation estimates in 2019, EPA included estimates from e-commerce sales classified under NAICS 4541 which represent establishments whose primary business segment is e-commerce. Since these companies are typically fulfilling orders with separate warehousing facilities this waste food generation was included with the wholesale category. Previously, only estimates of e-commerce sales from traditional

brick-and-mortar retail establishments were included as part of the retail sector's total revenue. EPA also included Target and Walmart supercenters to more fully capture wasted food generated in food retail.

For wasted food management estimates in 2019, EPA changed the management pathway characterization for several sectors. EPA applied the management distribution for restaurants, as derived from the BSR and FWRA surveys, to all other food services sectors for all management distributions except for anaerobic digestion. This was done because the latest anaerobic digester survey provided a breakdown for each sector sending wasted food to digesters (EPA, 2023) that was used as the basis for each sector-specific management estimate. This survey did not include nursing homes; zero tonnage was reported from military installations and correctional facilities; and only a very small tonnage was reported from food banks (less than 10 tons), so no anaerobic digestion management was assumed for these sectors. In addition, EPA applied the management distribution for retail/wholesale, as derived from the BSR and FWRA surveys, to food banks but modified the management distribution by zeroing out the "food donation" and "anaerobic digestion" categories and redistributing the management percentage to the other management pathways.

For food donation, EPA changed the assumption of which sectors donated food to redistribute the estimated food donations based on the Feeding America extrapolations. In 2018, the donations were assumed to equal one-third of distributions from food manufacturing and processing, food retail, and food service. In 2019, EPA used the distribution of donated meals reported to Feeding America to assign the food donation tonnages to these three sectors. This resulted in 28.2% coming from food manufacturing and processing, 68.3% coming from food retail, and 3.5% coming from food service, where Feeding America's "emerging retail" category was used as a proxy for the food service category as it included restaurants and hotels as well convenience stores (Feeding America, 2019). In addition, in 2019 food donations from the food service sector were assumed to come from various categories of the food service sector, proportional to each category's generation, while in 2018 the food donations from the food service sector were limited to the restaurant category of the food service sector.

EPA compared the 2019 excess food and food waste generation estimates with those of 2018. As shown in Table 8, total generation increased slightly (4.9%) between 2018 and 2019; restaurants, households, sports venues, and supermarkets and supercenters experienced the greatest increases in generation.[10] Supermarkets and supercenters likely experienced an increase in generation due to methodological reasons – between 2018 and 2019 EPA added food waste generated from large supercenters, such as Target and Walmart, as noted above. Food wholesale generation also experienced a slight increase as a result of adding e-commerce food waste generation into this sector.

EPA also compared the 2019 management pathway estimates with those of 2018. As shown in Table 9, the quantity of food waste managed from the food retail, food service, residential, and food bank sectors through landfill and controlled combustion was 15% higher in 2019 than 2018. Per-capita landfill and controlled combustion quantity was 14.5% higher in 2019 than in 2018, likely driven by the decrease in wasted food managed through the anaerobic digestion, land application, and animal feed pathways. However, these differences do not likely reflect actual changes in how these sectors managed their food waste between 2018 and 2019; rather, they are a result of methodological changes related to the 2019 anaerobic digestion survey. As shown in Table 10, the quantity of wasted food managed by anaerobic digestion increased by 68% for the

[10] Note that food banks experienced a 11% increase in food waste generated but were not included in the analysis as food waste from food banks is not added to total generation because it would represent "double counting," i.e., it is already accounted for in Total Generation.

food manufacturing and processing sector and decreased by 89.8% for the food retail, food service, and residential sectors. This change is the result of the 2019 anaerobic digestion survey including data about which sector categories the food waste was coming from, which previous surveys did not do. In the 2019 survey, the vast majority of food waste going to anaerobic digestion is reported to be from food manufacturers and processors, but in 2018, EPA did not have that breakdown, and had to make assumptions regarding how much food waste each sector category was sending to anaerobic digestors that allocated more food waste going to anaerobic digestion from sectors other than manufacturing and processing.

Finally, EPA changed the terminology for the sector categories between the 2018 and 2019 reports. In the "2018 Wasted Food Report" (EPA, 2020c), the sector categories were industrial, commercial, institutional and residential. In this report, we elected to use terminology that is more commonly used and understood among stakeholders, so the sector categories are now: manufacturing/processing, food retail, food service, and residential. These are defined in more detail in Sections 2 and 3.

Table 8. Comparison of 2018 and 2019 Wasted Food Generation Estimates

SECTOR	2018		2019		PERCENTAGE CHANGE IN ESTIMATED ANNUAL GENERATION BETWEEN 2018 AND 2019
	ESTIMATED ANNUAL GENERATION (TONS PER YEAR)	PERCENT OF TOTAL	ESTIMATED ANNUAL GENERATION (TONS PER YEAR)	PERCENT OF TOTAL	
Residential	24,954,863	39.53%	26,502,346	40.00%	6.20%
Supermarkets and Supercenters	8,683,093	13.75%	8,998,443	13.60%	3.63%
Food Wholesale	3,968,229	6.29%	3,973,516	6.00%	0.13%
Hotels	1,219,595	1.93%	1,196,076	1.80%	-1.93%
Restaurants (full and limited service)	17,090,835	27.07%	18,337,784	27.70%	7.30%
Sports Venues	38,154	0.06%	39,702	0.10%	4.06%
Hospitals	301,576	0.48%	298,576	0.50%	-0.99%
Nursing Homes	451,124	0.71%	415,591	0.60%	-7.88%
Military Installations	61,373	0.10%	62,627	0.10%	2.04%
Office Buildings	4,065,145	6.44%	4,093,447	6.20%	0.70%
Correctional Facilities	440,679	0.70%	425,232	0.60%	-3.51%
Colleges and Universities	613,106	0.97%	624,371	0.90%	1.84%
K-12 Schools	1,244,353	1.97%	1,248,532	1.90%	0.34%
Food Banks[1]	426,057	N/A	473,027	N/A	11.02%
TOTAL GENERATION (Food Retail, Food Service, Residential)	63,132,123	N/A	66,216,242	N/A	4.89%
Manufacturing/Processing	39,821,247	38.68%	40,050,707	37.69%	0.58%

[1] Food waste from food banks is not added to total generation because it would represent "double counting," i.e., it is already accounted for in Total Generation.

