Anaerobic Digestion Facilities Processing Food Waste in the United States (2017 & 2018)

Survey Results

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Author

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This report also could not have been developed without the outstanding technical support of David MacFarlane in EPA Region 3's Information Systems Branch who steadfastly and efficiently revised the electronic surveys and assisted with data management.

Again this year, all the meticulous and time-consuming work that went into the quality assurance review of the datasets can be attributed to the tireless efforts of Chris Carusiello in EPA's Office of Land and Emergency Management, Office of Resource Conservation and Recovery.

Document Review

Technical peer review of this document was provided by:

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Quality Assurance

EPA conducted a rigorous quality assurance review of the data and calculations used to generate the information in this report. All critical data points were checked for outliers, an assessment of units was conducted to ensure accuracy, and specific data points were compared to test for certain conditions (e.g., reported capacity is greater than reported amounts of feedstock processed). In many instances, anomalies with verified directly with the respondents to ensure accuracy.

Disclaimer

The anaerobic digestion facilities and their locations are provided for informational purposes only. Companies mentioned in this report are not certified or approved by US EPA. EPA does not guarantee the accuracy or completeness of this information.

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Executive Summary

In 2014, the United States Environmental Protection Agency (EPA) began building a dataset of names and locations of anaerobic digestion (AD) facilities processing food waste to better understand the practice and the prevalence of food waste digestion in the United States. In December 2016, EPA was granted the authority to survey digesters annually for three years, from 2017 – 2019. This report is the third in a series of three reports. Each report includes data for three types of AD facilities: (1) stand-alone food waste digesters; (2) on-farm digesters that co-digest food waste; and (3) digesters at water resource recovery facilities (WRRFs) that co-digest food waste.

In 2017 and 2018, EPA surveyed operators of AD facilities that accept food waste to identify the number of facilities in the U.S. and their locations, and to learn about their operations. EPA previously published two reports utilizing data from the 2017 and 2018 surveys. In September 2018, the first report was published, which was titled: Anaerobic Digestion Facilities Processing Food Waste in the United States in 2015 and in September 2019 the second report was published, which was titled: Anaerobic Digestion Facilities Processing Food Waste in the United States (2016).

EPA administered the survey for a third time in 2019 and the data collected from the 2019 survey is summarized in this report. The report reflects three years of data. The following three critical data points reflect calendar years 2017 and 2018: the amount of food waste[1] processed, the amount of non-food waste[2] processed, and the amount of biogas produced. The remaining data points reflect circumstances in 2019: processing capacity, feedstock types, feedstock sources, tipping fees, pre-processing/de-packaging, operational specifications, biogas uses, gas cleaning systems, solid digestate uses, and liquid digestate uses. The data used in this report was voluntarily submitted by survey respondents.

EPA offered the survey to 209[3] operating facilities, including all 134 facilities that provided responses in 2018. EPA also made the surveys available on the Agency's AD website. EPA received responses to the 2019 survey from 118 operational facilities. Table ES-1 shows the number of responses broken down by facility type. EPA also added to the dataset of AD facilities that are known to be operational, in the planning and design phase, or under construction; as well as facilities that have ceased operation or ceased co-digestion activities. This report includes information on the status of AD facilities in each of those situations.

[1] For the purposes of this report, food waste includes, but is not limited to: food scraps that have been separated and collected by municipalities from residential sources; food scraps that have been separated and collected from institutions or venues (e.g., prisons, hospitals, stadiums); food scraps from food preparation at restaurants, cafeterias, and other food services; plate scrapings from restaurants, cafeterias, and other food services; fats, oils and grease (FOG); unused food collected from grocery stores (e.g., bakery items, bruised fruit, items past shelf life); and pre-consumer by-products of the food and beverage processing industries.

[2] Non-food waste feedstocks include, but are not limited to: mixed yard waste, crop residues, manure, wastewater solids (sludge), septage, de-icing fluid, lab (or pharma) wastes, paper mill wastes, and crude glycerin.

[3] The number of operational facilities receiving surveys in 2019 is slightly fewer than the number of facilities receiving surveys in 2018. This decrease is due to several facilities that are no longer operating or have stopped accepting food waste due to various reasons.

The 2019 response rates for each type of survey are comparable to the response rates from the 2017 and 2018 surveys (74% in 2017 and 68% in 2018). However, the operational facilities responding to the 2017, 2018, and 2019 surveys are not identical. For each year that the survey has been administered, the list of operating facilities has been slightly different. Please see Appendix A for the list of facilities and the specific year they responded to the survey.

Table ES-1 summarizes the response rates for operational facilities by digester type in 2019. See Section II of this report for a more detailed description of respondent participation for each survey year (specifically Table 3).

Table ES-1: Number of Operational Anaerobic Digestion Facilities Surveyed and Response Rate by Digester Type in 2019

Digester type	Number of Facilities Surveyed	Submitted Survey	Survey Response Rate
Stand-alone digesters	68	45	66%
On-farm co-digesters	59	10	17%
Co-digestion systems at WRRFs	82	63	77%
Total	**209**	**118**	**56%**

The 2019 survey results indicate that six more facilities ceased operations in 2018, bringing the total number of facilities that have ceased operations from 11 in 2018 to 17 in 2019.

Processing Capacity and Amounts Processed

Based on the data submitted by the 117[4] survey respondents, the total processing capacity for food waste in all three digester types combined in 2019 was over 24.3 million tons per year. The total amount of food waste processed in all three digester types in 2017 was over 9.7 million tons.[5] The total amount of food waste processed in all three digester types in 2018 was approximately 9.9 million tons (Table ES-2).[6]

Table ES-2: Total Capacity for Processing Food Waste and Total Amount of Food Waste Processed in 2017 and 2018 by Digester Type

Digester Type	Reported Capacity in 2019 (tons per year)	Reported Amount Processed in 2017 (tons)	Reported Amount Processed in 2018 (tons)
Stand-alone digesters	20,699,807	8,095,127	8,210,705
On-farm co-digesters	162,716	100,685	119,300
Co-digestion systems at WRRFs	3,485,535	1,437,561	1,484,866
Total	**24,348,058**	**9,633,373**	**9,814,871**

The total reported amount of non-food waste processed in all three digester types in 2017 was over 1.4 billion gallons of liquid waste and approximately 3.4 million tons of solid waste (Table ES-3).[7]

[4] The total number of surveys may not be equal to the total number of respondents providing answers to any particular question. Some respondents did not answer all of the questions.
[5] This number is based on data reported by 111 survey respondents.
[6] This number is based on data reported by 112 survey respondents.
[7] This is based on data submitted by 56 survey respondents.

Table ES-3: Total Amount of Non-Food Waste Processed by Digester Type (2017)

Digester Type	Liquid Amount (in gallons)	Solid Amount (in tons)*
Stand-alone digesters	46,602,911	111,001
On-farm co-digesters	16,497,139	800
Co-digestion systems at WRRFs	1,338,060,110	3,280,147
Total	**1,401,160,160**	**3,391,948**
* Amounts were reported in liquid and solid units. Because there is no common conversion factor for non-food waste, these values are separated.		

The total reported amount of non-food waste processed in all three digester types in 2018 was close to 1.5 billion gallons of liquid waste and approximately 3.4 million tons of solid waste (Table ES-4). [8]

Table ES-4: Total Amount of Non-Food Waste Processed by Digester Type (2018)

Digester Type	Liquid Amount (in gallons)	Solid Amount (in tons)*
Stand-alone digesters	43,554,102	109,768
On-farm co-digesters	15,322,271	800
Co-digestion systems at WRRFs	1,384,608,939	3,246,870
Total	**1,443,485,312**	**3,357,438**
* Amounts were reported in liquid and solid units. Because there is no common conversion factor for non-food waste, these values are separated.		

