

Food Waste Management in the United States, 2014

U.S. Environmental Protection Agency

Office of Resource Conservation and Recovery

December 2016

1. *Food Waste Management*

1.1 *Introduction*

U.S. Environmental Protection Agency (EPA) characterizes the generation and management of municipal solid waste (MSW) in the Advancing Sustainable Materials Management: Facts and Figures report¹ series. EPA researched and estimated the amount of MSW food waste donated, composted and used as animal feed in 2014. This document summarizes the data sources and methodology used to arrive at these estimates. EPA also reviewed anaerobic digestion of food waste and the management of the resulting digestate; however, there was not sufficient data to make numeric estimates of anaerobic digestion.

2. *Food Donation*

2.1 *Introduction*

Each year, significant amounts of food products are donated by residents and commercial and institutional establishments (e.g., grocery stores, restaurants, hospitals) to local food banks and charities to feed people. EPA estimated these national food donations, which is the second step in EPA's food recovery hierarchy depicted in Figure 1. A portion of these food donations divert food from the solid waste stream that would otherwise be managed through composting, anaerobic digestion, combustion with or without energy recovery or landfilling.

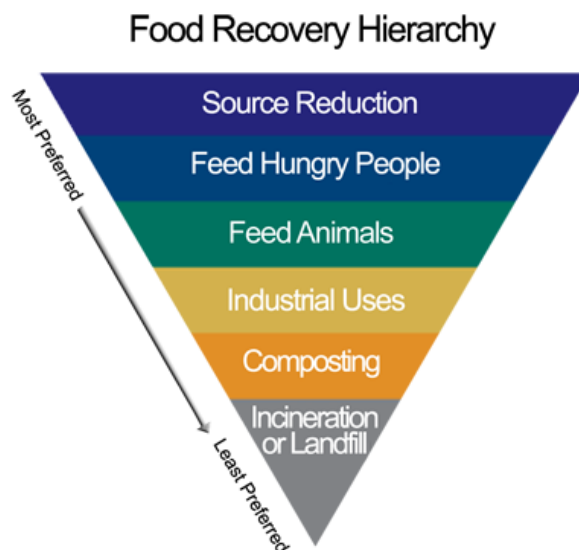


Figure 1. EPA's Food Recovery Hierarchy

Differentiating data reported in the literature between food donation diversion (i.e., wholesome but not-for-retail food products diverted from the waste stream) and charitable food donations (i.e. food drives) of saleable products is often difficult. The latter does not result in diverted

waste. This section provides an overview of available information used to quantify national food waste diversion through donation of wholesome but not-for-retail foods.

2.2 Data Sources – Food Donations

EPA gathered quantitative food donation data from two major food donation organizations: Feeding America (FA) and Food Donation Connection (FDC). This subsection provides background information on these organizations and describes the structure of the food donation programs that they run.

FA, formerly called America's Second Harvest, is the nation's largest non-profit food donation organization consisting of 200 food banks and food rescue organizations with a total of 60,000 food pantries and meal programs.² A portion of the food provided by FA includes food generated specifically for donation and does not represent food captured before it's discarded. However, FA runs several programs, such as the Retail Store Donation (RSD) program, that coordinate the donation of surplus food from retail stores that would otherwise be handled through the solid waste management system. As of 2011, the RSD program consisted of over 10,500 grocery stores. FA also organizes food donations from the manufacturing and agricultural sectors, but it is unclear whether these programs donate food that would otherwise be handled through the solid waste management system or be generated specifically for donation.

FDC is another non-profit food donation organization consisting of more than 300 food-service entities and 17,000 food service locations.³ The goal of this organization is to coordinate the donation of surplus food from restaurants that would otherwise be handled through the solid waste management system.

It is important to note EPA only collected and summarized data representing these two organizations. However, the relative size of these programs likely represents a large portion of national food diversion through donation. For example, the majority of the 10,500 stores that participate in FA's RSD program represent the country's largest firms in the food retail industry in terms of sale volumes.

2.3 Methodology

EPA estimated amounts of 2014 food donation using available data from FA's 2014 annual report.⁴ The RSD program donations were calculated by multiplying the number of meals provided by an estimated meal weight of 1.2 pounds. FDC estimates were obtained from the FDC website.⁵

2.4 Results

Table 1 summarizes the FA and FDC program results 2004 through 2014. The volume of food donations has increased over the years. EPA verified through personal communication with organization representatives that the FA RSD and the FDC programs donate food that would otherwise be handled through the solid waste management system.