Table 9. Comparison of 2018 and 2019 Wasted Food Management Estimates for the Food Retail, Food Service, Residential, and Food Bank Sectors

MANAGEMENT PATHWAY	2018 QUANTITY MANAGED (TONS)	2018 PERCENTAGE MANAGED	2019 QUANTITY MANAGED (TONS)	2019 PERCENTAGE MANAGED	PERCENTAGE CHANGE BETWEEN 2018 AND 2019
Donation[1]	4,787,378	7.60%	5,135,293	7.76%	7.27%
Animal Feed	1,814,984	2.90%	1,516,771	2.29%	-16.43%
Bio-based Materials/ Biochemical Processing	1,841,411	2.90%	2,335,988	3.53%	-21.17%
Anaerobic Digestion	5,262,857	8.30%	538,539	0.81%	-89.77%
Composting	2,592,566	4.10%	3,304,764	4.99%	27.47%
Land Application	259,448	0.40%	141,371	0.21%	-45.51%
Controlled Combustion	7,552,705	12.00%	9,646,263	14.57%	27.72%
Landfill	35,277,543	55.90%	39,621,902	59.84%	12.31%
Sewer/ Wastewater Treatment	3,743,229	5.90%	3,975,352	6.00%	6.20%
TOTAL	63,132,123	100%	66,216,242	100%	4.89%

[1] Excludes portion of donations (473,027 tons) that could not be used and were re-routed to the other management pathways.

Table 10. Comparison of 2018 and 2019 Wasted Food Management Estimates for the Food Manufacturing and Processing Sector

MANAGEMENT PATHWAY	2018 QUANTITY MANAGED (TONS)	2018 PERCENTAGE MANAGED	2019 QUANTITY MANAGED (TONS)	2019 PERCENTAGE MANAGED	PERCENTAGE CHANGE BETWEEN 2018 AND 2019
Donation	3,411,578	8.57%	2,205,990	5.51%	-35.34%
Animal Feed	19,579,841	49.17%	13,709,339	34.23%	-29.98%
Bio-based Materials/Biochemical Processing	345,461	0.87%	64,737	0.16%	-433.64%
Anaerobic Digestion	5,508,940	13.83%	17,055,531	42.58%	67.70%
Composting	862,707	2.17%	583,305	1.46%	-47.90%
Land Application	8,627,526	21.67%	5,183,851	12.94%	-66.43%
Controlled Combustion	189,101	0.47%	330,326	0.82%	42.75%
Landfill	1,296,094	3.25%	917,630	2.29%	-41.24%
Sewer/ Wastewater Treatment	-	-	-	-	-
TOTAL	39,821,247	100%	40,050,707	100%	0.57%

7 CAVEATS AND UNCERTAINTIES

There are caveats and uncertainties associated with the estimates provided in this report, which include the following:[11]

- **Lack of empirical data in some sectors.** EPA sought to incorporate original, empirical studies of generation factors. In several sectors, however, the research highlights a shortage of literature providing such generation factors. Instead, many generation studies rely upon a relatively small set of widely cited empirical studies. Relative to their role in overall generation, key sectors with a lack of empirical data include food manufacturing and processing, supercenters (distinct from supermarkets), food wholesalers, and office buildings.
- **Current generation may be overestimated.** In recent years, states and municipalities have introduced rules banning landfilling of organics (including food) or mandating that organic wastes be recycled. At the time of this report drafting, bans or mandate related laws had been enacted in California, Connecticut, Maryland, Massachusetts, New Jersey, New York, Rhode Island, Vermont, Washington, the District of Columbia and the cities of Austin, Boulder, Honolulu, Minneapolis, New York City, San Francisco, and Seattle. Many of the generation studies applied in the methodology precede some of these bans. Therefore, as bans continue to take effect and be implemented through increased source reduction, the methodology may overstate current generation, and may become increasingly biased over time.
- **Generation studies do not exist for all sectors.** EPA's methodology is limited to sectors for which original generation rate studies exist, and those sectors likely account for the majority of wasted food in the U.S. However, it is possible that non-negligible quantities of wasted food originate in sectors not included, including theme parks, fairs, and exposition centers.
- **Uncertainty regarding revenue from e-commerce**. There is some uncertainty associated with the new estimated food and beverage revenue from businesses whose primary function is e-commerce (NAICS 4541) in the wholesale category of the food retail sector. The Annual Retail Trade Survey e-Commerce supplemental document provides a breakdown of e-commerce, with one line being food and beverage sales. However, there is some uncertainty with sector delineations of NAICS 4541 at the 3-digit level due to the survey's amount of sampling error and non-sampling error. Additionally, for NAICS 4541 alcohol sales are not separated out from other food and beverage sales, and so this revenue could be overestimating wasted food.
- **Composting and anaerobic digestion may be underestimated.** Composting and anaerobic digestion represent growing alternatives to food waste disposal in landfills and combustion facilities. Although new survey data allow improved characterization of composting and anaerobic digestion quantities, uncertainties remain. EPA did not extrapolate to account for states that do not publicly provide food waste composting estimates, nor do the estimates account for backyard and community composting, so the national composting estimate is likely an underestimate. Anaerobic digestion quantities may also be understated given that only 99 of the 275 anaerobic digestion facilities nationwide responded to EPA's survey (EPA, 2023), only 89 of the 275 responded regarding the amount food waste they processed, and EPA did not extrapolate to account for the additional facilities. It is notable that the

[11] For detailed caveats and limitations associated with each sector, please refer to "Wasted Food Measurement Methodology Scoping Memo" (EPA, 2020a).

survey collecting 2019 data had a much lower participation rate of 36 percent, as compared to the previous survey collecting 2018 and 2017 data that had a 67 percent participation rate.

- **Food donation may be overestimated.** There is some uncertainty in the specific amounts of excess food being donated which could lead to overestimation of this value. Feeding America reports donated meals by sector and these meals are then translated to a weight per meal metric. These meal donations could include food that would otherwise be wasted as well as other donations from the food manufacturing and processing, food retail, and food service sectors. The Feeding America network includes 200 food banks, which are larger warehouses, some of which donate to smaller food pantries or soup kitchens. The tonnage received per Feeding America facility was extrapolated to the total number of food banks nationally (1,270, based on data available from Hoovers, 2019), which resulted in an estimate of 7.8 million tons. However, it is likely that the food banks in Feeding America's network operate on a larger scale than many food banks that are not in the Feeding America network, which could potentially lead to an overestimate nationally. The final estimate of 7.8 million tons for all sectors is significantly higher than the initial estimate of approximately 2.8 million tons that was based on management distributions based on percent of generated wasted food that is donated (Food Waste Reduction Alliance, 2016).

