Postconsumer Food Diverted Through Donation, Animal Feed, Anaerobic Digestion, and Composting for 2013
U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery
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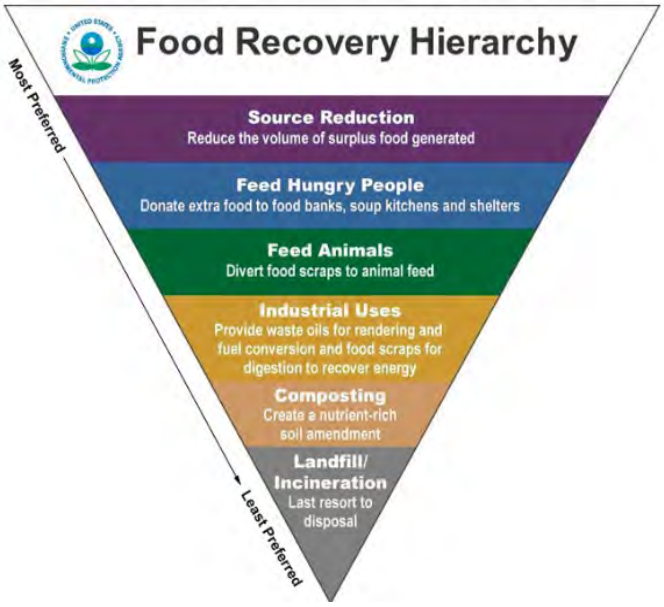
1.0 Introduction

In 2013, 37.06 million tons of postconsumer food ready for end of life management were generated in the United States (U.S. EPA, 2015b). This includes restaurant, grocery, and household food and excludes preconsumer food from food processing facilities, agricultural operations, or other industrial processes. In support of EPA's municipal solid waste (MSW) characterization efforts, EPA's contractor estimated how much postconsumer food was managed through donation, composting, and converting to animal feed. The contractor researched the amount of food diverted through anaerobic digestion; however, the data identified were insufficient to extrapolate to a U.S. total.

The contractor estimated food diversion through donation (Section 2.1) using data from the Food Waste Reduction Alliance (FWRA), Feeding America (FA), and the Food Donation Connection (FDC). To estimate the amount of food diverted from disposal to animal feed (Section 2.2), the contractor contacted representatives of state agencies and various industry organizations including FWRA, as well as conducted literature searches to identify potential data sources. To estimate food diverted through composting (Section 2.4), the contractor gathered food composting data from state environmental agency websites, with follow up to a limited number of states to clarify published data. These calculations are discussed in further detail below.

Not enough data are readily available to estimate the amount of postconsumer food being used as digester influent, or the amount of digestate being disposed of. No centralized data sources exist for the management of food through anaerobic digestion; therefore the contractor has taken steps to compile what information is available through the AgSTAR project database, along with literature searches about the anaerobic digestion systems across the country that are known to accept food as a feedstock (Section 2.3).



2.0 Food Management

Postconsumer food diversion methods covered in this analysis include food donated to feed people, food diverted to feed animals, food processed through anaerobic digestion, and food aerobically composted. EPA's Food Recovery Hierarchy prioritizes actions organizations can take to prevent and divert wasted food.

EPA's contractor identified and reviewed a multi-tiered study that investigated food management methods used in three points in the food supply chain (manufacturing[1], retail/wholesale, and restaurants). The study, aimed at gaining a better understanding of the quantity of food generated, diverted, and disposed of by different sectors in the food industry, was commissioned by FWRA, a workgroup with members from the Food Marketing Institute, the Grocery Manufacturers Association, and the National Restaurant Association. The Tier I Assessment (FWRA, 2012) was an initial attempt to estimate food amounts based on interviews and publicly available reports as of 2011. The Tier II Assessment (FWRA, 2013) analyzed food data gathered through a survey of food manufacturers, grocery retailers, and wholesalers. The Tier II study contained 2011 estimates for food generated, diverted, and disposed of by the retail/wholesale sector and by the manufacturing sector.

FWRA conducted a similar assessment in 2013, the results of which were published in November 2014 and shown in Table 1 (FWRA, 2014). In addition to the manufacturing and retail/wholesale sectors, the restaurant sector was surveyed for this study. This survey was sent to more than 200 individuals and targeted the largest members of FMI, GMA, and NRA to ensure that the companies generating the most food were included in the findings. Table 1 summarizes how much of the reported food generated was diverted and how it was diverted by the respondents.

Table 1. Food generation, diversion, and disposition amounts for surveyed facilities.

Sector and Number of Respondents	Total Food Generated (Tons/Year)[a]	Annual Tons Donated	Annual Tons Composted	Annual Tons Digested[b]	Annual Tons to Animal Feed	Annual Tons Disposed Of
Manufacturing (16)	3,550,000	53,900 (1.5%)	67,400 (1.9%)	3,370 (0.1%)	2,920,000 (82.4%)	181,000 (5.1%)
Retail/wholesale (13)	700,000	69,200 (9.9%)	73,000 (10.4%)	24,600 (3.5%)	77,800 (11.1%)	403,000 (57.6%)
Restaurants (27)	1,050,000	14,500 (1.4%)	32,000 (3.0%)	< 490[c] (< 0.05%)	160 (0.02%)	885,000 (84.3%)

a. Total waste may not equal the sum of the presented amounts for individual diversion methods because not all food management methods are included in this table (e.g. rendering, biofuel, land application, recycling used cooking oil).

b. Includes both anaerobic and aerobic digestion; the report did not differentiate between the two.

c. For the restaurant sector, no value was presented specifically for anaerobic or aerobic digestion, but it is assumed that this diversion, if used, would be covered under the reported "other" category.