Table 1. Food Donation Programs Representing Food Diversion through Donation

| Year | Retail Store Donation Program (Tons) ⁽¹⁾⁽²⁾ | Food Donation Connection (Tons) ⁽²⁾ | Total (Tons) |
|------|--|--|--------------|
| 2004 | 125,000 | 5,000 | 130,000 |
| 2005 | 132,000 | 7,000 | 139,000 |
| 2006 | 139,000 | 8,000 | 147,000 |
| 2007 | 146,000 | 9,000 | 155,000 |
| 2008 | 160,000 | 11,000 | 171,000 |
| 2009 | 217,000 | 11,000 | 228,000 |
| 2010 | 273,000 | 15,000 | 288,000 |
| 2011 | 330,000 | 18,000 | 348,000 |
| 2012 | 450,000 | 18,000 | 468,000 |
| 2013 | 533,000 | 18,000 | 551,000 |
| 2014 | 600,000 | 21,500 | 621,500 |

(1) 2004–2013: U.S. EPA. (2015) "Postconsumer Food Diverted Through Donation, Animal Feed, Anaerobic Digestion, and Composting for 2013".

(2) 2014: FA (Feeding America). 2014 Annual Report: Bringing Hope to 46 Million People. <http://www.feedingamerica.org/about-us/about-feeding-america/annual-report/2014-annual-report.pdf> and FDC (Food Donation Connection). 2015. About Us. <http://www.foodtodonate.com/Fdcmain/About.aspx>

3. Composted Food Waste

3.1 Introduction

Composting is the decomposition of organic materials by aerobic microorganisms. Composting facilities manage the amount of moisture, amount of oxygen and mixture of organic materials for optimal composting conditions. The composting process emits heat, water vapor and biogenic carbon dioxide, reducing the raw organic materials in mass and volume to create compost.⁶

This section includes estimated 2014 residential, commercial and institutional food waste composting (tonnage and percent of generation), statistics on residential curbside food waste

collection programs, number of food waste composting facilities and a list of city and state regulations banning commercial food waste landfill disposal. Collection programs, infrastructure and regulations drive the quantity of food waste diverted through composting.

3.2 Methodology

The use of composting to manage residential, commercial and institutional food waste has grown considerably in recent years, as people learn how composting converts food waste from municipal solid waste (MSW) into a valuable soil amendment and waste management professionals search for ways to divert organics from landfills.

EPA first estimated food waste generation, which is defined at the point the waste is ready to be managed (i.e., post donation of unsalable food to feed people or animals). EPA developed food waste generation and composting estimates from published data.

Generation: Food waste generation was estimated using factors based on sampling study data from various parts of the country in combination with demographic and economic data on population; grocery store sales; restaurant sales; numbers of employees; and in institutions the numbers of students, patients, and prisoners. The residential and commercial sourced factors were reviewed and revised as more sampling studies became available.

The sample based method estimated 2014 residential food waste at 0.371 pounds per person per day. The data range was 0.16 to 0.67 pounds per person per day. This data range was from curbside sampling in Arizona, California, Canada, Illinois, Iowa, Maryland, Minnesota, Missouri, Vermont, Washington, and Wisconsin. Lower end data were from Minnesota and Wisconsin; higher end data were from Arizona and California. The per capita factor was applied to U.S. population to estimate U.S. residential food waste generation.

EPA developed average commercial and institutional food waste generation factors from sampling studies conducted in the following sectors: grocery stores, restaurants, hotels, employee cafeterias, educational institutions, prisons, nursing homes and residential hospitals. To estimate national commercial/institutional food waste generation, these factors were applied to appropriate economic measurements such as grocery store sales, restaurant sales, numbers of employees and numbers of students, patients and prisoners in institutions.

Composting: To estimate composting, EPA gathered food waste composting statistics from environmental agency websites and published reports.

3.3 Results

Table 2 shows the generating sector, number of studies used to develop generation factors, and the 2014 profile estimated from the sample based method. Total food waste generation was estimated at 38.4 million tons in 2014.