Biogas Production

Based on the data reported by 104 survey respondents, the total amount of biogas produced by all three digester types in 2017 was 25,274 standard cubic feet per minute (SCFM), which is equivalent to 79 megawatts (MW) of installed capacity, or 588 million kilowatt-hours (kWh) of electricity generated per year which is enough energy to power almost 48,411 homes for a year (Table ES-5).

Table ES-5: Summary of Biogas Data Reported by Digester Type (2017)

Digester type	SCFM*	MW	kWh/yr (million)	Equivalent Number of Homes Powered for One Year
Stand-alone digesters	6,402	20	149	12,267
On-farm co-digesters	1,042	3	22	1,811
Co-digestion systems at WRRFs	17,830	56	417	34,332
Total	**25,274**	**79**	**588**	**48,411**
*SCFM values are reported by facility operators and added together to get total SCFM for 2017 (25,274). The MW, kWh/yr, and homes powered numbers are calculated using the LMOP interactive conversion tool. These values are rounded to the nearest whole number, which accounts for the fact that the column totals may not sum.				

The total amount of biogas produced by all three digester types in 2018 was 27,193 SCFM[9], equivalent to 85 MW of installed capacity, or 633 million kWh of electricity generated per year, which is enough energy to power 52,116 homes for a year (Table ES-6).

[8] This is based on data submitted by 54 survey respondents.

[9] This is based on data submitted by 106 survey respondents.

Table ES-6: Summary of Biogas Data Reported by Digester Type (2018)

Digester type	SCFM*	MW	kWh/yr (million)	Equivalent Number of Homes Powered for One Year
Stand-alone digesters	7,282	23	171	14,079
On-farm co-digesters	1,225	4	30	2,470
Co-digestion systems at WRRFs	18,686	58	432	35,567
Total	**27,193**	**85**	**633**	**52,116**

* SCFM values are reported by facility operators and added together to get total SCFM for 2018 (27,193). The MW, kWh/yr, and homes powered numbers are calculated using the LMOP interactive conversion tool. These values are rounded to the nearest whole number, which accounts for the fact that the column totals may not sum.

The figures in Tables ES-2 through ES-6 above likely underestimate actual processing capacity, food waste and non-food waste processed, and biogas production because not all operational facilities provided a survey response.

Based on the 2019 survey responses, 30 states have at least one operating digester (Figure ES-1). California has the greatest number of operating digesters (23) followed by Wisconsin (10). Ohio and New York both have nine digesters, Massachusetts has eight digesters and Pennsylvania has six digesters. The rest of the states have five or fewer operating digesters.

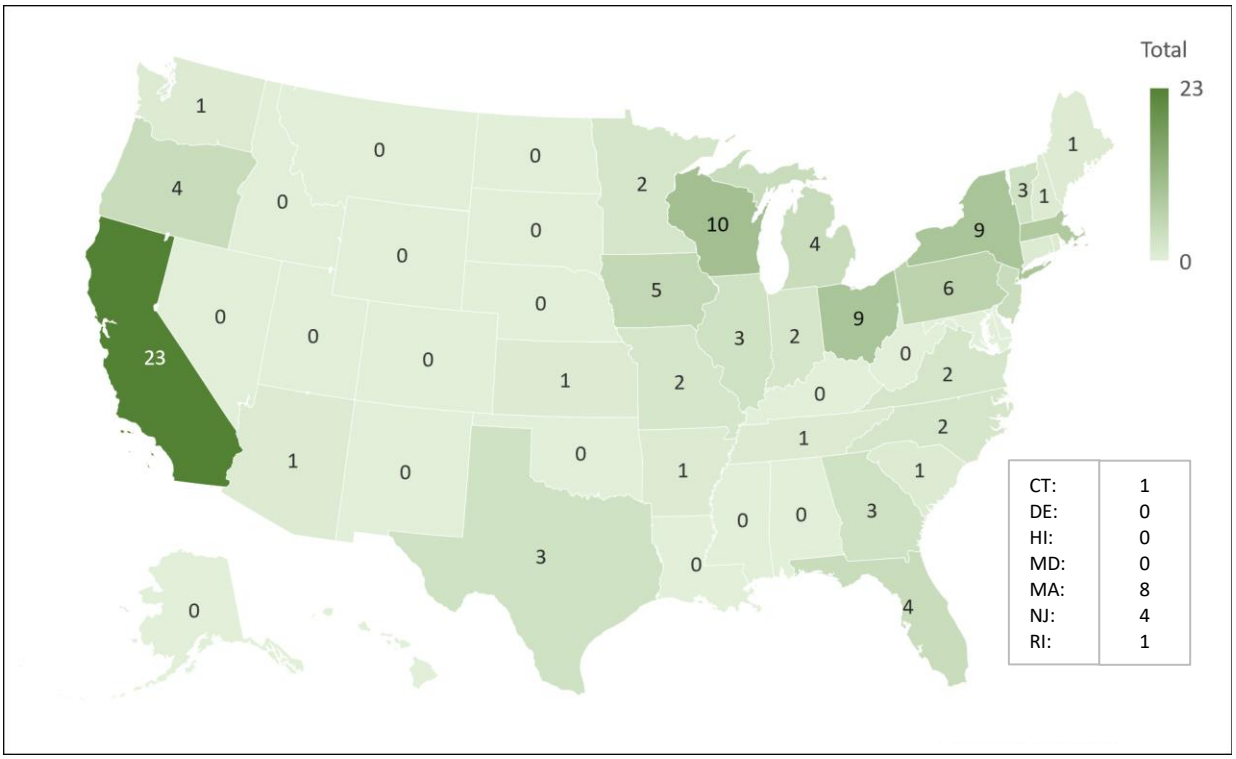

Figure ES-1: Operating Food Waste Digesting Facilities that Returned Surveys by State

Operational Specifications and Pre-Processing Activity

In terms of operational specifications, the majority of the digester types were found to be wet and mesophilic systems, similar to the previous two surveys. The top pre-processing activity for stand-alone

digesters is grinding and/or maceration, which is a change from last year. The top pre-processing activity for co-digestion facilities at WRRFs continues to be screening and/or sorting. For on-farm co-digesters, the number one activity continues to be manual or mechanized de-packaging.

Feedstock Sources and Types

When aggregated, the top five feedstock sources for anaerobic digesters in the U.S. in 2019 in order were:

- Food/beverage processors;
- Restaurants and food service;
- Grocery stores/supermarkets
- Industrial sources; and
- Biodiesel production.

When aggregated, the top five feedstocks accepted by anaerobic digesters in the U.S. in 2019 in order were:

- Fats, oils and greases (FOG);
- Food processing industry waste;
- Beverage processing industry waste;
- Fruit/vegetative waste; and
- Food service waste, pre- and post-consumer.

Biogas Uses and Cleaning Systems

The top use of biogas across all three digester types in 2019 was production of combined heat and power (CHP). The next two most common uses by digester type are listed below.

- **Stand-Alone Digesters**: to produce electricity (sold to the grid), and to fuel boilers and furnaces to heat other spaces;
- **On-Farm Co-Digesters**: to produce electricity (sold to the grid), and to produce electricity used behind the meter; and
- **Co-Digestion Facilities at WRRFs**: to fuel boilers and furnaces to heat digesters, and to fuel boilers and furnaces to heat other spaces.

Approximately 82% of stand-alone digesters, 40% of farm co-digesters and 77% of co-digesters at WRRFs reported that they utilized gas cleaning systems. The top constituents removed for stand-alone and on-farm digesters were moisture and sulfur. The top constituents removed for co-digestion systems at WRRFs were moisture and siloxanes.