The manufacturing sector respondents divert most of their food to animal feed (82.4 percent). The retail/wholesale sector diverts about evenly to donation to people (9.9 percent), composting (10.4 percent), and animal feed markets (11.1 percent). The restaurant sector respondents divert about twice the amount of food to composting versus donations (3.0 percent versus 1.5 percent). Restaurant sector respondents reported the highest percentage of food still going to disposal (84.3 percent). While this study provides a better understanding of the current state of food diversion in the food industry, its scope is limited to the relatively small sample space of businesses that

[1] Although preconsumer food quantities are not included in the analyses presented in this memorandum, the results of the industry report are presented for both pre- and postconsumer food (industrial and retail/wholesale and restaurants) as an overview of management.

provided data[2] and cannot easily be used to extrapolate quantitative information on a national scale. According to the report, there were 56 survey respondents, which represented 17.0 percent of the manufacturing sector, 31.8 percent of the retail sector and 15.2 percent of the restaurant sector by revenue.

2.1 Food Donation

Apart from reducing food at the source, the most desirable food management practice is to divert food through food donation. Each year, significant amounts of food products are donated by residents and commercial establishments[3] (e.g., grocery stores, restaurants) to local food banks and charities to feed people. Some of these donations divert food from the solid waste stream that would otherwise need to be managed through feeding animals, anaerobic digestion, composting or disposal. Regulations governing how food is donated vary from state to state, but at the federal level, the 1996 Bill Emerson Good Samaritan Food Donation Act[4] is the primary regulation affecting food donation programs. The law protects good faith food donors from civil and criminal liability should the product later cause harm to its recipient. Furthermore, it gives uniform federal protection to donors who may cross state lines (FDC, 2014). Even so, misinformation about regulatory constraints (which impact, for instance, good food past saleable date or food bank acceptance limitations) is among the most commonly noted barriers to food donation efforts. Other barriers include transportation costs, lack of refrigerated trucks and drivers chain of custody issues, or insufficient onsite storage and refrigeration (FWRA, 2013).

It is often difficult to differentiate between the literature's data on food donation diversion—i.e., wholesome but not-for-retail food products diverted from the waste stream—and data on charitable food donations of saleable products. (The latter does not result in diverted waste.) This section provides an overview of available information used to quantify national food diversion through donation of wholesome but not-for-retail foods.

FA and FDC are among the largest food donation organizations in the United States. FA comprises over 200 food banks and 60,000 food pantries and meal programs across the United States and supplies food to those in need. Among other programs, FA runs a retail store donation (RSD) program, which coordinates the donation of surplus food from over 10,500 grocery stores representing the country's largest firms in the food retail industry. FDC consists of 277 business entities and nearly 14, 600 food service locations (including restaurants, airports, travel plazas, retailers, universities, hospitals, and distribution centers) and coordinates the donation of surplus food from these facilities—food that would otherwise be handled through the solid waste management system.

According to FA's *2013 Annual Report* (FA, 2013), around 888 million meals were donated through FA's RSD program in 2013. The report estimates an average of 1.2 pounds of food per meal, yielding a total 532,800 tons of food donated. According to FDC's website (FDC, 2014), 36 million pounds (18,000 tons) of food were donated through FDC programs to around 7,900 hunger relief programs.

Summing the total donations attributed to these two organizations yields a total of 551,000 tons of food diverted from landfills disposal to feeding those in need. This constitutes about 1.5 percent of the total U.S. food generated

[2] See source document (FWRA 2014) Appendix A: Additional Analysis Details for data availability and accuracy discussion.
[3] Although the food manufacturing sector also diverts food through donation, the focus of this analysis is postconsumer food waste, so preconsumer food from the manufacturing sector is not considered in the calculations herein.
[4] Public Law 104 – 210: http://www.gpo.gov/fdsys/pkg/PLAW-104publ210/content-detail.html.

in 2013. Table 2 summarizes the FA and FDC program results for years 2004 through 2013. The food donations have grown by a factor of four, from 130,000 tons in 2004 to 551,000 tons in 2013.

Table 2. Food donation programs representing food diversion through donation.

Year	EPA Estimate of Food Generation (Tons)[a]	Retail Store Donation Program (Tons)[b]	Food Donation Connection (Tons)[c]	Total (Tons)	Percentage of U.S. Food Donated
2004	32,460,000	125,000	5,000	130,000	0.4%
2005	32,930,000	132,000	7,000	139,000	0.4%
2006	32,270,000	139,000	8,000	147,000	0.5%
2007	33,560,000	146,000	9,000	155,000	0.5%
2008	34,300,000	160,000	11,000	171,000	0.5%
2009	35,270,000	217,000	11,000	228,000	0.6%
2010	35,740,000	273,000	15,000	288,000	0.8%
2011	36,310,000	330,000	18,000	348,000	1.0%
2012	36,430,000	450,000	18,000	468,000	1.3%
2013	37,060,000	533,000	18,000	551,000	1.5%

a. 2004–2013: EPA MSW characterization reports (http://www.epa.gov/osw/nonhaz/municipal/msw99.htm).
b. 2004–2012: EPA's "Food Waste Loss and Donation" memorandum (May 2013).
2013: Calculated based on FA, 2013.
c. 2004–2012: Communication with Jim Larson, a representative from FDC.
2013: FDC, 2014.