EPA gathered food waste composting statistics from 33 state environmental agency websites, resulting in an estimated 1.57 million tons of postconsumer food waste diverted through composting in 2014. The state-by-state composting statistics are shown in Table 3. Food waste composting was 4.1 percent of generation. An additional 0.37 million tons of mixed MSW

containing food waste was composted in 2014, increasing the Food, Other composting rate to 5.1 percent.⁷

Table 2. EPA Food Waste Generation Characterization, 2014

| Sector | Sampling Studies (number) | Percent of Total Food Waste Generation ⁽¹⁾ |
|--|---------------------------|---|
| Residential | 24 | 56% |
| Grocery stores | 16 | 10% |
| Restaurants full/limited/specialty service | 22 | 26% |
| Institutions educational/prisons/medical | 30 | 8% |

(1) EPA 2016 working papers Table Q-01 Food Waste Generation and Composting. April. Unpublished.

Table 3. State-by-State Food Composting

| State | Food Composted | |
|---------------|--------------------------|-------------|
| | (Tons) ⁽¹⁾⁽²⁾ | (Data Year) |
| California | 715,119 | 2012 |
| Colorado | 29,130 | 2013 |
| Connecticut | 4,644 | 2013 |
| Delaware | 17,626 | 2013 |
| Florida | 158,711 | 2014 |
| Georgia | 8,021 | 2014 |
| Hawaii | 39,287 | 2014 |
| Indiana | 13,525 | 2013 |
| Iowa | 4,334 | 2010 |
| Kansas | 1,127 | 2010 |
| Maine | 1,658 | 2010 |
| Maryland | 69,643 | 2014 |
| Massachusetts | 2,753 | 2014 |
| Michigan | 8,700 | 2013 |
| Minnesota | 46,751 | 2013 |
| Mississippi | 242 | 2013 |
| Missouri | 16,000 | 2014 |
| Nevada | 35,869 | 2014 |
| New Hampshire | 110 | 2012 |
| New Jersey | 28,634 | 2012 |
| New York | 44,405 | 2013 |

| State | Food Composted | |
|----------------------------------|---------------------------|-------------|
| | (Tons) ^{(1)/(2)} | (Data Year) |
| North Carolina | 38,014 | 2014 |
| Ohio | 81,450 | 2014 |
| Oregon | 50,143 | 2013 |
| Pennsylvania | 56,851 | 2013 |
| Rhode Island | 150 | 2014 |
| South Carolina | 4,277 | 2014 |
| Tennessee | 1,500 | 2013 |
| Texas | 188 | 2012 |
| Vermont | 14,738 | 2013 |
| Virginia | 2,454 | 2014 |
| Washington | 65,221 | 2013 |
| Wisconsin | 8,677 | 2013 |
| Total Composted (tons/yr) | 1,569,952 | |

- (1) State environmental websites search supplemented with a limited number of personal contacts.
 (2) Latest data available.

3.4 Infrastructure Collection Programs

Recent growth in the number of residential curbside composting programs that accept food indicates that diversion of food waste through composting is likely to increase in the near future. A survey conducted by *BioCycle* in fall 2014 identified 198 communities with curbside collection of food waste serving 2.74 million households across 19 states. This represented significant growth compared to 42 communities with curbside collection in 2007 representing 752,000 households.⁸ Additional research identified eight more communities offering residential curbside food collection programs in conjunction with MSW hauling services, for a total of 206 communities in 2014. Table 4 shows residential curbside collection programs were available to 2.8 million households, which is 2.4 percent of all U.S. households in 2014. Curbside food collection programs continued to grow with the expansion of programs in Denver, New York City, and Austin and new programs in Cambridge, Ipswich, Salem, and Manchester-by-the-Sea in Massachusetts.⁹

In addition, several alternative composting programs exist to serve communities where curbside collection through the MSW hauler is not an option. First, many cities and towns encourage residents to compost food in their backyards, if space is available. Second, a number of communities—such as Cambridge and Manchester-by-the-Sea in Massachusetts; Minneapolis, Ramsey, and Hennepin Counties in Minnesota; Boulder County in Colorado, Napa Valley in California; and Washington, D.C.—have drop-off sites that accept food for composting in place of or in addition to curbside programs. Third, new private companies have formed to fill the demand for home pick-up services for food composting where municipal curbside programs do not exist.