Solid and Liquid Digestate Uses

The top three solid digestate uses by digester type in 2019 are:

- **Stand-Alone Digesters**: composted into a reusable/salable product, other uses, and de-watered/dried and land applied;

- **On-Farm Co-Digesters**: processed into animal bedding, de-watered and land applied, and other uses; and
- **Co-Digestion Facilities at WRRFs:** de-watered and land applied. Landfilled, Dried into a reusable/ salable product (e.g., fertilizer) and other uses (three-way tie for second).

The top two uses of liquid digestate by stand-alone digesters were split evenly between “reused as fertilizer via land application” and “discharged to a wastewater treatment plant.” The top use of liquid digestate by on-farm co-digesters was “reused as fertilizer via land application” and co-digestion facilities at WRRFs was “recirculated through the digester.”

I. Background

In the United States (U.S.), food is the greatest fraction of material, by weight, in the municipal solid waste stream. In other words, food is the most common type of waste in our garbage. In 2018, almost 103 million tons of wasted food were generated in the industrial, residential, commercial, and institutional sectors, [10] imposing significant economic and environmental costs. To help alleviate these costs, EPA encourages diversion of food waste from landfills, including its use in anaerobic digestion facilities.

In 2014, EPA began building a dataset of names and locations of AD facilities processing food waste. EPA built the original dataset using publicly available information (e.g., American Biogas Council project profiles, BioCycle articles, EPA AgSTAR[11] database).

To enhance the quality and quantity of available data, EPA sought and was granted authority under an Information Collection Request to collect information through a survey for digesters (see Appendix D for a list of survey questions). The approval allowed EPA to collect data annually for three years, from 2017 to 2019. This report is the third in a series of three reports. Each report includes data for three types of AD facilities: (1) stand-alone food waste digesters; (2) on-farm digesters that co-digest food waste; and (3) digesters at water resource recovery facilities (WRRFs) that co-digest food waste. This information is gathered to better understand the practice and prevalence of digestion of food waste in the United States (e.g., the current amount of food waste being processed by digesters, available capacity, etc.).

EPA has collected data regarding anaerobic digestion facilities processing food waste for three consecutive years (2017, 2018, and 2019). Because AD facilities are typically not able to provide data for the current year, most of the critical[12] data points (e.g. total amount processed) are calculated after the close of the previous calendar year. Other data are available at the time the survey was conducted (e.g. operational specifications). As a result, each of the published reports contain data from previous years of operation as well as the year in which the survey was conducted. The table below summarizes the different types of data that are included in each report as well as the years from which the data originate.

[10] EPA 2018 Wasted Food Report, page 5. Estimate includes residential, commercial, industrial, and institutional sources of food waste, but not on-farm sources.

[11] AgSTAR is an EPA program that promotes the use of biogas recovery systems to reduce methane emissions from livestock waste.

[12] The critical data points are time-specific data points tied to a calendar year. These data points are: amount of food waste processed, amount of non-food waste processed, and amount of biogas produced.

Table 1: Reports Published and Data Included

Report name	Year survey conducted (data collected)	Year(s) associated with critical data points*	Year associated with remaining data points†	Date report published
Anaerobic Digestion Facilities Processing Food Waste in the United States in 2015	2017	2015	2017	September 2018
Anaerobic Digestion Facilities Processing Food Waste in the United States (2016)	2018	2016	2018	September 2019
Anaerobic Digestion Facilities Processing Food Waste in the United States (2017 & 2018)	2019	2017 & 2018	2019	January 2021

* The critical data points are the amount of food waste processed, the amount of non-food waste processed, and the amount of biogas produced in a given year.
† The remaining data points are processing capacity, feedstock types, feedstock sources, tipping fees, pre-processing/de-packaging, operational specifications, biogas uses, gas cleaning systems, solid digestate uses, and liquid digestate uses.

This report includes data collected via the 2019 survey and reflects calendar years 2017 and 2018 for the following three data points: the amount of food waste[13] processed, the amount of non-food waste[14] processed, and the amount of biogas produced. Processing capacity, feedstock types, feedstock sources, tipping fees, pre-processing/de-packaging, operational specifications, biogas uses, gas cleaning systems, solid digestate uses, and liquid digestate uses reflect circumstances in 2019.

To identify respondents for the 2019 survey, EPA used the information gathered during the 2017 and 2018 surveys as a starting point. Ongoing research conducted throughout 2017, 2018, and 2019 also contributed to the development of both the list of operating AD facilities that accept food waste (See Appendix A, Tables 1A, 2A and 3A) and the list of AD facilities under development (See Appendix B).[15]

[13] Food waste includes, but is not limited to: food scraps that have been separated and collected by municipalities from residential sources; food scraps that have been separated and collected from institutions or venues (e.g., prisons, hospitals, stadiums); food scraps from food preparation at restaurants, cafeterias, and other food services; plate scrapings from restaurants, cafeterias, and other food services; fats, oils and grease (FOG); unused food collected from grocery stores (e.g., bakery items, bruised fruit, items past shelf life); and pre-consumer by-products of the food and beverage processing industries.

[14] Non-food waste feedstocks include, but are not limited to: mixed yard waste, crop residues, manure, wastewater solids (sludge), septage, de-icing fluid, lab (or pharma) wastes, paper mill wastes, and crude glycerin.

[15] "Under development" refers to phases of development prior to the facility becoming operational: siting, permitting, design, construction, etc.

This report does not address whether the food waste processed at AD facilities could have been prevented, donated to feed people, or used to feed animals. By the time food that may at one time have been recoverable is received by an AD facility, it is considered "food waste." Therefore, the term "food waste" is used throughout this document to describe the food-based feedstock being processed in digesters.

II. Survey Data Collection

Under Information Collection Request (ICR) No. 2533.01, EPA developed electronic data collection surveys for each digester type: stand-alone food waste digesters, on-farm digesters that co-digest food waste, and digesters at WRRFs that co-digest food waste. EPA emailed the surveys directly to digester owners and operators and made the surveys available on EPA's Anaerobic Digestion website. This report is based on data collected via the 2019 survey. EPA collected data from October 2019 through February 2020, and then the surveys were inactivated. For the 2019 survey, the critical data points[16] reflect calendar years 2017 and 2018. All other data reflects circumstances in 2019.

The 2019 data collection allowed EPA to:

- Identify the number and location of AD facilities that are operational and under development[17];
- Document the total processing capacity at AD facilities;
- Document how much food waste and non-food waste was processed (in 2017 and 2018);
- Document how much biogas was produced (in 2017 and 2018);
- Document the types of food and non-food wastes, and the sources of these wastes, that are accepted at these AD facilities;
- Analyze the end-uses of AD products (biogas and digestate); and,
- Understand additional information about AD facilities such as pre-processing/de-packaging activity, operational specifications, and gas cleaning systems.

Completion of the survey was voluntary, and the data collected was freely reported by survey respondents. EPA sent the 2019 survey to all of the AD facilities that responded to the 2018 survey (both operating facilities and facilities under development).[18] EPA also identified additional facilities to survey as a result of research and collaboration with Agency partners. The number of facilities surveyed and the number of facilities responding to the survey in 2019, both operating and non-operating, are identified in Table 2.

Table 2: Number of Operational and Not Operating Anaerobic Digestion Facilities Surveyed and Responding to the 2019 Survey

Operational Status	Number of Facilities Surveyed	Number of Surveys Submitted	Survey Response Rate
Operational	209	118	56%
Not operating	20	14	70%
Total	**229**	**132**	**58%**

[16] Amount of food waste processed, amount of non-food waste processed, and amount of biogas produced

[17] This data is current as of December 2019.