2.2 Animal Feed

The recovery of discarded food as 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, 25 states prohibit feeding waste containing meat to livestock. The remaining states allow feeding treated waste (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 (Porter-Spalding, 2015). At the federal level, the 1980 Swine Health Protection Act is the primary regulation that affects the use of food as animal feed.

The amount of food diverted as animal feed from 2000 through 2010 was previously developed by EPA (U.S. EPA, 2014a). EPA developed the 2000 to 2010 time series estimate of the quantity of food being fed to animals using the FWRA survey value and the amount of wholesale and retail food loss each year based on USDA ERS Loss-Adjusted Food Availability data (USDA, 2013a). 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 estimate the food diverted for animal feed for 2011 through 2013, the contractor first calculated the amount of commercial food generated in 2010: 15,610,000 tons (U.S. EPA, 2014b). Using the previously estimated commercial food diverted to animal feed in 2010 (116,000 tons, as shown in Table 3) the contractor developed a revised percentage of 0.74 (116,000 ÷ 15,610,000). This percentage (0.74) was applied to EPA's estimate of commercial food generation from 2011 through 2013 to estimate commercial food diverted for animal feed. Table 3 summarizes the results.

Table 3. Amount of food used for animal feed.

Year	Amount of Food Used for Animal Feed (1,000 Tons)[a, b]
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

a. 2004–2010: U.S. EPA, 2014a.

b. 2011–2013: To create these estimates, the contractor multiplied EPA's annual estimates of commercial food generation by 0.74.

The contractor 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 (Farms.com, 2011). The contractor applied the steps below for this estimate:

1. Assuming most of the diverted food going to animal feed is used for swine; the contractor collected swine population data and gathered information about the typical amounts of food fed to hogs. In 2001, about 50,000 pigs throughout the United States were being fed food (Gay, 2001). A more recent estimate was unavailable, so the contractor assumed that the percentage of pigs being fed food has not changed significantly since 2001.

2. The contractor 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 (Westendorf and Myer, 2004).

3. Using total U.S. swine count estimates for 2001 and 2013 (USDA, 2001, 2013b), the contractor extrapolated the number of swine being fed 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 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 3. The contractor believes 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 by Gay, about 70 operations in North Carolina (one of the biggest pork producing states in the nation (USDA, 2013b)) were garbage feeders in 2001, but a North Carolina USDA representative reported only 34 swine operations were feeding food in 2013 (Schaefbauer, 2014).

2.3 Anaerobic Digestion

Anaerobic digestion (AD) is often used at wastewater treatment plants to treat biosolids, and on farms to treat animal manure. This process uses bacteria to break down organic matter in an oxygen-free environment, yielding biogas (comprising methane and carbon dioxide) that can be used to generate energy. Digester effluent is often land-applied, and sometimes the solids from the effluent are removed and converted into soil amendment or animal bedding. It is therefore worth noting that the total mass of food going to anaerobic digestion cannot entirely be considered diverted, because a portion of the influent remains after digestion and may be disposed of by land application.

In addition to biosolids and manure, some facilities may use other organics, including food, as a supplement to AD. Co-digestion of food can be beneficial because existing infrastructure can be used to divert organic materials from the waste stream and these materials can be used to adjust the percent of solids for optimal digestion and increase biogas production. Food is more readily digestible than biosolids, so methane production from food can be three times greater than that of sewage sludge. For instance, food may have a methane production potential of more than 300 cubic meters of methane per ton of feedstock, while the methane production potential of biosolids is around 120 cubic meters per ton, and for cattle manure only 25 cubic meters per ton (EPA, 2015a).

The American Biogas Council (ABC, 2014) reports about 1,500 digesters operating at wastewater treatment plants (WWTP) throughout the United States. According to EPA's Combined Heat and Power Partnership (U.S. EPA, 2011), as of June 2011 there were 1,454 WWTPs with AD, and 104 of these facilities were using digester gas as their primary fuel source. However, it is unclear whether any food is co-digested with the wastewater. As

there is no centralized database documenting the details of these systems, the total number of these digesters that accept food is not known.

EPA's AgSTAR database tracks on-farm and regional digesters that accept livestock manure (AgSTAR, 2014). Of the reported 244 digester systems operating, the database lists around 45 projects that co-digest food with manure. It is important to note, however, that AgSTAR's definition of food includes food processing waste, so only a subset of these digesters are likely using postconsumer food.