- **Lack of data on food waste sent to sewer/wastewater.** The amount of food waste being sent to sewer/wastewater treatment facilities remains poorly characterized. Few studies provide information on the prevalence of in-sink disposals in households and restaurants, or on in-sink disposal usage behavior. In addition, biosolids generated at treatment plants are often subsequently managed through land application or anaerobic digestion, suggesting that the sewer/wastewater treatment plants may be best viewed as temporary collection points rather than a true management destination for food waste. Given the lack of specific data on the routing of food waste from the sewer/wastewater pathway to other management sectors, EPA did not revise the amount of food waste initially estimated to go to sewer/wastewater treatment facilities.

While the estimates contained in this report reflect 2019 data, which is prior to the start of the covid-19 pandemic, EPA is evaluating available information regarding the effects of the pandemic on wasted food generation and management. These findings will be incorporated into future estimates for 2020 and beyond.

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9 APPENDIX

9.1 GLOSSARY

Animal Feed: Diverting material from the food supply chain (directly or after processing) to animals (excludes crops intentionally grown for bioenergy, animal feed, seed, or industrial use). (Food Loss and Waste Protocol, 2016)

Bio-based Materials/Biochemical Processing: Converting material into industrial products. Examples include creating fibers for packaging material, creating bioplastics (e.g., polylactic acid), making "traditional" materials such as leather or feathers (e.g., for pillows), and rendering fat, oil, or grease into a raw material to make products such as soaps, biodiesel, or cosmetics. "Biochemical processing" does not refer to anaerobic digestion or production of bioethanol through fermentation. (Food Loss and Waste Protocol, 2016)

Codigestion/anaerobic digestion[12]: Breaking down material via bacteria in the absence of oxygen. This process generates biogas and nutrient-rich matter. Codigestion refers to the simultaneous anaerobic digestion of food loss and waste and other organic material in one digester. This destination includes fermentation (converting carbohydrates—such as glucose, fructose, and sucrose—via microbes into alcohols in the absence of oxygen to create products such as biofuels). (Food Loss and Waste Protocol, 2016) Often referred to as "anaerobic digestion" or "AD".

Composting/aerobic processes: Breaking down material via bacteria in oxygen-rich environments. Composting refers to the production of organic material (via aerobic processes) that can be used as a soil amendment. (Food Loss and Waste Protocol, 2016) Often referred to as simply "composting".

Controlled combustion: Sending material to a facility that is specifically designed for combustion in a controlled manner, which may include some form of energy recovery (this may also be referred to as incineration). (Food Loss and Waste Protocol, 2016)

Excess food: Food that is donated to feed people.

Food: Any substance—whether processed, semi-processed, or raw—that is intended for human consumption. "Food" includes drink, and any substance that has been used in the manufacture, preparation, or treatment of food. "Food" also includes material that has spoiled and is therefore no longer fit for human consumption. It does not include cosmetics, tobacco, or substances used only as drugs. It does not include processing agents used along the food supply chain, for example, water to clean or cook raw materials in factories or at home. (Food Loss and Waste Protocol, 2016). Throughout this document, EPA uses the term "food" as a shorthand to refer to both "food" and "inedible parts".

Food donation: Collection and redistribution of unspoiled excess food to feed people through food pantries, food banks and other food rescue programs.

Food loss: This term often refers to unused product from the agricultural sector, such as unharvested crops. For purposes of Sustainable Development Goal Target 12.3, food loss occurs from production up to (and not including) the retail level (FAO, 2023).

Food waste: Food and inedible parts not ultimately consumed by humans that are discarded or recycled, such as plate waste (i.e., food that has been served but not eaten), spoiled food, or peels and rinds considered

[12] Anaerobic digestion may occur in a standalone facility dedicated for food waste or it may occur when food waste is added to an existing digester that accepts other types of organic material.

inedible. For purposes of Sustainable Development Goal Target 12.3, food waste occurs at the retail and consumer-facing levels and is managed by landfill; controlled combustion; sewer; litter, discards and refuse; co/anaerobic digestion; compost/aerobic digestion; and land application (FAO, 2023; UNEP, 2021).

Inedible parts: Components associated with a food that, in a particular food supply chain, are not intended to be consumed by humans. Examples of inedible parts associated with food could include bones, rinds, and pits/stones. "Inedible parts" do not include packaging. What is considered inedible varies among users (e.g., chicken feet are consumed in some food supply chains but not others), changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography. (Food Loss and Waste Protocol, 2016)

Land Application: Spreading, spraying, injecting, or incorporating organic material onto or below the surface of the land to enhance soil quality. (Food Loss and Waste Protocol, 2016)

Landfill: Sending material to an area of land or an excavated site that is specifically designed and built to receive wastes. (Food Loss and Waste Protocol, 2016)

Sewer/wastewater treatment: Sending material down the sewer (with or without prior treatment), including that which may go to a facility designed to treat wastewater. (Food Loss and Waste Protocol, 2016)

Wasted food: Food that was not used for its intended purpose and is managed in a variety of ways, such as donation to feed people, creation of animal feed, composting, anaerobic digestion, or disposal in landfills or combustion facilities. Examples include unsold food from retail stores; plate waste, uneaten prepared food, or kitchen trimmings from restaurants, cafeterias, and households; or by-products from food and beverage processing facilities. The term wasted food can be used to refer to both excess food and food waste.

9.2 SECTOR-SPECIFIC REFERENCES

The following is a list of references used for each sector. For more information on generation factors and studies used to estimate generation, please refer to "Wasted Food Measurement Methodology" (U.S. EPA, 2020b), Section 6.2.