[18] Data collected during the 2018 survey was published in the 2019 report titled *Anaerobic Digestion Facilities Processing Food Waste in the United States (2016)*, September 2019. Data collected during the 2019 survey is included in this report.

Consistent with prior survey results, the operational facilities that responded to the 2019 survey were different from the facilities that responded to the 2018 survey. Table 3 below provides information on the number of facilities providing surveys for both years. Please see Tables 1A, 2A, and 3A for lists of facilities including the years that each facility responded to the survey located in Appendix A.

Table 3: Comparison of Facilities Responding to 2018 and 2019 Surveys

Digester Type	Number of Facilities Responding in 2018	Number of Facilities Responding in 2019	Number of Facilities Responding in both 2018 and 2019	Number of Facilities Responding in 2018 that did not Respond in 2019	Number of New Facilities Reporting in 2019
Stand-alone digesters	46	45	40	5	5*
On-farm co-digesters	16	10	6	10	4†
Co-digestion systems at WRRFs	72	63	62	10‡	1
Total	**134**	**118**	**108**	**23**	**10**

*Two of these facilities responded in 2017 but not 2018.
†One of these farms responded in 2017 but not 2018.
‡Two of these facilities responded to the survey but did not provide operating data because they are temporarily shut down.

In all three reports issued in this series (2018, 2019, and 2021), EPA aggregated the technical data collected for each facility (e.g., processing capacity) and summarized it such that individual facility information could not be identified. Personally Identifiable Information (PII) will be protected to the extent allowable under the Freedom of Information Act.

III. Results

A. Response Rates and Location Data

Out of the 209 surveys distributed to AD facilities that are operational, 118 were returned. Out of the 20 surveys distributed to AD facilities that are not operating, 14 were returned. This report only identifies the status of those facilities providing survey responses. Another 71 facilities are believed to be operating (for a total of 189); however, the status of these facilities cannot be documented at this time.[19] The number of operational facilities surveyed and the number of operational facilities returning responses by facility type is provided in Table 4. Names of facilities confirmed via survey response to be currently operating can be found in Appendix A (Tables 1A, 2A and 3A).

[19] The 71 facilities in this category that did not respond to the survey are believed to be operational based on current research, available public information and information provided by facility representatives other than survey responses (e.g., phone and face-to-face conversations).

Table 4: Number of Operational Anaerobic Digestion Facilities Surveyed and Responding to Survey by Digester Type

Digester Type	Number of Facilities Surveyed	Number of Surveys Submitted	Survey Response Rate
Stand-alone digesters	68	45	66%
On-farm co-digesters	59	10	17%
Co-digestion systems at WRRFs	82	63	77%
Total	**209**	**118**	**56%**

EPA is also tracking facilities that are under development or temporarily shut down. EPA distributed 20 surveys to a group of stand-alone AD facilities and WRRF co-digestion systems that are in one of the following phases: planning, design, permitting, under construction, start-up mode or temporarily shut down. Currently, no on-farm co-digesters have been identified as under development or temporarily shut-down. EPA received survey responses confirming the operational status of 16 facilities that are in one of these categories. Names of these facilities and their operational status as reported via survey response can be found in Appendix B (Tables 1B and 2B). This report only identifies the status of those facilities providing responses. The operational status of the remaining four facilities surveyed cannot be documented at this time.

EPA's research also identified facilities that have ceased operations or did not advance beyond the pilot stage for a variety of reasons. The facilities that have ceased operation are identified in Appendix C. Fifteen WRRFs considering co-digestion did not advance beyond the pilot stage. A list of these facilities is not included in this report.

Stand-Alone Digesters

Stand-alone digesters are primarily built to process food waste. While many of these digesters accept other organic materials (e.g., manure, wastewater solids), they are typically designed for food waste processing. Stand-alone digesters are divided into two categories, as described below: multi-source food waste digesters, and industry-dedicated digesters.

> **Multi-Source Food Waste Digester:** A digester that accepts and processes feedstocks from offsite sources. These feedstocks may be accepted both for their tipping fee revenue and their biogas yield potential. These digesters are sometimes called "merchant digesters." Feedstocks are predominantly food waste, although non-food waste feedstocks (e.g., manure and wastewater solids) may also be processed at these digesters. In most instances, feedstocks are obtained from many different sources.
>
> **Industry-Dedicated Digester:** A digester that is developed to manage food waste generated from a single business (e.g., grocery store chain, food or beverage processing plant). These digesters may accept organic materials from other sources for tipping fees, but this practice is not typical for this type of digester.

EPA received 45 responses to the 2019 survey from a field of 68 operational stand-alone facilities, for a response rate of 66%. The remaining 23 operational facilities did not submit data. See Table 4 above for

response rates for operational facilities. See Appendix A (Table 1A) for a list of operational stand-alone facilities and Appendix B (Table 1B) for a list of stand-alone facilities under development.

According to the survey responses received from the 45 operating stand-alone digesters: 26 are multi-source (58%); 18 are industry dedicated (40%); and one was identified by survey respondents as "other" (2%).

Operational stand-alone digesters are located within 22 states. See Figure 1 for a map and Table 5 for a listing of the number of operating stand-alone facilities by state.

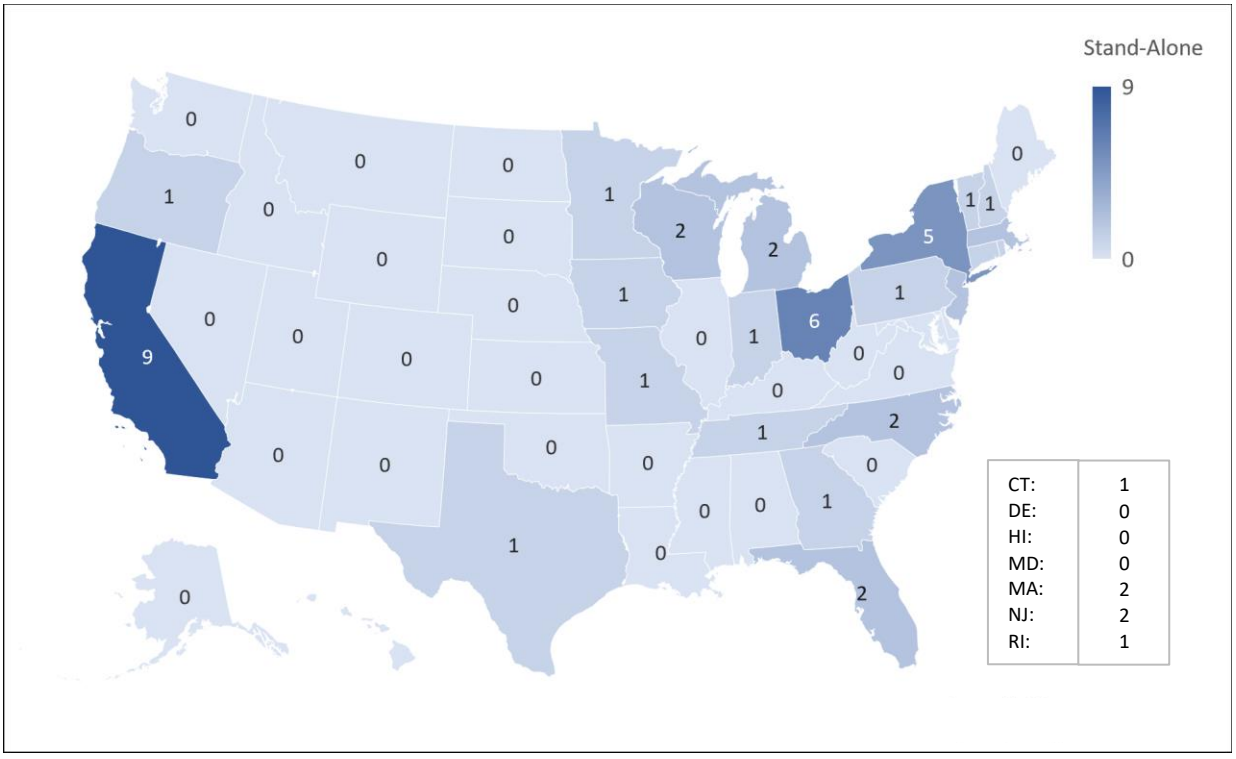

Figure 1: Operating Stand-Alone Food Waste Digesting Facilities that Returned Surveys by State

In all three reports issued in this series (2018, 2019, and 2021), EPA aggregated the technical data collected for each facility (e.g., processing capacity) and summarized it such that individual facility information could not be identified. Personally Identifiable Information (PII) will be protected to the extent allowable under the Freedom of Information Act.