Although the majority of known AD systems in the United States are primarily for treating manure and biosolids, new AD technologies have been developed that are better suited to process the high solids content of food and yard waste in MSW. For example:

- The dry fermentation AD facility in Marina, California, operated by Zero Waste Energy and the Monterey Regional Waste Management District is designed to process up to 3,500 tons of commercial and institutional food and 1,500 tons of yard waste per year (Beane, 2013). No additional water is required for the system, which collects and reuses water from the decomposing waste. The biogas produced is combusted in a combined heat and power unit. Digester processes use the heat and 5 percent of the electricity generated. The remaining electricity is sold to the Monterey Regional Water Pollution Control Agency, supplying about 10 percent of the wastewater treatment plant's electricity demand (Beane, 2013).
- The CleanWorld plant in Sacramento, California, is a high-rate, high-solids anaerobic digester that utilizes anaerobic phased solids technology (CleanWorld, 2014a). The digester processed 25 tons of commercial and institutional food per day in 2013; a plant expansion to 100 tons per day in 2014 should produce the equivalent of 1 million kilowatt hours of electricity and 700,000 gallons of diesel in the form of compressed natural gas to fuel the Atlas Disposal waste collection fleet and Sacramento city vehicles (CleanWorld, 2013, 2014c).

An additional benefit of the AD facilities that process only food, yard, and agricultural wastes is that the digestate is usually composted and sold as a soil amendment (Beane, 2013; CleanWorld, 2014b). Consequently, virtually 100 percent of the food in these types of systems is diverted from the waste stream.

Due to the lack of centralized, publicly available data on these systems, EPA's contractor conducted literature reviews to identify digesters known to digest or co-digest food. Table 4 lists the 109 facilities identified; 60 of the operations co-digest manure and food. Where data were available, digested postconsumer food amounts range from 1 ton per day from small-scale operations (institutional dining hall food, for instance) to capacities of 150 tons per day for larger operations. Higher values are also reported, but preconsumer and postconsumer waste cannot be distinguished in these cases for comparison.

As the table shows, these digesters vary significantly in capacity and in terms of what types of food are accepted. Note that this list of facilities is not exhaustive, nor are the associated data pertaining to influent volumes and mass reduction. The contractor was therefore unable to quantify total postconsumer food diverted through AD on a national scale. Likewise, the disposition of the AD digestate from food could not be estimated.

Table 4. Anaerobic digesters identified that digest or co-digest food.

Name	Location	Type of Waste	Amount Processed	Digestate Disposal/ Mass Reduction	Sources/ Notes
Allenstown WWTP	Allenstown, NH	Food or fats, oils, grease (FOG)			24
Amana Farms	Amana, IA	Cattle manure; food or FOG			19, 24
American River Packaging (ARP) Digester	Sacramento, CA	Designed for 9.5 tons/day commercial food processing and retail food along with 0.5 tons of unrecyclable corrugated cardboard	8 tons/day	Fertilizers/soil amendments	13
Bach Digester, LLC	Dorchester, WI	Dairy manure; unspecified food			19
Barham Farms	Zebulon, NC	Swine manure; unspecified food			19
Bennington WWTP	Bennington, VT	Food or FOG			24
Blue Spruce Farm	Bridport, VT	Dairy manure; food or FOG			19, 24
Bortnick Dairy	Conneautville, PA	Dairy manure; food (90–95% wet corn paste from formation of pelletized dog food)			19
Boxler Dairy	Varysburg, NY	Dairy manure; organic wastes (silage leachate and food)			19
Brattleboro WWTP	Brattleboro, VT	Food or FOG			24
Brookside Dairy	Homer City, PA	Dairy manure; food (waste from local cheese factory)			19
Brubaker Farms	Mount Joy, PA	Dairy manure; dry chicken manure, food			19
Buckeye Ridge	LaFarge, WI	Food or FOG			24
Cayuga Regional Digester Bioenergy Enterprise	Auburn, NY	Dairy manure; food (10 tons/week organic potato solid waste clippings [25% TS] and 24,000 gallons/week organic liquid potato wastewater sludge [5.7% TS]; 5 tons/day grease trap fat/cooking fats [18% TS])			19
Chaput Family Farms	North Troy, VT	Dairy manure; agricultural substrates (fish processing waste, waste grain, food, waste dairy products, waste crops, or crops grown specifically for digester)			19
City of Millbrae, CA	Millbrae, CA	FOG			18
City of Pendleton WWTP	Pendleton, OR	Food or FOG			24
City of Riverside	Riverside, CA	Fats, oils, grease from local restaurants and food processing plants	25,000 gallons per day FOG		2, 15
CleanWorld—Sacramento	Sacramento, CA	Ag residues, food processing wastes, restaurant and supermarket food	40,000 tons/year	10 million gallons/year of fertilizer and soil amendments	10
Collinwood Facility	Cleveland, OH	Dairy manure; food			19, 24
Crapo Hill Landfill	Dartmouth, MA	Food			24
CRMC Bio Energy	New Bedford, MA	Commercial/industrial food, organic sludges, FOG or other liquid or slurried non-hazardous organics.			24