9.2.1 Food Manufacturing and Processing Sector

TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
Identifying, Quantifying, and Mapping Food Residuals from Connecticut Business and Institutions	Connecticut DEP (Draper/Lennon Inc. and Atlantic Geoscience Corp.)	Connecticut DEP	2001	https://portal.ct.gov/-/media/DEEP/compost/ssomfile/ssomreportpdf.pdf?la=en
Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Restaurants	Food Waste Reduction Alliance (BSR)	BSR	2014	https://foodwastealliance.org/wp-content/uploads/2020/05/FWRA_BSR_Tier3_FINAL.pdf
Identification, characterization, and mapping of food waste and food waste generators in Massachusetts	Massachusetts DEP (Draper/Lennon Inc.)	Massachusetts DEP	2002	https://www.mass.gov/doc/study-identification-characterization-mapping-of-food-waste-generators-in-massachusetts-2002/download
2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543
Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Wholesalers	BSR	BSR	2013	http://www.kbcsandbox3.com/fw/wp-content/uploads/2013/06/FWRA_BSR_Tier2_FINAL.pdf
2014 ICI Waste Characterization Program	Tetra Tech for Metro Vancouver	Metro Vancouver	2015	http://www.metrovancouver.org/services/solid-waste/SolidWastePublications/FinalReport-2014ICIWasteCharacterizationProgram3-Jun-15.pdf
Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Restaurants (2016)	Food Waste Reduction Alliance	Food Waste Reduction Alliance	2016	https://foodwastealliance.org/wp-content/uploads/2020/05/FWRA-Food-Waste-Survey-2016-Report_Final.pdf

9.2.2 Residential Sector

TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
State of Vermont Waste Composition Study	Vermont DEC (DSM Environmental Services, MidAtlantic Solid Waste Consultants)	Vermont DEC	2013	https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/finalreportvermontwastecomposition13may2013.pdf
King County Solid Waste Division: Organics Study	King County Department of Natural Resources and Parks (Cascadia Consulting Group)	King County Department of Natural Resources and Parks	2009	https://kingcounty.gov/~/media/depts/dnrp/solid-waste/garbage-recycling/documents/Organics-Study-2009-final-report.ashx?la=en
Best Management Practices in Food Scraps Program	U.S. EPA Region 5 (Juri Freeman and Lisa Skumatz, Econservation Institute)	U.S. EPA Region 5	2011	https://studylib.net/doc/8407390/best-management-practices-in-food-scraps-programs

TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
2011 Iowa Statewide Waste Characterization Study	Iowa Department of Natural Resources (MSW Consultants)	Iowa Department of Natural Resources	2011	www.iowadnr.gov/Portals/idnr/uploads/waste/wastecharacterization2011.pdf
Montgomery County Waste Composition Study: Summary of Results	Montgomery County Division of Solid Waste Services (Prepared by SCS Engineers)	Montgomery County Division of Solid Waste Services	2013	https://www.montgomerycountymd.gov/sws/resources/files/studies/waste-composition-study-130726.pdf
City of San Diego Waste Characterization Study 2012-2013	City of San Diego (Cascadia Consulting Group)	City of San Diego	2014	https://www.sandiego.gov/sites/default/files/legacy/environmental-services/pdf/recycling/CompMultiFam.pdf
2014 Residential Waste Stream Composition Study: Final Report	Seattle Public Utilities (prepared by Cascadia Consulting Group)	Seattle Public Utilities	2014	http://www.seattle.gov/util/cs/groups/public/@spu/@garbage/documents/webcontent/1_043661.pdf
2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543
Source separated residential composting in the U.S.	Yepsen, R., Goldstein, N.	BioCycle	2007	https://www.biocycle.net/2007/12/19/source-separated-residential-composting-in-the-u-s/
Residential food waste collection in the U.S.	Yepsen, R.	BioCycle	2013	https://www.biocycle.net/2013/03/19/residential-food-waste-collection-in-the-u-s-biocycle-nationwide-survey/
Potentials for food waste minimization and effects on potential biogas production through anaerobic digestion	Schott, A. B. S., Vukicevic, S., Bohn, I., & Andersson, T.	Waste Management & Research	2013	https://www.ncbi.nlm.nih.gov/pubmed/23681829
Total and per capita value of food loss in the United States	Buzby, J.C., Hyman, J.	Food Policy	2012	http://www.sciencedirect.com/science/article/pii/S0306919212000693
Assessing U.S. food wastage and opportunities for reduction	Dou, Z., Ferguson, J.D., Galligan, D.T., Kelly, A.M., Finn, S.M., Giegengack, R.	Global Food Security	2016	https://www.sciencedirect.com/science/article/pii/S2211912415300195
BioCycle nationwide survey: Residential food waste collection in the U.S.	Yepsen, R.	BioCycle	2012	https://www.biocycle.net/2012/01/12/residential-food-waste-collection-in-the-u-s/
Food waste collection innovations	Goldstein, N.	BioCycle	2014	https://www.biocycle.net/2014/07/15/food-waste-collection-innovations/
Getting the public tuned in to food waste reduction	Johnston, M.	BioCycle	2013	https://www.biocycle.net/2013/11/18/getting-the-public-tuned-in-to-food-waste-reduction/
Residential food waste collection in the U.S.	Yepsen, R.	BioCycle	2015	https://www.biocycle.net/2015/01/15/residential-food-waste-collection-in-the-u-s-2/
Urban food waste generation: Challenges and opportunities	Adhikari, B.K., Barrington, S.F., Martinez, J.M.	International Journal of Environment and Waste Management	2009	https://hal.archives-ouvertes.fr/hal-00615443/document
The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States	Buzby, J.C., Wells, H.F., Hyman, J.	USDA ERS	2014	https://www.ers.usda.gov/webdocs/publications/43833/43680_eib121.pdf

TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
Food: Too Good to Waste An Evaluation Report for the Consumption Workgroup of the West Coast Climate and Materials Management Forum	U.S. EPA	U.S. EPA	2016	https://www.epa.gov/sites/production/files/2016-07/documents/ftgtw_finalreport_7_19_16.pdf
City of Boulder Food Waste Audit	Phillips, C., Hoenigman, R., Dansky, H.	Boulder Food Rescue	2016	https://www.boulderfoodrescue.org/wp-content/uploads/2016/03/2916-Boulder-Food-Waste-Audit.pdf
A Roadmap to Reduce U.S. Food Waste by 20 Percent	ReFED	ReFED	2016	https://www.refed.com/downloads/ReFED_Report_2016.pdf
2014 Disposal-Facility-Based Characterization of Solid Waste in California	CalRecycle	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1546
The environmental impacts of alternative food waste treatment technologies in the U.S.	Thyberg, K.L., Tonjes, D.J.	Journal of Cleaner Production	2017	http://www.sciencedirect.com/science/article/pii/S0959652617309149
Estimating quantities and types of food waste at the city level	NRDC	NRDC	2017	https://www.nrdc.org/sites/default/files/food-waste-city-level-report.pdf
Global food losses and food waste	FAO	FAO	2011	http://www.fao.org/3/mb060e/mb060e00.pdf
The food waste disposer as a municipal tool for waste diversion: An evaluation in five cities	InSinkErator	InSinkErator	2016	https://www.aham.org/AHAMdocs/Main%20Site/InSinkErator.pdf
The Household Use of Food Waste Disposal Units as a Waste Management Option: A Review	Iacovidou, E., Ohandja, D., Gronow, J., Voulvoulis, N.	Critical Reviews in Environmental Science and Technology	2011	https://www.tandfonline.com/doi/abs/10.1080/10643389.2011.556897?journalCode=best20&
PlaNYC: 2011 Full Report	NYC Mayor's Office of Recovery & Resiliency		2011	http://www.nyc.gov/html/planyc/downloads/pdf/publications/planyc_2011_planyc_full_report.pdf
Residential Food Waste Collection Access in the U.S.	Streeter, V., Platt, B.	BioCycle	2017	https://www.biocycle.net/2017/12/06/residential-food-waste-collection-access-u-s/
Wasted Food Measurement Study – Oregon Households	Oregon Department of Environmental Quality	Oregon Department of Environmental Quality	2019	https://www.oregon.gov/deq/mm/food/Pages/Wasted-Food-Study.aspx