Table 4. Residential Curbside Food Collection Programs in the United States, 2014

| State | Households Served ⁽¹⁾ |
|--|----------------------------------|
| California | 1,339,076 |
| Colorado | 54,113 |
| Connecticut | 1,100 |
| Illinois | 12,500 |
| Iowa | 39,630 |
| Kentucky | 400 |
| Maryland | 18,350 |
| Massachusetts | 13,050 |
| Michigan | 63,000 |
| Minnesota | 85,752 |
| New Jersey | 9,600 |
| New York | 101,306 |
| Ohio | 73,889 |
| Oregon | 216,686 |
| Pennsylvania | 580 |
| Texas | 134,000 |
| Vermont | 2,700 |
| Washington | 682,436 |
| Wisconsin | 600 |
| <i>Total U.S. Households Served</i> | <i>2,848,368</i> |
| <i>Total U.S. Households in 2014⁽²⁾</i> | <i>117,259,427</i> |
| <i>Percent of U.S. Households Served</i> | <i>2.4%</i> |

(1) Yepsen collected data on curbside collection of residential food available in 2014 by survey. EPA used additional Internet research to supplement and update these data. Yepsen, R. 2015. BioCycle Nationwide Survey: Residential Food Waste Collection in the U.S. *BioCycle* January.

(2) Number of households in the United States from U.S. Census Bureau. Selected Housing Characteristics: 2014 American Community Survey 1-Year Estimates.
http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_1YR_DP04&prodType=table

3.5 Infrastructure Facilities

In 2013, *BioCycle* conducted a state-by-state survey to determine the number of composting facilities in the United States.¹⁰ The survey identified 347 composting sites for food across the country, with results shown by state in Table 5. New York had the greatest number of composting operations, with a total of 45 sites, while California, Illinois, Massachusetts, Ohio, Pennsylvania, and Washington each had between 20 and 30 facilities. The low number of food composting facilities is especially significant in Connecticut, where the law requiring food

diversion by commercial enterprises generating more than two tons of food per week depends on the existence of a food recycling facility no more than 20 miles away (see Section 3.6).

Table 5. Number of Food Composting Facilities in the United States, by State, 2013

| State | Number of Facilities ⁽¹⁾ | State | Number of Facilities ⁽¹⁾ | State | Number of Facilities ⁽¹⁾ |
|----------------------|-------------------------------------|----------------|-------------------------------------|----------------|-------------------------------------|
| Alabama | | Kentucky | | North Dakota | 0 |
| Alaska | 0 | Louisiana | | Ohio | 20 |
| Arizona | | Maine | 10 | Oklahoma | |
| Arkansas | 1 | Maryland | 4 | Oregon | 10 |
| California | 26 | Massachusetts | 27 | Pennsylvania | 25 |
| Colorado | 2 | Michigan | 7 | Rhode Island | 3 |
| Connecticut | 3 | Minnesota | 9 | South Carolina | 1 |
| Delaware | 2 | Mississippi | 3 | South Dakota | 0 |
| District of Columbia | | Missouri | 6 | Tennessee | 2 |
| Florida | 2 | Montana | 1 | Texas | 4 |
| Georgia | 1 | Nebraska | 0 | Utah | 4 |
| Hawaii | | Nevada | | Vermont | 13 |
| Idaho | 4 | New Hampshire | 9 | Virginia | 1 |
| Illinois | 21 | New Jersey | 1 | Washington | 29 |
| Indiana | 11 | New Mexico | | West Virginia | |
| Iowa | 7 | New York | 45 | Wisconsin | 14 |
| Kansas | 4 | North Carolina | 7 | Wyoming | 1 |
| U.S. Total | | | | | 347 |

(1) Platt and Goldstein report the number of food composting facilities in each state as determined by a survey *BioCycle* administered to state governments. Blanks indicate states for which no data were provided.

3.6 Food Waste Regulations

Regulations in states and cities requiring diversion of food from the waste stream have driven collection and composting of commercial food. Table 6 lists the cities and states that have implemented or are implementing commercial food bans. San Francisco and Seattle each have an ordinance that prohibits both commercial and residential food in the waste stream. The food disposal bans passed in northeastern states and New York City specifically target commercial generators of large quantities of food and other organic wastes. A study of Massachusetts commercial and institutional food generation shows that the commercial food disposal ban could divert up to 848,000 tons of food from MSW each year.¹¹ Since food makes up over 20 percent of MSW combusted with energy recovery or landfilled in the United States,¹² commercial food disposal bans are often seen as a critical step toward long-term waste reduction goals.