Name	Location	Type of Waste	Amount Processed	Digestate Disposal/ Mass Reduction	Sources/ Notes
Des Moines, IA Major FOG/Co-Digestion Program	Des Moines, IA	Industrial greases + FOG/others			18
Dovan Farms	Berlin, PA	Dairy manure; food			19
East Bay Municipal Utility District (EBMUD)—BAAD study	Oakland, CA	Food	22,000 tons/year	Landfill cover/land application	2
Essex Junction WWTP	Essex Junction, VT	Food or FOG			24
Farm Power Lynden	Lynden, WA	Dairy manure; food (substrates)			19
Farm Power Rexville	Mount Vernon, WA	Dairy manure; food (substrates)			19
Five Star Dairy Farm	Elk Mound, WI	Dairy manure; substrate (high-fat food such as greases and oils)			19
Forest County Potawatomi Community	Millwaukee, WI	Food			24
Freemont Community Digester	Freemont, MI	Swine manure; unspecified food			19, 24
Garelick Farms – Lynn	Lynn, MA	Industry food			24
Garelick Farms – Franklin	Franklin, MA	Industry food			24
GenEarth Berkeley	Moncks Corner, SC	Food or FOG			
Gervais Family Farm	Enosburg Falls, VT	Dairy manure; food or FOG			19, 24
Gills Onions	Oxnard, CA	Onion peel juice	150 tons of peels per day		2, 3
Gloversville—Johnstown WWTF	Johnston, NY	Food processing waste from yogurt and cheese plants, and also dissolved air flotation sludge from dairy industry			2, 12
Goodell Farm	Westminster, VT	Food or FOG			24
Green Mountain Dairy, LLC	Sheldon, VT	Dairy manure; food (ice cream substrate from nearby Ben & Jerry's plant)			19
Gresham Waste Water Treatment Plant	Gresham, OR	Food or FOG			24
Hard Earned Acres	Shippensburg, PA	Dairy manure; food			19
Harvest Power—Orlando	Orlando, FL	Biosolids and food from restaurants and hospitality industry (pre- and postconsumer) and food processors (preconsumer)	120,000 tons/year (capacity)		7, 9
Hill Canyon WWTP	Thousand Oaks, CA	Food or FOG			24
Hillcrest Dairy (formerly New Horizons)	Elmwood, IL	Dairy manure; crop wastes, food, haylage, and cooking grease			19
Holsum Dairy—Elm Road	Hilbert, WI	Dairy manure; food (non-farm food processing waste from three industries)			19
Humboldt County Waste Authority	Eureka, CA	Still in assessment; not operational yet			2, 16
Ideal Family Farms	Beavertown, PA	Swine manure; food			19

Name	Location	Type of Waste	Amount Processed	Digestate Disposal/ Mass Reduction	Sources/ Notes
Inland Empire—Environ	Chino, CA	Mostly food, some dairy waste	700 tons/day capacity		2, 7
Janesville WWTP	Janesville, WI	Food or FOG			24
Jordan Farms/AGreen Energy, LLC	Rutland, MA	Dairy manure; food			19
Ken's Foods	Framington, MA	Industry food			24
Kish View Farm Partnership	Belleville, PA	Dairy manure; food or FOG			19, 24
Kroger Food Waste to Biogas AD Plant	Compton, CA	Food that cannot be sold or donated; onsite food-processing effluent	55,000 tons/year (capacity)	Digested solids are composted	1
Landyshade Farms	Lancaster, PA	Dairy manure; food			19
Lawnhurst Energy	Stanley, NY	Dairy manure; food or FOG			19, 24
Lochmead Farms	Junction City, OR	Dairy manure; food or FOG			19, 24
Longview Farms/Bgreen Energy LLC	Hadley, MA	Dairy manure; food		Land applied—no solids separation	19, 20
Maplehurst Farm	Greenboro, VT	Dairy manure; food or FOG			19, 24
Marin County—Central Marin Sanitary Agency Food to Energy	Marin County, CA	Biosolids mixed with commercial food, FOG	Up to 5,000 gallons/day FOG; up to 15 tons/day commercial food	During dry weather season, solids used as fertilizer for growing hay and alfalfa for horse and livestock feed; during wet weather, digestate hauled to landfill for use as alternate daily cover	2, 14
Maxwell Farm/ Neighborhood Energy, LLC	Coventry, VT	Dairy manure; waste food products (waste grain, waste dairy products, waste crops, crops grown specifically for use in digester)			19
Mill Creek Dairy	West Unity, OH	Dairy manure; food			19
Montagne Farm	St. Albans, VT	Dairy manure; food or FOG			19, 24
MSU Digester	Lansing, MI	Dairy manure; food			19
Napoleon Biogas	Napoleon, OH	Dairy manure; food, WWTP sludge			19
Niagra Bioenergy	Wheatfield, NY	Food			24
Norswiss Farms	Rice Lake, WI	Dairy manure; off-farm food (whey, slaughterhouse, food station, mostly grease)			19
Novi Energy Digester	Freemont, MI	Swine manure; food processing residuals			19
Oak Hill Farm	Nottingham, PA	Swine and cattle manure; food			19
Patterson Farms	Auburn, NY	Dairy manure; industry food			24
Pine Island Farm	Schffield, MA	Dairy manure; food or FOG			24
Pinellas County	Clearwater, FL	FOG	30,000 gallons per day FOG		15, 17
Purdue University—West Lafayette	West Lafayette, IN	Fats, oil, and grease (FOG) from restaurants, food stores, food from Purdue dining halls	1–2 tons/day from dining courts		11
Qualco Energy	Monroe, WA	Dairy manure; food: "chicken blood, trap grease, pulp, whey, expired beer, wine and soda"			19, 21