On-Farm Co-Digesters

According to EPA's AgSTAR program, there are over 263 anaerobic digester facilities operating on livestock farms in the U.S. These digesters are primarily used for manure management. This survey targeted only those digesters that are co-digesting food waste.

Using the information gathered from on-farm co-digesters during the 2018 survey as a starting point, in 2019, EPA identified and surveyed 59 on-farm co-digester facilities that are potentially co-digesting food waste. EPA received 10 survey responses out of the 59 identified digesters for a response rate of 17%. The remaining 49 farms did not submit data. This response rate is comparable to the on-farm digester

response rate reported in the 2019 Report (27%). This report identifies the status of only those on-farm co-digesters that provided responses. The operational status of the remaining 49 farms surveyed cannot be documented at this time. The actual number of digesters on farms that are co-digesting food waste is likely much higher than 10.

Operational on-farm digesters co-digesting food waste were confirmed to be located in six states. See Table 2A in Appendix A for a list of the 10 farms that provided data and Figure 2 for a map depicting the number of operating on-farm co-digesters by state.

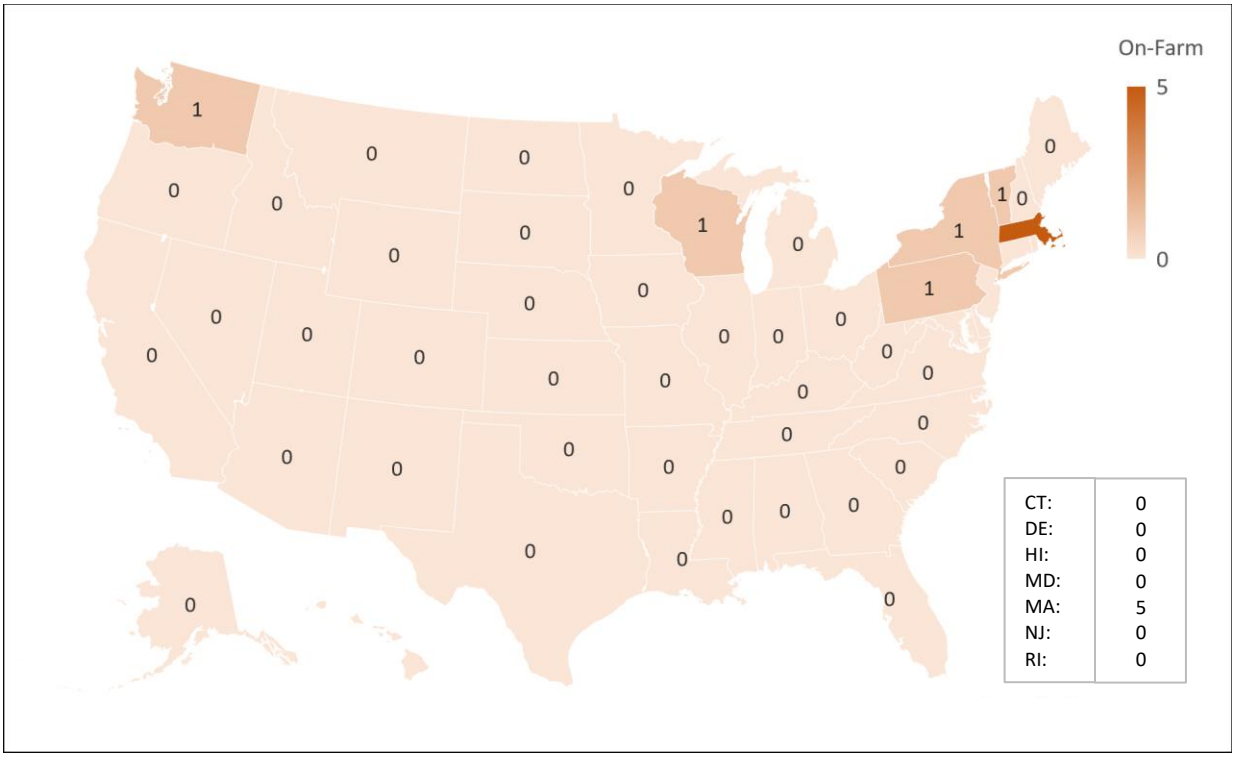

Figure 2: Operating On-Farm Food Waste Co-Digestion Systems that Returned Surveys by State

Digesters at Water Resource Recovery Facilities (WRRFs)

The Water Environment Federation and the American Biogas Council built and maintain a database (www.resourcerecoverydata.org) of information on WRRFs.[20] This database identifies approximately 1,265 WRRFs in the U.S. that have anaerobic digesters to manage wastewater solids, and roughly 20% of these facilities co-digest materials, including food waste from offsite sources.

In 2019, EPA received 63 survey responses from a field of 82 WRRFs with operational food-waste co-digestion systems for a response rate of 77%. The remaining 12 facilities did not submit data. This report identifies the status of only those facilities providing responses. The operational status of the remaining

[20] Please see http://www.resourcerecoverydata.org/biogasdata.php for a listing of those WRRFs with operating anaerobic digesters.

12 WRRFs surveyed cannot be documented at this time. See Table 4 above for response rates for operational WRRF co-digestion systems. See Table 3A in Appendix A for a list of the 63 facilities providing data and Figure 3 for a map depicting the number of operating WRRF food waste co-digestion systems by state. WRRFs with operating co-digestion systems are located within 24 states.