Table 6. Commercial Food Disposal Bans in the United States

| State/City ⁽¹⁾ | Effective Date ⁽²⁾ | Ban Requirements ⁽²⁾ |
|---------------------------|-------------------------------|--|
| San Francisco, CA | October 21, 2009 | The Mandatory Recycling and Composting Ordinance bans businesses and residents from disposing of food in the landfill waste stream. |
| Connecticut | January 1, 2014 | The 2011 law banned generators of 2 or more tons of food per week from sending food to landfills if within 20 miles of a recycling facility. In 2013, the law was expanded to include generators of 1 ton of food per week beginning in 2020. |
| Vermont | July 1, 2014 | The 2012 law banned generators of 2 or more tons of food per week from sending food to landfills if within 20 miles of a recycling facility. The requirement expands to facilities that generate 1 ton per week in 2015 and then to facilities that generate 0.5 tons per week in 2016. By July 1, 2017, food scraps must be collected curbside at residences and beginning July 1, 2020 all food scraps, including residential sources, will be banned from landfills. Initially, the diversion requirements only apply if an organics recycling facility is located within 20 miles; however, this exception is eliminated in 2020 due to anticipated development of statewide organics processing infrastructure. |
| Massachusetts | October 1, 2014 | The law bans disposal of food by businesses and institutions that dispose of 1 ton or more of organic materials per week. |
| Seattle, WA | January 1, 2015 | City ordinance prohibits the disposal of food and compostable paper waste in commercial, residential, and self-haul garbage. |
| New York City, NY | July 1, 2015 | The Commercial Organics Law requires large food service establishments to recycle their organic waste if within 100 miles of a recycling facility. The Department of Sanitation will determine if and to what extent Local Law 146 will be implemented based on cost and regional processing capacity. |
| California | April 1, 2016 | The law mandates organic waste recycling by businesses generating 8 or more cubic yards of organic waste in 2016, 4 or more cubic yards of organic waste in 2017, and 4 or more cubic yards of commercial solid waste in 2019. The law also requires local jurisdictions to implement a commercial organic waste recycling program, with exemptions allowed for jurisdictions in counties with a population less than 70,000. |
| Rhode Island | January 1, 2016 | Generators of 2 or more tons of food per week may not landfill food if within 15 miles of a recycling facility. Public schools are exempt. The ban expands to include generators of 1 ton or more of food per week starting in 2020. |
| Portland, OR | August 1, 2014 | City administrative rules require mandatory food diversion for the largest commercial food generators. The city has not yet defined the generation quantity that would cause businesses to be subject to the requirement. |

- (1) Henricks provides a list of cities and states that prohibit organic waste in landfills.
- Henricks, M. 2014. More States Ban Organic Waste in Landfills. American Recycler. January. <http://www.americanrecycler.com/0114/2428more.shtml>.
- (2) Details on each ban were found in each state or city's online resources:
- SF Environment. 2014. Mandatory Recycling and Composting Ordinance. <http://www.sfenvironment.org/article/recycling-and-composting/mandatory-recycling-and-composting-ordinance>;
 - Connecticut General Assembly. 2013. General Statutes of Connecticut, Chapter 446d: Solid Waste Management. Revised January 1. http://cga.ct.gov/2014/sup/chap_446d.htm#sec_22a-226e;
 - Vermont DEC. 2014. Universal Recycling Timeline. October 27. http://www.anr.state.vt.us/dec/wastediv/solid/documents/UR_Timeline_Summary.pdf;
 - Massachusetts DEP. 2014. Commercial Food Waste Disposal Ban. <http://www.mass.gov/eea/agencies/massdep/recycle/reduce/food-waste-ban.html>;

- NYC Department of Sanitation. 2014. NYC Commercial Organics Law. <http://www1.nyc.gov/assets/dsny/zerowaste/businesses/commercial-food-waste.shtml> and <http://www.nyc.gov/html/planyc/html/sustainability/composting-organic-waste-diversion.shtml>
- California 2014. California Legislative Information. 2014. Assembly Bill No. 1826. Chaptered September 28, 2014. http://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1826;
- City of Portland Bureau of Planning and Sustainability 2014. *Administrative Rules: Business Solid Waste, Recycling and Composting*. <https://www.portlandoregon.gov/auditor/27430?a=294930>;
- Rhode Island General Assembly. 2014. An Act Relating to Health and Safety—Food Residuals Recycling. Revised June 30. <http://webserver.rilin.state.ri.us/BillText/BillText14/HouseText14/H7033Aaa.pdf>;
- Seattle Public Utilities. 2014. Ban Ordinances on Recyclables in Garbage. <http://www.seattle.gov/util/myservices/garbage/aboutgarbage/solidwastepans/aboutsolidwaste/banordinance/>