Name	Location	Type of Waste	Amount Processed	Digestate Disposal/ Mass Reduction	Sources/ Notes
Quasar Energy Group—central Ohio	Columbus, OH	Dairy manure; mixed biomass (biosolids, regional food, fats, oils, grease)			19
Quasar Energy Group—Wooster	Wooster, OH	Dairy manure; food, grass, crop waste			19
Reinford Farms	Mifflintown, PA	Heifer manure; commercial food (outdated food no longer eligible for sale in stores, from about 50 Wal-Mart locations in Pennsylvania and nearby grocery stores—waste that normally would have ended up in landfills)	80 tons/week food	Solids separated and used for bedding and sold to other farms; liquid to storage pond and land-applied; total solids reduction of 10.3%	19, 22
Reinford-Frymoyer Farm	Mifflintown, PA	Dairy manure; food		Solids separated and used for bedding and sold to other farms; liquid to storage pond and land-applied; total solids reduction of 10.3%	19, 23
Reno-Sparks Truckee Meadows WRF	Sparks, NV	Still in planning/construction			15
Ridgeline Farm	Clymer, NY	Dairy manure; food or FOG			24
Ringler Energy, LLC	Cardington, OH	Swine manure; food (food sludge, whey, yeast, popcorn residual, taco meat)			19
S & A Kreider Farms	Quarryville, PA	Dairy manure; food			19
St. Pierre/ Pleasant Valley Farms	Berkshire, VT	Dairy manure; food or FOG			19, 24
Sacramento County Co. Regional WWTP	Sacramento, CA	Source-separated organics, cans of off-spec food packaged and unpackaged food is collected by local haulers from dining halls at UC Davis, grocery stores, correctional facilities, and food processors; yard waste also accepted	Original capacity of 25 tons/year; 100 tons/day by 2014		2, 13
Scenic View Dairy—Fennville	Fennville, MI	Dairy and swine manure; food processing waste (syrup stillage from ethanol plant; crude glycerine from biodiesel plant)			19
Schrack Farms Partnership, LLC	Greene Twp, PA	Dairy manure; food or FOG			24
Sensenig Farm	Kirkwood, PA	Dairy, swine, and poultry manure; food			19
Sheboygan Regional Wastewater Treatment Facility	Sheboygan, WI	Food or FOG			24
Santa Monica WWTP	Santa Monica, CA	Food or FOG			24
Stargest Power/ Five Star Dairy Farm	Elk Mound, WI	Food or FOG			19, 24
Stonyvale Farm/Exeter Agri-Energy, LLC	Exeter, ME	Dairy manure; food			19
Storms Farm Waste to Energy Digester Facilities	Bladenboro, NC	Swine manure, swine mortality, poultry litter, and off site food, DAF, and FOG			19, 24

Name	Location	Type of Waste	Amount Processed	Digestate Disposal/ Mass Reduction	Sources/ Notes
SUNY at Morrisville	Morrisville, NY	Dairy manure; food /organic waste			19
Synergy Dairy—Covington	Covington, NY	Dairy manure; organic food and agricultural residue			19
Theresa St. WWTP	Lincoln, NE	FOG/wastes			18
UC Davis Renewable Energy Anaerobic Digestion facility	Davis, CA	Not operational yet—source-separated organics from UC Davis campus and other area generators	20,000 tons/year starting in 2014		13
UC Irvine/ Waste Management of Orange County Pilot Plant	Orange County, CA	Dining hall food	>400 tons/year		2, 6
University of Wisconsin	Oshkosh, WI	Pre- and postconsumer food, yard waste, animal bedding waste, and curbside organics	10,000 tons/year	Composted and sold as soil amendment	2, 8
Vander Haak Dairy	Lynden, WA	Dairy manure; egg breakage, fish solids, food breading, sauce, other feedstocks (substrates)			19
Vermont Tech Community AD	Randolph, VT	Dairy manure; food			19, 24
Village of Ridgewood WWTP	Ridgewood, NJ	Food or FOG			24
Waste No Energy	Monticello, IN	Swine and cattle manure; restaurant waste, outdated grocery and bakery goods, food industry waste, restaurant waste (FOG), and others	Up to 100–125 tpd organic waste, including 22 tpd swine manure and 4 tpd cattle manure	Effluent used as organic fertilizer source (30,000 gallons per day) and sold to area farmers	19, 23
Watsonville, CA	Watsonville, CA	FOG			18
Western Plains Energy	Oakley, KS	Cattle manure; food			19, 24
Westminster Farms	Putney, VT	Dairy manure; agricultural substrates (waste grain, food, whey, crops, manure from neighboring farms)			19
Wild Rose Dairy	LaFarge, WI	Dairy manure; food (grease and fats from local restaurants)			19
Yippee! Farms	Mount Joy, PA	Dairy manure; food			19
Zero Waste Energy—Monterey	Monterey, CA	70–80% Municipal organics (food, paper) and yard waste	90,000 tons/year capacity	High-quality compost; 63% mass reduction	2, 5
Zero Waste Energy—San Jose	San Jose, CA	Municipal organics (food, paper)	5,000 tons/year capacity	High-quality compost; 56% mass reduction	2, 4
Zuber Farms	Byron, NY	Dairy manure; food (milk processing waste sludge, powdered milk processing waste, wasted milk, tomato paste)			19

Table 4 Sources/Notes:

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2. http://www.renewable-waste.com/pdf/AnaerobicDigestionEbrief.pdf
3. http://www.gillsonions.com/waste-to-energy (Only juice is digested; onion pulp repurposed as cattle feed. All was land-applied before digestion system installed.)
4. http://zerowasteenergy.com/what-we-do/our-projects/city-of-san-jose/
5. http://zerowasteenergy.com/what-we-do/our-projects/monterey-regional-waste-management-district/
6. http://www.ocregister.com/articles/waste-538707-food-irvine.html
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22. http://extension.psu.edu/natural-resources/energy/waste-to-energy/resources/biogas/documents/reinford-1209.pdf
23. http://www.wastenoenergyllc.com/operations/
24. Data provided by EPA Region 3.