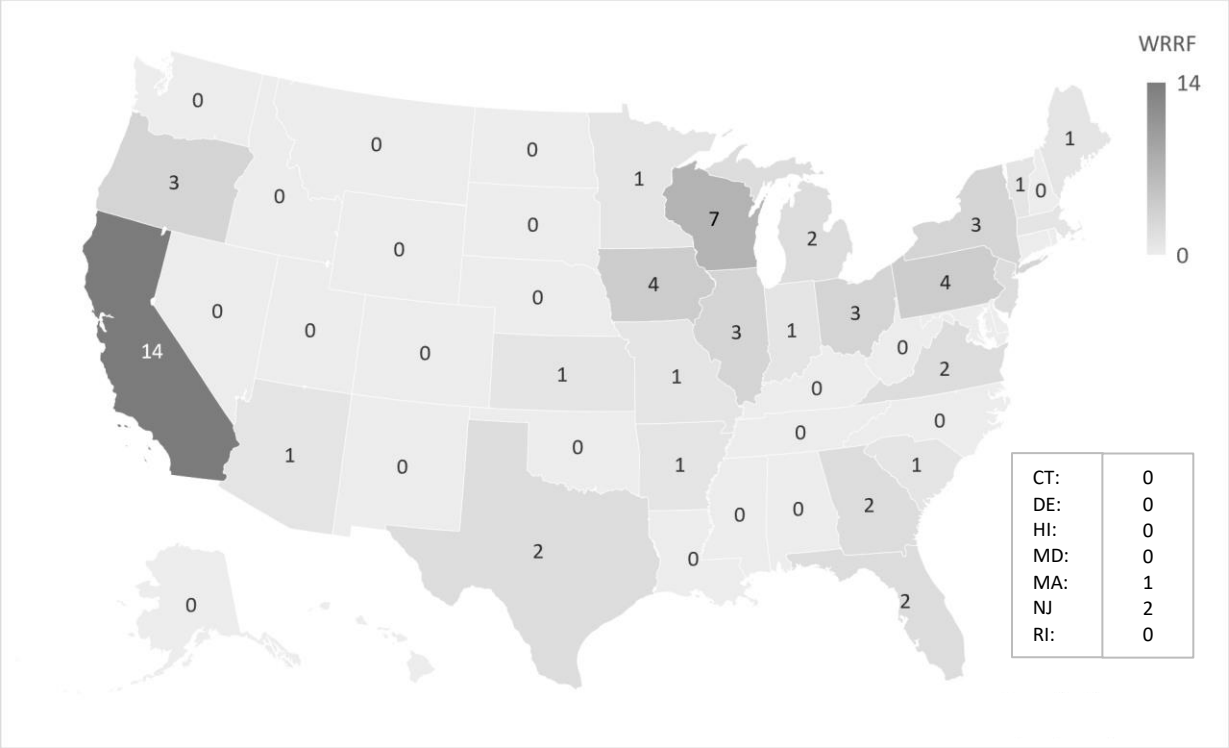

Figure 3: Operating WRRF Food Waste Co-Digestion Systems that Returned Surveys by State

Total Operating Digesters in the U.S.

Figure 4 and Table 5 summarize total operating digesters by type and location. Note that there are other operating AD facilities processing food waste in the U.S. Table 5 identifies the number of operating facilities that provided survey responses.

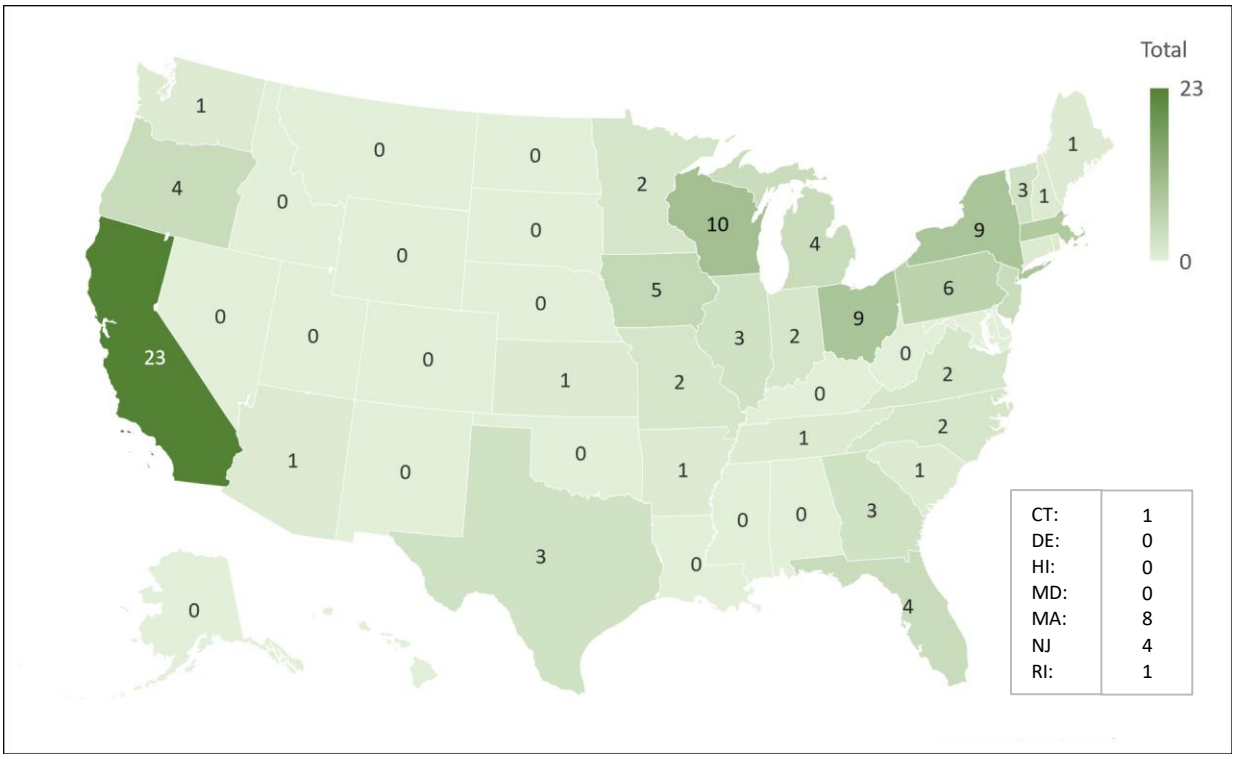

Figure 4: Operating Food Waste Digesting Facilities that Returned Surveys by State

Table 5: Number of Operating Anaerobic Digestion Facilities in each State that Returned Surveys by Facility Type

	Number of Facilities*		
State	***Stand-Alone***	***On-Farm***	***WRRF***
Alabama	0	0	0
Alaska	0	0	0
Arizona	0	0	1
Arkansas	0	0	1
California	9	0	14
Colorado	0	0	0
Connecticut	1	0	0
Delaware	0	0	0
Florida	2	0	2
Georgia	1	0	2
Hawaii	0	0	0
Idaho	0	0	0
Illinois	0	0	3
Indiana	1	0	1
Iowa	1	0	4
Kansas	0	0	1
Kentucky	0	0	0
Louisiana	0	0	0
Maine	0	0	1
Maryland	0	0	0
Massachusetts	2	5	1
Michigan	2	0	2

	Number of Facilities*		
State	***Stand-Alone***	***On-Farm***	***WRRF***
Minnesota	1	0	1
Mississippi	0	0	0
Missouri	1	0	1
Montana	0	0	0
Nebraska	0	0	0
Nevada	0	0	0
New Hampshire	1	0	0
New Jersey	2	0	2
New Mexico	0	0	0
New York	5	1	3
North Carolina	2	0	0
North Dakota	0	0	0
Ohio	6	0	3
Oklahoma	0	0	0
Oregon	1	0	3
Pennsylvania	1	1	4
Rhode Island	1	0	0
South Carolina	0	0	1
South Dakota	0	0	0
Tennessee	1	0	0
Texas	1	0	2
Utah	0	0	0
Vermont	1	1	1
Virginia	0	0	2
Washington	0	1	0
West Virginia	0	0	0
Wisconsin	2	1	7
Wyoming	0	0	0
Total	**45**	**10**	**63**

*The number of digesters per state shown in Table 5 represents the digesters that EPA received surveys from in 2019.

B. Processing Capacity

Processing capacity refers to the maximum amount of food waste feedstock an anaerobic digester can accept per unit time. EPA collected data on food waste processing capacity in either gallons or tons per year.[21] Capacity reported in gallons per year was converted to tons per year to quantify the total capacity available for processing food waste. [22] EPA recognizes that most anaerobic digesters typically process a liquid slurry. However, for food waste processing capacity, EPA converted the data from gallons per year to tons per year because tons are the industry standard for measuring food waste.

Out of the 118 operational facilities that provided survey responses, 116 provided information about food waste processing capacity. EPA documented that the total capacity for processing food waste in all three

[21] Throughout this document "ton" refers to a US ton, which equals 2,000 lbs.