9.2.3 Food Retail Sector

TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
Identifying, Quantifying, and Mapping Food Residuals from Connecticut Business and Institutions	Connecticut DEP (Draper/Lennon Inc. and Atlantic Geoscience Corp.)	Connecticut DEP	2001	https://portal.ct.gov/-/media/DEEP/compost/ssomfile/ssomreportpdf.pdf?la=en
Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Restaurants	Food Waste Reduction Alliance (BSR)	BSR	2014	https://foodwastealliance.org/wp-content/uploads/2020/05/FWRA_BSR_Tier3_FINAL.pdf
Targeted statewide waste characterization study: Waste disposal and diversion findings for selected industry groups	California EPA (Cascadia Consulting Group)	CalRecycle	2006	https://www2.calrecycle.ca.gov/Publications/Details/1184
Mecklenburg County Food Waste Diversion Study	Mecklenburg County Solid Waste (Kessler Consulting, Inc.)	Mecklenburg County Solid Waste	2012	https://www.waste.ccacoalition.org/file/1780/download?token=HjywueDB
2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/WasteCharacterization/PubExtracts/2014/GenSummary.pdf
Characterization of food waste generators: A Hawaii case study	Okazaki, W.K., Turn, S.Q., Flachsbart, P.G.	Waste Management	2008	https://pubmed.ncbi.nlm.nih.gov/18375111/
North Carolina 2012 Food Waste Generation Study	North Carolina Department of Environment and Natural Resources	NC Department of Environment and Natural Resources	2012	https://files.nc.gov/ncdeq/North%20Carolina%202012%20Food%20Waste%20Generation%20Study.pdf
A Roadmap to Reduce U.S. Food Waste by 20 Percent	ReFED	ReFED	2016	https://www.refed.com/downloads/ReFED_Report_2016.pdf
Summary Analysis of Massachusetts Commercial/Institutional Food Waste Generation Data	EPA Region 1	U.S. EPA Region 1	2011	https://www.mass.gov/doc/summary-analysis-massachusetts-commercialinstitutional-food-waste-generation-data-2011/download
Estimating quantities and types of food waste at the city level	NRDC	NRDC	2017	https://www.nrdc.org/sites/default/files/food-waste-city-level-report.pdf
Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Wholesalers	BSR	BSR	2013	http://www.kbcsandbox3.com/fw/wp-content/uploads/2013/06/FWRA_BSR_Tier2_FINAL.pdf
Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Restaurants (2016)	Food Waste Reduction Alliance	Food Waste Reduction Alliance	2016	https://foodwastealliance.org/wp-content/uploads/2020/05/FWRA-Food-Waste-Survey-2016-Report_Final.pdf

9.2.4 Food Service Sector

SECTOR	TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
Restaurants	Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Restaurants	Food Waste Reduction Alliance (BSR)	BSR	2014	https://foodwastealliance.org/wp-content/uploads/2020/05/FWRA_BSR_Tier3_FINAL.pdf
	Targeted statewide waste characterization study: Waste disposal and diversion findings for selected industry groups	California EPA (Cascadia Consulting Group)	CalRecycle	2006	https://www2.calrecycle.ca.gov/Publications/Details/1184
	Identification, characterization, and mapping of food waste and food waste generators in Massachusetts	Massachusetts DEP (Draper/Lennon Inc.)	Massachusetts DEP	2002	https://www.mass.gov/doc/study-identification-characterization-mapping-of-food-waste-generators-in-massachusetts-2002/download
	2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543
	Characterization of food waste generators: A Hawaii case study	Okazaki, W.K., Turn, S.Q., Flachsbart, P.G.	Waste Management	2008	https://pubmed.ncbi.nlm.nih.gov/18375111/
	North Carolina 2012 Food Waste Generation Study	North Carolina Department of Environment and Natural Resources	North Carolina Department of Environment and Natural Resources	2012	https://files.nc.gov/ncdeq/North%20Carolina%202012%20Food%20Waste%20Generation%20Study.pdf
	Summary Analysis of Massachusetts Commercial/Institutional Food Waste Generation Data	EPA Region 1	U.S. EPA Region 1	2011	https://www.mass.gov/doc/summary-analysis-massachusetts-commercialinstitutional-food-waste-generation-data-2011/download
	Feasibility Study on Food Waste Generated in Columbia, South Carolina	Battelle		2015	
Hotels	Targeted statewide waste characterization study: Waste disposal and diversion findings for selected industry groups	California EPA (Cascadia Consulting Group)	CalRecycle	2006	https://www2.calrecycle.ca.gov/Publications/Details/1184
	2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543
	Characterization of food waste generators: A Hawaii case study	Okazaki, W.K., Turn, S.Q., Flachsbart, P.G.	Waste Management	2008	https://pubmed.ncbi.nlm.nih.gov/18375111/
	2014 ICI Waste Characterization Program	Tetra Tech for Metro Vancouver	Metro Vancouver	2015	http://www.metrovancouver.org/services/solid-waste/SolidWastePublications/FinalReport-2014ICIWasteCharacterizationProgram3-Jun-15.pdf
Sports venues	Targeted statewide waste characterization study: Waste disposal and diversion findings for selected industry groups	California EPA (Cascadia Consulting Group)	CalRecycle	2006	https://www2.calrecycle.ca.gov/Publications/Details/1184
	2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543