2.4 Composting

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 (Platt and Goldstein, 2014).

Use of composting to manage residential and commercial food has grown considerably in recent years, as people learn how composting converts food from MSW into a valuable soil amendment and waste management professionals search for ways to divert organics from rapidly filling landfills. The contractor gathered food composting statistics from 35 state environmental agency websites, resulting in an estimated 1.47 million tons of postconsumer food[5] diverted through composting in 2013. The state-by-state statistics are shown in Table 5.

This section also includes statistics on residential curbside food collection programs, a list of city and state regulations banning commercial food landfill disposal, and number of food composting facilities. Collection programs, regulations, and infrastructure drive the quantity of food diverted through composting.

Recent growth in the number of residential curbside composting programs that accept food indicates that diversion of food through composting is likely to increase in the near future. A nationwide survey by *BioCycle* summarized the availability of residential curbside food collection programs in the United States (Yepsen, 2013). Research by the contractor identified 26 more communities offering residential curbside food collection programs in conjunction with MSW hauling services, for a total of 209 communities across 16 states in 2013. Table 6 shows that these residential curbside collection programs were available to 2.7 million households, which is 2 percent of all U.S. households in 2013. Curbside food collection programs continue to grow in 2014 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 (Denver Public Works, 2013; NYC Department of Sanitation, 2014b; Austin Resource Recovery, 2014; Cambridge Department of Public Works, 2014; Town of Ipswich, 2014; GreenSalem, 2014; Town of Manchester-by-the-Sea, 2014).

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-

[5] An additional 0.37 million tons of mixed MSW containing food waste was composted in 2013 (U.S. EPA, 2015b).

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. Some examples are Garbage to Garden in southern Maine; Veteran Compost and Remotion in Baltimore and Washington, D.C.; Fat Worm Compost and Compost Cab in metro Washington, D.C.; Blue Earth Compost in Hartford, Connecticut; and Evergreen Events in Roaring Fork Valley, Colorado.

Table 5. State-by-state food composting.

	Food Composted	
	(Tons)[a]	(Data Year)[b]
Alaska	24	2009
California	715,119	2012
Colorado	29,130	2013
Connecticut	5,178	2011
Delaware	12,701	2012
Florida	97,723	2013
Georgia	4,619	2009
Hawaii	38,466	2013
Indiana	13,525	2013
Iowa	4,334	2010
Kansas	1,127	2010
Maine	1,658	2010
Maryland	13,269	2013
Massachusetts	6,136	2013
Michigan	8,700	2013
Minnesota	23,466	2013
Mississippi	121	2012
Missouri	270	2011
Montana	1,000	2010
Nevada	69,882	2013
New Hampshire	110	2012
New Jersey	28,474	2011
New York	44,405	2013
North Carolina	29,040	2013
Ohio	51,372	2012
Oregon	47,665	2012
Pennsylvania	74,545	2012
South Carolina	5,148	2013
South Dakota	14,200	2008
Tennessee	1,500	2013
Texas	165	2012
Vermont	3,735	2012
Virginia	2,178	2013
Washington	109,652	2011
Wisconsin	8,677	2013
Total Composted (tons/yr)	1,467,314	

a. State environmental websites search supplemented with personal contacts.
b. Latest data available.

Table 5 Sources/Notes:

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2. California: BioCycle. U.S. Residential Food Waste Collection and Composting. Table 2. 2012 Data - http://www.biocycle.net/2013/03/residential-food-waste-collection-in-the-u-s-biocycle-nationwide-survey/
3. Colorado: David Snapp. Colorado DPHE. December 2014.
4. Connecticut: http://www.ct.gov/deep/lib/deep/reduce_reuse_recycle/data/average_state_msw_statistics_fy2011.pdf. Table 3
5. Delaware:http://www.dnrec.delaware.gov/dwhs/Recycling/Documents/The%20Twelfth%20Annual%20RPAC%20Report.pdf. Appendix C, Table 2.
6. Florida: http://appprod.dep.state.fl.us/www_rcra/Reports/WR/Recycling/2013AnnualReport/AppendixB/5B-3.pdf
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12. Maine: George McDonald. MDP Sustainability Unit. November 2014.
13. Maryland: ReTrac 2013.
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15. Michigan: Duane Roskoskey. MI DEQ. December 2014.
16. Minnesota: http://www.pca.state.mn.us/index.php/view-document.html?gid=20438. A-22.
17. Mississippi: http://www.deq.state.ms.us/mdeq.nsf/pdf/SW_2012SolidWasteAnnualReport/$File/2012%20Annual%20Report.pdf?OpenElement. Compost Facilities, Table 10.
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19. Montana: http://deq.mt.gov/Recycle/recycling_statistics_Page.mcpx
20. Nevada: http://nevadarecycles.nv.gov/Resources/Data/
21. New Hampshire: Keene State College R.O.C.K.S. http://www.keene.edu/rocks/materials.cfm?&print=1 and University of New Hampshire's Compost Program http://www.sustainableunh.unh.edu/compost
22. New Jersey: Joe Davis New Jersey DEP. November 2014.
23. New York: New York Department of Environmental Conservation "List of Compost Facilities in New York State" http://www.dec.ny.gov/chemical/55447.html
24. North Carolina: ReTrac 2013.
25. Ohio: ReTrac 2012.
26. Oregon http://www.deq.state.or.us/lq/pubs/docs/sw/2012MRWGRatesReport.pdf. Table 8.
27. Pennsylvania: JoAnne M. Yurcaba DEP. December 2014.
28. South Carolina: South Carolina DHEC. "South Carolina Solid Waste Management Annual Report for Fiscal Year 2013. http://www.scdhec.gov/library/CR-010906.pdf. Table 8.3.
29. South Dakota: Steve Kropp, South Dakota DENR. November 2014.
30. Tennessee: ReTrac 2013.
31. Texas: https://www.plano.gov/DocumentCenter/View/1487 (Sept 2013)
32. Vermont: http://www.anr.state.vt.us/dec/wastediv/solid/DandD.htm. Table 2.
33. Virginia: http://www.deq.virginia.gov/Portals/0/DEQ/Land/SolidWaste/swreport2014.pdf
34. Washington: http://www.ecy.wa.gov/programs/swfa/organics/pdf/2011CompostFacilities.pdf
35. Wisconsin: Dan Werner. DNR. December 2014