4. Food Waste Used as Animal Feed

4.1 Introduction

The collection of excess food for animal feed may be a viable option for restaurants, retailers, or wholesalers located close to local farms. However, regulations control the type of food that may be used and how food is handled. These regulations vary from state to state. For example, 48 states regulate feeding waste containing meat to livestock and 17 of those states prohibit the feeding of waste containing meat to swine and/or other livestock. The remaining 31 states allow feeding treated food waste containing vegetables and/or meat (cooked at a specified temperature for a specified amount of time to reduce the risk of foreign animal diseases in livestock and to eliminate any other harmful pathogens); the responsibility of licensing, monitoring, and enforcement may be carried out at the federal level, state level, or both, depending on the state.¹³ At the federal level, the 1980 Swine Health Protection Act is the primary regulation that affects the use of food as animal feed.

4.2 Methodology and Results

The amount of commercial sourced food diverted as animal feed from 2000 through 2010 was previously estimated by EPA.¹⁴ EPA developed the 2000 to 2010 time series estimate of the quantity of food being fed to animals using the Food Waste Reduction Alliance (FWRA) survey value¹⁵ and the amount of wholesale and retail food loss each year based on the United States Department of Agriculture Economic Research Service (USDA-ERS) Loss-Adjusted Food Availability data.¹⁶ The 2011 FWRA value was 0.7 percent of the USDA ERS retail to consumer (i.e., commercial) food loss values. Because of the lack of other data to extrapolate the values over the historical time series, EPA assumed that similar to 2010, 0.7 percent of the wholesale and retail food loss each year between 2000 and 2009 would become animal feed.

To extend the time series after 2010, an alternate method was developed using more current data. To estimate the food diverted for animal feed for 2011 through 2014, EPA first calculated the amount of commercial food generated in 2010: 15,610,000 tons.¹⁷ Using the previously estimated commercial food diverted to animal feed in 2010 (116,000 tons, as shown in Table 7) EPA developed a revised percentage of 0.74 ($116,000 \div 15,610,000$). This percentage (0.74) was applied to EPA's estimate of commercial food generation from 2011 through 2014 to estimate commercial food diverted for animal feed. Table 7 summarizes the results.

Table 7. Amount of Food Used for Animal Feed

| Year | Amount of Food Used for Animal Feed (1,000 Tons) ^{(1) (2)} |
|------|---|
| 2000 | 107 |
| 2001 | 107 |
| 2002 | 109 |
| 2003 | 110 |
| 2004 | 112 |
| 2005 | 112 |
| 2006 | 113 |
| 2007 | 114 |
| 2008 | 114 |
| 2009 | 112 |
| 2010 | 116 |
| 2011 | 118 |
| 2012 | 118 |
| 2013 | 122 |
| 2014 | 125 |

(1) 2004–2013: U.S. EPA. (2015). "Postconsumer Food Diverted Through Donation, Animal Feed, Anaerobic Digestion, and Composting for 2013". April.

(2) 2014: EPA's commercial food waste generation multiplied by 0.74. EPA 2016 working papers Table Q-01 Food Waste Generation and Composting. April. Unpublished.

EPA developed a second estimate of food diverted to animal feed using an alternate calculation method. Although food may be fed to other livestock species, it has most often been used as a source of feed for swine.¹⁸ EPA applied the steps below for this estimate:

1. Assuming most of the diverted food going to animal feed is used for swine; EPA collected swine population data and gathered information about the typical amounts of wasted food fed to hogs. In 2001, about 50,000 pigs throughout the United States were being fed wasted food.¹⁹ A more recent estimate was unavailable, so EPA assumed that the percentage of pigs being fed wasted food has not changed significantly since 2001.
2. EPA assumed that 9 pounds of food per pig per day is fed for hogs weighing less than 100 pounds, and 20 pounds of food per pig per day is fed for hogs greater than 100 pounds.²⁰
3. Using total U.S. swine count estimates for 2001 and 2013,²¹ EPA extrapolated the number of swine being fed wasted food in 2013, separated into two weight groups (over and under 100 pounds).
4. The pounds/pig/day values were applied to the swine counts, yielding a total estimate of 140,500 tons (281 million pounds) of wasted food going to swine in 2013.