SECTOR	TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
	Achieving sustainability beyond zero waste: A case study from a college football stadium	Costello, C., McGarvey, R.G., Birisci, E.	Sustainability	2017	https://www.mdpi.com/2071-1050/9/7/1236
Hospitals	Identifying, Quantifying, and Mapping Food Residuals from Connecticut Business and Institutions	Connecticut DEP (Draper/Lennon Inc. and Atlantic Geoscience Corp.)	Connecticut DEP	2001	https://portal.ct.gov/-/media/DEEP/compost/ssomfile/ssomreportpdf.pdf?la=en
	Collection of Recyclables from Multifamily Housing and Business	Walsh, P. Pferdehirt, W., & O'Leary, P.	Waste Age	1993	https://p2infohouse.org/ref/08/07954.pdf
	Identification, characterization, and mapping of food waste and food waste generators in Massachusetts	Massachusetts DEP (Draper/Lennon Inc.)	Massachusetts DEP	2002	https://www.mass.gov/doc/study-identification-characterization-mapping-of-food-waste-generators-in-massachusetts-2002/download
	2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543
	Practical Plan For Hospital Food Waste Recovery	Chardoul, N., Coddington, B.	BioCycle	2012	https://www.biocycle.net/practical-plan-for-hospital-food-waste-recovery/
	North Carolina 2012 Food Waste Generation Study	North Carolina Department of Environment and Natural Resources	North Carolina Department of Environment and Natural Resources	2012	https://files.nc.gov/ncdeq/North%20Carolina%202012%20Food%20Waste%20Generation%20Study.pdf
	Food Scrap Generator Database Calculations	Vermont Agency of Natural Resources	Vermont Agency of Natural Resources	2018	http://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/Universal-Recycling/FoodScrapVolume_Estimator.pdf
	Comparing Food Provided and Wasted before and after Implementing Measures against Food Waste in Three Healthcare Food Service Facilities	Strotmann, C., Friedrich, S., Kreyenschmidt, J., Teitscheid, P., Ritter, G.	Sustainability	2017	www.mdpi.com/2071-1050/9/8/1409/pdf

SECTOR	TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
Nursing Homes	Identification, characterization, and mapping of food waste and food waste generators in Massachusetts	Massachusetts DEP (Draper/Lennon Inc.)	Massachusetts DEP	2002	https://www.mass.gov/doc/study-identification-characterization-mapping-of-food-waste-generators-in-massachusetts-2002/download
	Comparing Food Provided and Wasted before and after Implementing Measures against Food Waste in Three Healthcare Food Service Facilities	Strotmann, C., Friedrich, S., Kreyenschmidt, J., Teitscheid, P., Ritter, G.	Sustainability	2017	www.mdpi.com/2071-1050/9/8/1409/pdf
	Comparison of waste composition in a continuing-care retirement community	Kim, T., Shanklin, C. W., Su, A. Y., Hackes, B. L., & Ferris, D.		1997	https://pubmed.ncbi.nlm.nih.gov/9120193/
Military Installations	Feasibility Study on Food Waste Generated in Columbia, South Carolina	Battelle		2015	
	Integrating food waste diversion into food systems planning: A case study of the Mississippi Gulf Coast	Evans-Cowley, J.S., Arroyo-Rodríguez, A.		2013	https://www.foodsystemsjournal.org/index.php/fsj/article/view/179
Office Buildings	Targeted statewide waste characterization study: Waste disposal and diversion findings for selected industry groups	California EPA (Cascadia Consulting Group)	CalRecycle	2006	https://www2.calrecycle.ca.gov/Publications/Details/1184
	2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543
	2014 ICI Waste Characterization Program	Tetra Tech for Metro Vancouver	Metro Vancouver	2015	http://www.metrovancouver.org/services/solid-waste/SolidWastePublications/FinalReport-2014ICIWasteCharacterizationProgram3-Jun-15.pdf
Correctional facilities	Identifying, Quantifying, and Mapping Food Residuals from Connecticut Business and Institutions	CT DEP (Draper/Lennon Inc. and Atlantic Geoscience Corp.)	Connecticut DEP	2001	https://portal.ct.gov/-/media/DEEP/compost/ssomfile/ssomreportpdf.pdf?la=en
	New York State Department of Correctional Services (DOCS)	U.S. EPA	U.S. EPA	1998	https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1004U0A.TXT
	Waste Reduction and Recycling Guide for Florida Correctional Facilities	FL DEP (Kessler Consulting Inc.)	Florida DEP	2004	http://www.businessperformance.org/sites/default/files/finalprisonguide-72ppi.pdf
	Composting 12,000 tons of food residuals per year	Marion, J.	BioCycle	2000	
	Food Waste at Correctional Facilities	CalRecycle	CalRecycle	2018	https://www.calrecycle.ca.gov/StateAgency/AgencyType/Correctional
	Correctional Facility Composting In Washington State	Mendrey, K.	BioCycle	2013	https://www.biocycle.net/correctional-facility-composting-in-washington-state/
	Food Scraps to Orchard Amendment at Philadelphia Prison	Goldstein, N.	BioCycle	2015	https://www.biocycle.net/2015/09/17/food-scraps-to-orchard-amendment-at-philadelphia-prison-complex/
Colleges and Universities	Identifying, Quantifying, and Mapping Food Residuals from Connecticut Business and Institutions	Connecticut DEP (Draper/Lennon Inc. and Atlantic Geoscience Corp.)	Connecticut DEP	2001	https://portal.ct.gov/-/media/DEEP/compost/ssomfile/ssomreportpdf.pdf?la=en