Table 6. Residential curbside food collection programs in the United States, 2013.

State	Households Served[a]
California	1,301,966
Colorado	37,824
Iowa	39,400
Kansas	73
Maryland	4,540
Massachusetts	9,599
Michigan	47,500
Minnesota	157,596
New Jersey	8,138
New York[b]	31,800
Ohio	73,813
Oregon	213,728
Pennsylvania	3,400
Texas	15,600
Vermont	2,700
Washington	770,458
Wisconsin	700
Total U.S. Households Served	*2,718,835*
Total U.S. Households in 2013 [c]	*116,291,033*
Percent of U.S. Households Served	*2.3%*

a. Yepsen (2013) collected data on curbside collection of residential food available in 2012 by survey. For 2013, the contractor used additional Internet research to supplement and update these data.

b. New York City's pilot program served over 30,000 households in 2013. The program was expanded in 2014 to 100,000 households served. Several other pilot programs around the country were started or expanded in 2014, including programs in Cambridge, Massachusetts, and Austin, Texas.

c. Number of households in the United States from U.S. Census Bureau, 2013.

Regulations in states and cities requiring diversion of food from the waste stream have driven collection and composting of commercial food. Table 7 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 (U.S. EPA Region 1 Office, 2011). Since food makes up over 20 percent of MSW disposed in the United States (U.S. EPA, 2015b), commercial food disposal bans are often seen as a critical step toward long-term waste reduction goals.

Table 7. Commercial food disposal bans in the United States[a]

State/City	Effective Date	Ban Requirements
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 law includes a gradual expansion of the ban until 2020, when all food will be banned from Vermont landfills.
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.
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	July 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.

a Henricks (2014) provides a list of cities and states that prohibit organic waste in landfills. Details on each ban were found in each state or city's online resources: SF Environmental (2014), Connecticut General Assembly (2013), Vermont DEC (2014), Massachusetts DEP (2014), Seattle Public Utilities (2014), NYC Department of Sanitation (2014a), California Legislative Information (2014), Rhode Island General Assembly (2014) , and City of Portland, OR (2014).

In 2013, *BioCycle* conducted a state-by-state survey to determine the number of composting facilities in the United States (Platt and Goldstein, 2014). The survey identified 347 composting sites for food across the country, with results shown by state in Table 8. 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 (Platt and Goldstein, 2014). The low number of food composting facilities is especially

significant in Connecticut, where the law requiring food diversion by commercial enterprises generating more than 2 tons of food per week depends on the existence of a food recycling facility no more than 20 miles away.

Table 8. Number of food composting facilities in the United States, by state, 2013.

State	Number of Facilities[a]	State	Number of Facilities[a]	State	Number of Facilities[a]
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**

a. Platt and Goldstein (2014) 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.

3.0 Conclusions

Over 2.1 million tons of food are estimated to be managed through the options reviewed in this memorandum. Towards the top of EPA's food hierarchy, 2013 food donations to feed people are estimates at 551,000 tons. Food to feed animals in 2013 is 122,000 tons and food to composting is estimated at over 1,467,000 tons.

Composting, the most common management method, is driven by collection and facility infrastructure and the existence of mandatory regulations. Food to people donation efforts are limited by numerous barriers including misinformation about regulatory constraints, transportation costs, lack of refrigerated trucks, chain of custody issues, and insufficient onsite storage and refrigeration. The recovery of discarded food as animal feed is a viable option for restaurants, retailers, or wholesalers when located close to local farms. However, there are regulations controlling the type of food that may be used and how the food is handled.

There is an established infrastructure to manage food through AD at wastewater treatment plants and on farms that treat animal manure. Co-digestion can be beneficial because food can be used to adjust the percent of solids for optimal digestion and increase biogas production. Food is more readily digestible than biosolids, so methane production from food can be three times greater than that of sewage sludge. Not enough data are readily available to estimate the amount of postconsumer food being used as feedstock for AD systems in the U.S.

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