The estimate produced by the second method is 15 percent higher than the estimate described above and shown in Table 7. The second estimate is potentially inflated because the percentage

of pigs being fed food may have decreased since 2001. For instance, according to the article from Scripps Howard News Service by Gay, about 70 operations in North Carolina (one of the biggest pork producing states in the nation²²) were garbage feeders in 2001, but a North Carolina USDA representative reported only 34 swine operations were feeding on wasted food in 2013.²³

5. *Anaerobically Digested Food Waste*

5.1 *Introduction*

Anaerobic digestion systems are widely used at livestock farms and water resource recovery facilities (WRRFs). The Federal Biogas Roadmap 2014 identified 239 farm-based anaerobic digestion systems in operation and more than 1,200 WRRFs with anaerobic digesters in the U.S.²⁴ Due to bans prohibiting the disposal of commercial food waste in landfills in several states and cities, there are an increasing number of anaerobic digestion systems dedicated solely to processing food waste, commonly referred to as source-separated organics. In addition, food waste is being co-digested at an increasing number of digesters located at farms and WRRFs. The facilities are able to generate revenue through tipping fees from organic waste haulers and also benefit from increased production of biogas.

The following sections further discuss the disposition of digestate from farm-based anaerobic digesters, WRRFs with anaerobic digestion, and digesters designed to process source-separated organics.

5.2 *Farm-based Anaerobic Digesters*

Anaerobic digestion systems on livestock farms use animal manure as a feedstock and are typically low-solids systems. The digestate is often separated into liquid and solid components. The liquid digestate from on-farm systems is typically land-applied to local fields. If the nutrient load from the liquid digestate is in excess of what the local fields can handle, then the liquid digestate may be sent to a landfill. Separated solids from the digestate are commonly used for cow bedding.

In many instances, farm-based anaerobic digestion systems are designed and built with excess capacity to accommodate livestock increases. There are recent examples of farm-based anaerobic digestion systems that have been designed with excess capacity for the purpose of accepting and processing food waste. For example, the anaerobic digester at Barstow's Longview Farm in Massachusetts processes 9,125 tons of manure and 14,000 tons of food waste per year. The digester is operated by Casella Organics and produces 30,000 tons of digestate per year, which is used as an organic liquid fertilizer.²⁵ In 2014, the farm began receiving material from a Whole Foods Market in the Boston area, which is using a system to grind the food waste into a liquid slurry that can then be pumped into the digester.²⁶ A nearby farm with a similar system, also operated by Casella Organics, uses digestate as fertilizer on their hay fields and observed that hay yields increased approximately 25 percent after using the digestate. The farm has saved approximately \$40,000 in avoided nitrogen fertilizer expenses.²⁷

5.3 *Anaerobic Digestion at Water Resource Recovery Facilities*

Water Resource Recovery Facilities (WRRFs) have been using anaerobic digestion to produce biogas for heat and power since the 1920s. It has become a common practice for WRRFs to enhance biogas production by adding fats, oil, and grease (FOG) to digesters. The co-digestion of other types of food waste, including municipally collected food waste and byproducts from food processing facilities, is also becoming increasingly common at WRRFs. The treatment of domestic sewage in a WRRF generates nutrient-rich organic materials called biosolids.

Beneficial uses of biosolids include land application as fertilizer for agriculture or silviculture, landfill alternative daily cover (ADC), composting, mine reclamation and energy generation (e.g., gasification). When biosolids are unable to be used beneficially, they may be combusted with or without energy recovery, landfilled or stored for future use.²⁸ A 2007 survey by the North East Biosolids & Residuals Association (NEBRA) found that in the United States 55 percent of biosolids were applied to soils for agronomic, silvicultural and/or land restoration purposes, while the remaining 45 percent were primarily combusted with or without energy recovery or landfilled.²⁹

In September 2014, EPA published a report, “Food Waste to Energy: How Six Water Resource Recovery Facilities are Boosting Biogas Production and the Bottom Line,” examining the co-digestion practices, performance and experiences of six WRRFs (three in California, two in Wisconsin, and one in Indiana). The WRRFs in Wisconsin and Indiana transported their biosolids to local farms to fertilize the fields and improve soil moisture. California heavily regulates the land application of biosolids and the practice is effectively banned in some counties. As a result, two of the WRRFs in California land apply a portion of their biosolids, while the third WRRF in California sends all of its biosolids to a landfill. Five out of the six WRRFs co-digest with FOG, which is typically obtained from local restaurants, groceries, and bakeries. Three out of the six facilities co-digest with post-consumer food waste. All six of the WRRFs interviewed for the report stated that although co-digestion presents challenges, the benefits outweigh the difficulties and they would recommend that other facilities pursue co-digestion.³⁰