SECTOR	TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
	2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543
	Composting feasibility study for the Randolph-Macon College Dining Facility	Virginia Department of Environmental Quality (The Vannet Group)	The Vannet Group, LLC	2008	
	Research and Solutions: AASHE Student Award-Winning Paper: Converting Food Waste to Biogas	Graunke, R., Wilkie, A.	Sustainability	2008	https://pdfs.semanticscholar.org/779f/08150db72ef3c39f2e37ff5f5327119ed274.pdf
	Estimating the biogas potential from colleges and universities	Ebner, J., Win, S.S., Hegde, S., Vadney, S., Williamson, A., Trabold, T.	The American Society of Mechanical Engineers (ASME)	2014	http://proceedings.asmedigitalcollection.asme.org/proceeding.aspx?articleid=1920668
	Food and non-edible, compostable waste in a University dining facility	Sarjahani, A., Serrano, E.L., Johnson, R.	Journal of Hunger & Environmental Nutrition	2009	http://www.tandfonline.com/doi/abs/10.1080/19320240802706874
	Impact on Plate Waste of Switching from a Tray to a Trayless Delivery System in a University Dining Hall and Employee Response to the Switch	Thiagarajah, K., Getty, V.M.	Eat Right	2013	https://www.ncbi.nlm.nih.gov/pubmed/23088899
	Energy recovery from waste food by combustion or gasification with the potential for regenerative dehydration: A case study	Caton, P.A., Carr, M.A., Kim, S.S., Beautyman, M.J.	Energy Conversion and Management	2010	http://www.sciencedirect.com/science/article/pii/S0196890409005317
	Quantifying the Impact of Going Trayless in a University Dining Hall	Kim, K., Morawski, S.	Journal of Hunger & Environmental Nutrition	2012	http://www.tandfonline.com/doi/abs/10.1080/19320248.2012.732918
	Written Messages Improve Edible Food Waste Behaviors in a University Dining Facility	Whitehair, K.J., Shanklin, C.W., Brannon, L.A.	Eat Right	2013	https://pubmed.ncbi.nlm.nih.gov/23260724/
K-12 Schools	Identification, characterization, and mapping of food waste and food waste generators in Massachusetts	Massachusetts DEP (Draper/Lennon Inc.)	Massachusetts DEP	2002	https://www.mass.gov/doc/study-identification-characterization-mapping-of-food-waste-generators-in-massachusetts-2002/download
	2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California	CalRecycle (Cascadia Consulting Group)	CalRecycle	2015	https://www2.calrecycle.ca.gov/Publications/Details/1543
	Food Waste Auditing at Three Florida Schools	Wilkie, A., Graunke, R., & Cornejo, C.	Sustainability	2015	http://www.mdpi.com/2071-1050/7/2/1370
	Food Waste Estimation Guide	Recycling Works Massachusetts	Recycling Works Massachusetts	2013	https://recyclingworksma.com/food-waste-estimation-guide/

SECTOR	TITLE	AUTHOR OR AGENCY	PUBLICATION	YEAR	WEBLINK
	Food Waste in a School Nutrition Program After Implementation of New Lunch Program Guidelines	Byker, C., Farris, A.R., Marcenelle, M., Davis, G.C., & Serrano, E.L.	Journal of Nutrition Education and Behavior	2014	https://pubmed.ncbi.nlm.nih.gov/24857599/
	Identifying, Quantifying, and Mapping Food Residuals from Connecticut Business and Institutions	Connecticut DEP (Draper/Lennon Inc. and Atlantic Geoscience Corp.)	Connecticut DEP	2001	https://portal.ct.gov/-/media/DEEP/compost/ssomfile/ssomreportpdf.pdf?la=en
	Estimating quantities and types of food waste at the city level	NRDC	NRDC	2017	https://www.nrdc.org/sites/default/files/food-waste-city-level-report.pdf
	Food Waste Warriors- A Deep Dive into Food Waste in US Schools	WWF	WWF	2019	https://c402277.ssl.cf1.rackcdn.com/publications/1271/files/original/FoodWasteWarriorR_CS_121819.pdf?1576689275

9.3 DETAILED GENERATION AND MANAGEMENT ESTIMATES OF WASTED FOOD

Table 11 contains estimates of the amount of wasted food generated by each sector and category, and the amount managed by each management pathway, per sector and category.

Table 11. Generation and Management Estimates of Wasted Food by Sector and Category (2019)

	WASTED FOOD MANAGED BY SECTOR AND CATEGORY (TONS)																
			FOOD RETAIL		FOOD SERVICE												
MANAGEMENT PATHWAY	MANUFACTURING/PROCESSING	RESIDENTIAL	SUPERMARKETS AND SUPERCENTERS	WHOLESALE	HOTELS	RESTAURANTS	SPORTS VENUES	HOSPITALS	NURSING HOMES	MILITARY INSTALLATIONS	OFFICE BUILDINGS	CORRECTIONAL FACILITIES	COLLEGES & UNIVERSITIES	K-12 SCHOOLS	FOOD BANKS	INTERMEDIATE AMOUNT MANAGED[1]	TOTAL MANAGED BY EACH PATHWAY[2]
Donation	2,205,990	-	3,700,112	1,633,888	12,269	188,110	407	3,063	4,263	642	41,991	4,362	6,405	12,807	-	**7,814,310**	**7,341,283**
Animal Feed	13,709,339	-	999,165	441,209	361	5,530	12	90	125	19	1,234	128	188	376	68,332	**15,157,777**	**15,226,110**
Bio-based Materials/ Biochemical Processing	64,737	-	194,019	85,674	90,808	1,392,231	3,014	22,668	31,552	4,755	310,780	32,284	47,403	94,790	26,008	**2,374,717**	**2,400,725**
Anaerobic Digestion	17,055,531	6,430	210,253	92,843	10,243	157,041	340	2,557	3,559	536	35,056	3,642	5,347	10,692	-	**17,594,070**	**17,594,070**
Composting	583,305	977,975	1,318,098	582,043	15,462	237,050	513	3,860	5,372	810	52,916	5,497	8,071	16,140	80,957	**3,807,112**	**3,888,068**
Land Application	5,183,851	-	84,036	37,109	-	-	-	-	-	-	-	-	-	-	20,226	**5,304,996**	**5,325,222**
Controlled Combustion	330,326	4,010,257	611,435	269,997	209,210	3,207,524	6,944	52,225	72,693	10,954	715,999	74,379	109,211	218,385	77,051	**9,899,537**	**9,976,589**
Landfill	917,630	17,532,332	1,881,325	830,752	857,724	13,150,297	28,471	214,113	298,027	44,911	2,935,472	304,940	447,746	895,341	200,453	**40,339,079**	**40,539,532**

	WASTED FOOD MANAGED BY SECTOR AND CATEGORY (TONS)																
			FOOD RETAIL		FOOD SERVICE												
MANAGEMENT PATHWAY	MANUFACTURING/PROCESSING	RESIDENTIAL	SUPERMARKETS AND SUPERCENTERS	WHOLESALE	HOTELS	RESTAURANTS	SPORTS VENUES	HOSPITALS	NURSING HOMES	MILITARY INSTALLATIONS	OFFICE BUILDINGS	CORRECTIONAL FACILITIES	COLLEGES & UNIVERSITIES	K-12 SCHOOLS	FOOD BANKS	INTERMEDIATE AMOUNT MANAGED[1]	TOTAL MANAGED BY EACH PATHWAY [2]
Sewer/ Wastewater Treatment	-	3,975,352	-	-	-	-	-	-	-	-	-	-	-	-	-	**3,975,352**	**3,975,352**
Total Food Waste & Excess Food	**40,050,707**	**26,502,346**	**8,998,443**	**3,973,516**	**1,196,076**	**18,337,784**	**39,702**	**298,576**	**415,591**	**62,627**	**4,093,447**	**425,232**	**624,371**	**1,248,532**	**473,027**	**106,266,950**	**106,266,950**

Note:

[1] Although an estimated 7,814,310 tons of excess food are donated to food banks, food banks are not able to distribute all the food that is donated to them due to spoilage, expiration, or other reasons. Therefore, approximately 473,027 tons of the 7,814,310 tons ends up being managed as food waste via all other management pathways, excluding sewer/wastewater treatment. In the Intermediate Amount Managed column, the estimates of food waste do not yet distribute the 473,027 tons to those other pathways.