[22] The gallons to tons conversion for food waste was calculated based on a factor of 3.8 lbs/gallon. This factor comes from *Volume-to-Weight Conversion Factors*, USEPA ORCR, April 2016).

digester types combined is 24,267,593 tons per year (Table 6). Note that the actual processing capacity for digesters in the United States is higher than the values reported in Table 6 because not all operating facilities responded to the survey.

Stand-Alone Digesters

For stand-alone digesters, all 45 (100%) of the survey respondents provided data on processing capacity. Stand-alone digester operators were asked to provide the following:

> *For the purposes of this survey, total processing capacity is the maximum amount of feedstock an anaerobic digester can accept per unit time. In this case, the unit of time is one year. Total capacity must be equal to or greater than the combined amount of food waste and non-food waste processed in any given year.*

The total available processing capacity reported for food waste at stand-alone digesters in the U.S. in 2019 was approximately 20.7 million tons per year.

On-Farm Co-Digesters

EPA asked operators of on-farm co-digesters to consider the following when calculating available food waste processing capacity:

> *Taking into account the average volume of manure from your livestock processed in your anaerobic digestion system, please identify the available capacity to co-digest other feedstocks. If you had an unlimited amount of offsite feedstock available to you – how much could you process in a year?*

EPA's goal was to determine how much outside food waste could potentially be processed at on-farm co-digesters in the U.S. All 10 survey respondents provided data on processing capacity. The total available processing capacity reported for on-farm co-digesters in 2019 was 162,716 tons per year. This number only represents 17% of the on-farm co-digestion systems identified by EPA to be operating in the U.S. Therefore, the actual capacity is likely to be greater than this amount.

Co-Digestion Facilities at WRRFs

Determining the capacity for WRRFs to co-digest food waste is more challenging because there are more factors to consider than just the size of the tanks. EPA asked plant operators to consider the following when calculating available food waste processing capacity:

> *Please identify your facility's available capacity to accept feedstocks from offsite sources. EPA is trying to determine how much outside feedstock could potentially be processed at your WRRF. If you had an unlimited amount of offsite feedstock available to you – how much could you process in a year?*

Again, EPA's goal was to determine how much food waste could potentially be processed at WRRFs in the U.S. The data in this report directly reflects the information provided by the plant operators that responded to the survey. For operating WRRF co-digestion systems, 97% of respondents (61 out of 63)

provided data on processing capacity. The total available processing capacity reported for food waste at co-digestion systems at WRRFs in the U.S. in 2019 was approximately 3.4 million tons per year.

Total Food Waste Processing Capacity

Table 6 below summarizes the total capacity for each type of digester and provides the mean and median. The total available processing capacity reported for food waste in 2019 for all three types of digesters in the U.S. was approximately 24 million tons per year.

Table 6: Total Reported Capacity for Processing Food Waste via Anaerobic Digestion by Digester Type

Digester Type	Capacity (tons per year)	Mean (tons per year)	Median* (tons per year)	Respondents Providing Data	Total Surveys Received
Stand-alone digesters	20,699,807	459,996	76,000	45	45
On-farm co-digesters	162,716	16,272	13,200	10	10
Co-digestion systems at WRRFs	3,405,070	54,049	12,804	61	63
Total	**24,267,593**			**116**	**118**
*Amounts were reported by facility response.					

C. Operational Dates

The dates that the AD facilities became operational have not changed since EPA's report published last year. However, the individual facilities that provided survey data are slightly different than last year (see Table 3). It is still the general perception that processing food waste via AD is a relatively new practice.

Most of the facilities that provided data for this survey began operations before 2015 (Figure 5). A stand-alone digester that began operations in 1958 was the earliest start date recorded again this year. For co-digestion at WRRFs, the earliest start date reported in the 2019 survey was 1985 and for co-digestion at farms the earliest start date reported was 2004.

Based on the data received in 2019, seventeen stand-alone and WRRF digesters began processing food waste in the 1980s and 1990s, whereas none of the ten farm co-digesters returning surveys this year started operations during that timeframe. In the early 2000s, AD of food waste and co-digestion of food waste with other waste streams started to become more prevalent in the U.S. Although the number of facilities responding to this survey has remained relatively constant, more facilities continue to come online. Four facilities reported a start date for operations in 2019 and one in 2018.

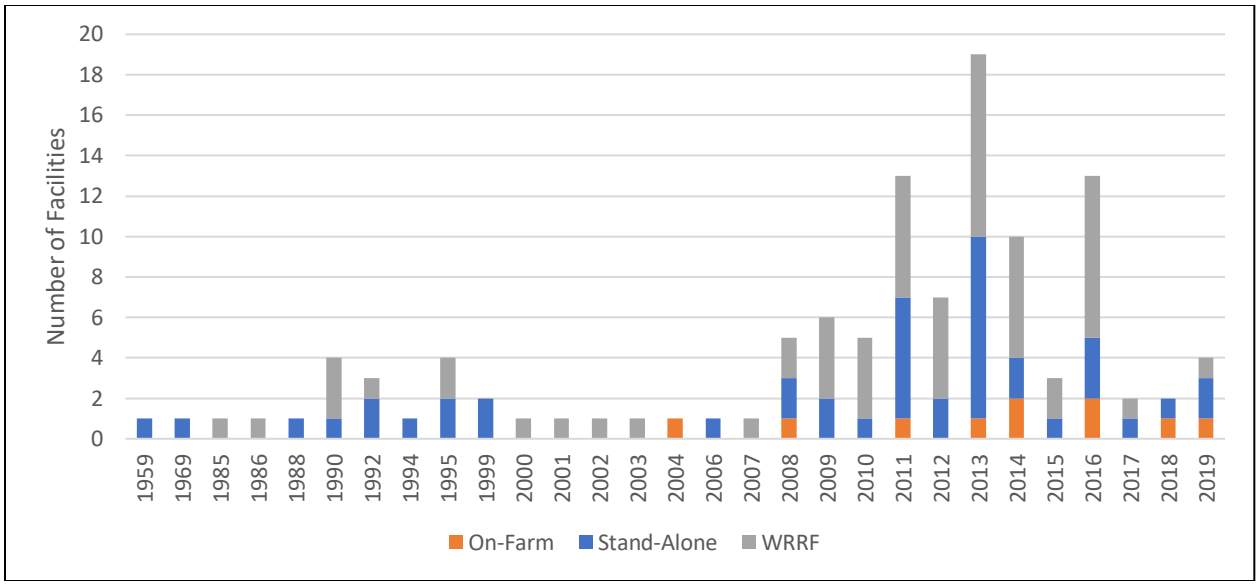

Figure 5: **Distribution of First Year of Digester Operation by Digester Type**

D. Food Waste Processed

EPA requested AD facilities report the data on the amount of food waste processed in either gallons or tons. EPA converted any amounts reported in gallons to tons.[23] As with the information about capacity, the amount of material processed is reported in tons because tons are the industry standard for measuring food waste. Note that the actual amount of food waste processed in 2017 and 2018 was likely higher than the values reported in Tables 7 and 8 because not all facilities known to be operating provided data. In addition, out of the 118 operational facilities that provided survey responses, 110 provided information about the amount of food waste processed in 2017 and 111 provided information about the amount of food waste processed in 2018. Projecting or predicting volumes processed at non-reporting facilities was not within the scope of this report.

Table 7: Total Reported Amount of Food Waste Processed by Each Digester Type (2017)

Digester Type	Amount Processed (tons)	Mean (tons)	Median* (tons)	Respondents Providing Data	Total Surveys Received
Stand-alone digesters	8,095,127	179,892	18,249	42	45
On-farm co-digesters	100,685	10,068	8,115	8	10
Co-digestion systems at WRRFs	1,437,561	23,186	5,259	60	63
Total	**9,633,373**			**110**	**118**

*Amounts were reported by facility response

[23] The gallons-to-tons conversion for food waste was calculated using 3.8 lbs/gallon (See *Volume-to-Weight Conversion Factors*, USEPA ORCR, April 2016).