5.4 *Food Waste Digesters*

As municipalities have begun to ban commercial and residential food waste from landfills, a growing number of anaerobic digesters are being designed and built for the sole purpose of processing food waste. The City of San Jose recently completed the first phase of a high-solids anaerobic digestion facility to process organic waste from commercial sources in the city. The facility can process up to 90,000 tons per year of organic waste after the first phase of construction and will be able to process up to 270,000 tons per year once the build-out of the facility is complete. The digestate is composted on-site using in-vessel composting tunnels for four to five days and then moved to an outdoor curing pad for four to five weeks of curing in open windrows.³¹

5.5 Anaerobic Digesters in States with Food Waste Bans

Vermont: Act 148 phases in food waste disposal requirements in Vermont from 2014 through 2020 (see Table 6 for additional detail). The Vermont Waste Management & Prevention Division website provides a list of permitted composting facilities in the state, but does not list any anaerobic digestion facilities permitted for food waste.³² However, a report on the status of anaerobic digestion in New England identifies two WRRFs with anaerobic digesters and five farm-based anaerobic digesters in Vermont that accept food waste or FOG.³³

Massachusetts: Amendments to the Code of Massachusetts Regulations 310 CMR 19.000 banned the disposal of commercial organic material in Massachusetts effective October 1, 2014. The ban applies to commercial facilities that generate more than one ton of food and vegetative material for solid waste disposal per week.³⁴ There are four anaerobic digestion facilities accepting food waste in Massachusetts with a total daily permitted capacity of 312 tons per day.

Connecticut: Public Act 11-217, as amended by Section 4 of Public Act 13-285, provides a phased-in approach to commercial organics recycling in Connecticut. The law requires commercial facilities that generate more than two tons per week of source-separated organics and are located within 20 miles of a permitted recycling facility to recycle source-separated organics effective January 1, 2014. In 2020, the source-separated organics recycling requirement will be expanded to include facilities that generate more than one ton per week of organic waste.³⁵ Three proposed anaerobic digestion facilities in Connecticut have applied for permits to process source-separated organics with a combined capacity totaling 1,200 tons per day.³⁶

Rhode Island: Amendments to R.I. General Laws in Chapter 23-18.9 banned the landfilling of commercial food waste in Rhode Island effective January 1, 2016. The ban applies to commercial facilities that generate more than two tons per week of organic waste material and are located within 15 miles of an authorized composting or anaerobic digestion facility with available capacity to accept the material.³⁷ Construction of one source-separated organics anaerobic digestion facility began in May 2015 with a capacity of 250 tons per day and there is another facility in the planning stage that is expected to be operational by the end of 2016.³⁸

In addition to state-wide bans in Connecticut, Massachusetts, Rhode Island, and Vermont, there are also several cities that have banned the landfill disposal of food waste including San Francisco, Portland, and Seattle. A rule requiring large-scale commercial food establishments in New York City to separate organic waste was proposed in July 2015³⁹ and was later adopted.

5.6 Anaerobic Digestion and Food Waste Trends

Increases in residential collection of food waste (Section 3.4) in conjunction with bans on food waste disposal in many states and cities (Section 3.6) are encouraging the development of new anaerobic digestion projects designed with food waste as the primary feedstock. In addition, increased focus on renewable energy and alternative fuels is also driving the development of new anaerobic digestion projects.⁴⁰

EPA recently completed the “Waste to Biogas Mapping Tool,” which is an interactive map created to connect organic waste producers (e.g. grease rendering facilities or food processing facilities) and potential users for the purpose of biogas production through co-digestion. Co-

digestion is the addition of high strength wastes such as food scraps and fats, oils, and grease (FOG) to WRRFs or farm-based digesters. Co-digesting organic waste materials allows facilities to save and make money while reducing greenhouse gas emissions, providing a renewable energy source, and diverting valuable resources from landfills and/or sewer pipes.⁴¹

As awareness spreads about the potential biogas production gains and revenue from tipping fees associated with adding food waste and FOG to anaerobic digesters at WRRFs and farms, it is likely that more of these facilities will build capacity to co-digest food waste with their existing feedstocks. In addition, farm-based digesters are increasingly being designed with excess capacity to process organic food waste.⁴² However, the development of increased capacity has the potential to increase competition for source-separated organics.

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