[2] Although an estimated 7,814,310 tons of excess food are donated to food banks, food banks are not able to distribute all the food that is donated to them due to spoilage, expiration, or other reasons. Therefore, approximately 473,027 tons of the 7,814,310 tons ends up being managed as food waste via all other management pathways, excluding sewer/wastewater treatment. In the Total Managed by Each Pathway column, the estimates of food waste generated by food banks are included in the management pathway estimates for each pathway.

9.4 STATE COMPOSTING ESTIMATES

Table 12. State Composting Estimates (2019)

STATE[1]	REPORTED QUANTITY (TONS)	SOURCE
Arizona	218,448	Arizona Department of Environmental Quality. 2019 Arizona Municipal Recycling Data Report. https://static.azdeq.gov/wqd/recy/2019_recycling_data.pdf
California	571,330	CalRecycle. (2021). State of Disposal and Recycling for Calendar Year 2019. https://www2.calrecycle.ca.gov/Publications/Download/1742
Colorado	170,732	Colorado Department of Public Health & Environment. (2020). 2019 Colorado Recycling Totals. Colorado Department of Public Health & Environment. https://cdphe.colorado.gov/colorado-recycling-totals
Delaware	1,878	Delaware Solid Waste Authority. Annual Report 2019—Delaware. Delaware Solid Waste Authority. https://dswa.com/wp-content/uploads/2019/11/AR-2019-Use.pdf
District of Columbia	170.31	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022.
Florida	69,443	Florida Department of Environmental Protection. 2019 Total Tons of MSW Materials Collected & Recycled in Florida by Descending Population. https://floridadep.gov/sites/default/files/2019_Total_Tons_of_MSW_Other_Paper_Food_Textiles_Misc.pdf
Indiana	19,011	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022.
Kentucky	700	University of Kentucky. (2019). 2019 Annual Report (Material Management, p. 12). University of Kentucky. https://www.uky.edu/facilities/sites/www.uky.edu.facilities/files/Recycling/2019%20Annual%20Report_Final.pdf University of Louisville. (2022). Composting. University of Louisville. https://louisville.edu/sustainability/operations/composting#:~:text=2018%3A%2044%20tons.,2021%3A%2036%20tons.
Louisiana	125	Louisiana Department of Environmental Quality. (2019). 2019 Annual Report- Louisiana (p. 38). Louisiana Department of Environmental Quality. https://deq.louisiana.gov/assets/docs/Annual_Reports/LDEQAnnualReport2019.pdf
Maine	68,912	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022
Maryland	87,078	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022
Massachusetts	40,469	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022.
Michigan	10,024	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022.
Minnesota	61,080	Minnesota Pollution Control Agency. (2021, April 29). Report on 2019 SCORE programs. Minnesota Pollution Control Agency. https://www.pca.state.mn.us/waste/report-2019-score-programs
Mississippi	208	Mississippi Department of Environmental Quality. 2019 Status Report on Solid Waste Management Facilities and Activities (p. 66). Mississippi Department of Environmental Quality. https://www.mdeq.ms.gov/wp-content/uploads/2020/12/2019-Annual-Status-Report.pdf
Montana	1,418	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022.
Nebraska	695	City of Lincoln, Nebraska. 2019 Solid Waste Grant Awarded- Nebraska. City of Lincoln, Nebraska. https://lincoln.ne.gov/city/ltu/solid-waste/grant/awarded.htm
Nevada	11,153.16	Nevada Recycles. 2019 State Recycling Data- Nevada.
New York	56,465	The City of New York Department of Sanitation. 2019 Annual Report: New York City Curbside and Containerized Municipal Refuse and Recycling Statistics (p. 1). The City of New York Department of Sanitation. https://dsny.cityofnewyork.us/wp-content/uploads/2019/10/about_dsny-curbside-collections-FY2019.pdf
North Carolina	42,744	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022.

STATE[1]	REPORTED QUANTITY (TONS)	SOURCE
Ohio	493,215	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022.
Oregon	72,182	Oregon Department of Environmental Quality. (2021). 2019 Oregon Material Recovery and Waste Generation Rates Report. Oregon Department of Environmental Quality. https://www.oregon.gov/deq/recycling/Documents/recMrwgRatesReport2019.pdf
South Carolina	13,412.61	South Carolina Department of Health and Environmental Control. 2019 South Carolina Solid Waste Management Annual Report (p. 102). South Carolina Department of Health and Environmental Control. https://scdhec.gov/sites/default/files/Library/OR-1988.pdf#page=12
Vermont	36,127	Vermont Agency of Natural Resources. (2020). 2019 Diversion and Disposal Report- Vermont (p. 20). Vermont Department of Environmental Concern. https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/2019-Diversion-and-Disposal-Report.pdf
Virginia	1,189.16	Virginia Department of Environmental Quality. (2020). 2020 Annual Solid Waste Report for CY2019 (p. 26). Virginia Department of Environmental Quality. https://www.deq.virginia.gov/home/showpublisheddocument/4832/637480306804470000#:~:text=Based%20on%20the%20facilities'%20reports,tons%20originated%20from%20other%20jurisdictions.
Washington	134,649	Virginia Department of Environmental Quality. (2020). 2020 Annual Solid Waste Report for CY2019 (p. 26). Virginia Department of Environmental Quality. https://www.deq.virginia.gov/home/showpublisheddocument/4832/637480306804470000#:~:text=Based%20on%20the%20facilities'%20reports,tons%20originated%20from%20other%20jurisdictions.
Wisconsin	5,267	EPA State Data Measurement Program. 2019 SMP Data. EPA. Data available May 31, 2022.
Subtotal	**2,998,745**	
Mixed MSW Composting[2]	306,019	
Subtotal	**3,304,764**	
Food Waste Composted by Food Manufacturers/Processors	583,305	
Total	**3,888,068**	

Note:

[1] Not all states are included in these composting estimates due to a lack of state composting data found.
[2] Includes a small portion of non-food waste.