Table 8: Total Reported Amount of Food Waste Processed by Each Digester Type (2018)

Digester Type	Amount Processed (tons)	Mean (tons)	Median* (tons)	Respondents Providing Data	Total Surveys Received
Stand-alone digesters	8,210,705	182,460	19,950	43	45
On-farm co-digesters	119,300	11,930	9,365	8	10
Co-digestion systems at WRRFs	1,484,866	23,929	6,426	60	63
Total	**9,814,871**			**111**	**118**
*Amounts were reported by facility response					

E. Non-Food Waste Processed

EPA also collected data on the amount of non-food waste processed via AD, in either gallons or tons. Non-food waste feedstocks include, but are not limited to: mixed yard waste, crop residues, manure, wastewater solids (sludge), septage, de-icing fluid, lab (or pharma[24]) wastes, paper mill wastes, and crude glycerin. Given that the content of non-food waste feedstocks is highly variable and can be liquid or solid, there is no suitable conversion factor to combine values reported in different units. Therefore, both liquid volume and solid weight amounts reported by facility operators are presented in Tables 9 and 10.

The scope of the survey was limited to anaerobic digesters that digest food waste. For example, the survey scope does not include the amount of manure being digested at farm digesters that do not co-digest food, or the amount of wastewater solids being digested in digesters at WRRFs that do not co-digest food. As a result, the numbers below represent only a portion of non-food waste being digested in the U.S. The non-food waste data collected was intended to provide additional information about the types of wastes being processed via AD.

Processing of non-food waste occurs at stand-alone digesters, but the frequency is relatively low. For example, of the 45 stand-alone digesters providing survey responses in 2019, only 19 (44%) reported that non-food waste was processed in 2017 and 18 (40%) reported that non-food waste was processed in 2018. Non-food waste is processed at all on-farm co-digesters (manure) and WRRF digestion systems (wastewater solids).

The amount of both liquid and solid non-food waste reported to be processed in 2016 (published in the 2019 AD Report) was significantly different than the amounts reported to be processed in 2017, shown in Table 9 below.

The amount of non-food waste reported to be processed at stand-alone digesters in 2018 (for the 2016 operating year[25]) was just over 30 million gallons. Two stand-alone facilities reporting in 2019 that did not report in 2018 reported approximately 14 million and 15 million gallons of non-food waste processed in the 2017 calendar year, which accounts for the increase shown in this table. The amount of non-food waste reported to be processed at farm digesters in 2018 (for the 2016 calendar year) was approximately 1.7 million gallons. This difference is due to one farm reporting 11 million gallons of non-food waste processed in 2017, which is significantly greater than any other farm. The amount of liquid non-food waste reported to be processed at WRRF digesters in 2018 (for the 2016 operating year) was approximately 492 million gallons. This difference is mostly due to the fact that three WRRFs reported zero gallons of liquid

[24] In the survey, lab wastes are described as “pharma” wastes, which is an abbreviation of pharmaceutical.
[25] This report uses "calendar year" and "operating year" interchangeably.

non-food waste processed in 2016 and the same three WRRFs reported a combined amount of just over one billion gallons of liquid non-food waste processed in 2017.

The amount of solid non-food waste reported to be processed at WRRF digesters in 2018 (for the 2016 operating year) was just over 22,000 tons. This difference is mostly due to the fact that three WRRFs reported zero tons of solid non-food waste processed in 2016 and the same three WRRFs reported a combined amount of just over 3.2 million tons of solid non-food waste processed in 2017.

Table 9: Total Reported Amount of Non-food Waste Processed by each Digester Type (2017)

Digester Type	Liquid Amount (in gallons)	Solid Amount (in tons)*	Respondents Providing Data	Total Surveys Received
Stand-alone digesters	46,602,911	111,001	19	45
On-farm co-digesters	16,497,139	800	3	10
Co-digestion systems at WRRFs	1,338,060,110	3,280,147	34	63
Total	**1,401,160,160**	**3,391,948**	**56**	**118**

*Amounts were reported in liquid and solid units. Because there is no common conversion factor for non-food waste, these values are separated.

Table 10: Total Reported Amount of Non-food Waste Processed by each Digester Type (2018)*

Digester Type	Liquid Amount (in gallons)	Solid Amount (in tons)†	Respondents Providing Data	Total Surveys Received
Stand-alone digesters	43,554,102	109,768	18	45
On-farm co-digesters	15,322,271	800	3	10
Co-digestion systems at WRRFs	1,384,608,939	3,246,870	33	63
Total	**1,443,485,312**	**3,357,438**	**54**	**118**

*The discrepancies between the non-food waste data between 2016 and 2017 data described above in Table 9 apply to the 2018 data shown in this table as well.

†Amounts were reported in liquid and solid units. Because there is no common conversion factor for non-food waste, these values are separated.

As mentioned previously, not all operational digesters responded to this survey. The actual amount of non-food waste processed at anaerobic digesters in 2017 and 2018 is likely to be higher than the values reported above.

F. Feedstock Types

A wide variety of feedstocks are processed in digesters throughout the U.S. Some feedstocks are more common than others, which varies based on local availability, demand, and type of digester accepting the feedstock. Tables 11, 12 and 13 and Figure 6 show the types of food waste and non-food waste feedstocks processed at each of the three types of digesters.

Feedstocks are classified as follows:

- **Food**: beverage processing industry waste; food processing industry waste; FOG; fruit/vegetative wastes; food service waste pre- & post-consumer; retail food waste; slaughterhouse wastes; and source-separated commercial, institutional or residential organic wastes.

- **Non-Food:** crude glycerin; manure; wastewater solids (sludge); septage; crop residues; mixed yard waste; de-icing fluid; lab (or pharma) wastes; and paper mill wastes.

For the 2019 survey, respondents from all 45 stand-alone facilities, eight out of 10 on-farm co-digesters (80%), and 61 of the 63 WRRFs (97%) provided data on the type of feedstocks processed. Figure 6 shows the top five feedstocks accepted by digester type. The top five feedstocks processed overall are: FOG, food processing industry waste, beverage processing industry waste, fruit/vegetable wastes, and pre-and-post- consumer food services waste. EPA did not collect data on the quantity of individual feedstocks processed.

Table 11: Types of Food Waste and Non-Food Waste Feedstocks Processed at Stand-Alone Digesters

Feedstock	Number of Stand-Alone Facilities processing this feedstock	Percentage of Stand-Alone Facilities processing this feedstock*
Beverage processing industry waste	33	73%
Food processing industry waste	28	62%
Fruit/vegetative wastes	26	58%
FOG	26	58%
Food service waste, pre- & post-consumer	20	44%
Retail food waste	18	40%
Source-separated commercial, institutional or residential organic wastes	17	38%
Crude Glycerin	16	36%
Manure	10	22%
Slaughterhouse wastes	9	20%
Crop residues	8	18%
Wastewater solids (sludge)	7	16%
Mixed yard waste	5	11%
Other (please specify)†	1	2%
Septage	1	2%
Lab (or Pharma) wastes	1	2%

*Percentage calculated based on the 45 facilities providing data on the type of feedstocks processed.

†Other reported feedstocks include grease trap wastes and leachate from compost operation.

Table 12: Types of Food Waste and Non-food Waste Feedstock Processed at On-Farm Co-Digesters

Feedstock	Number of On-Farm Facilities processing this feedstock	Percentage of On-Farm Facilities processing this feedstock*
Beverage processing industry waste	8	100%
Food processing industry waste	8	100%
Fruit/vegetative wastes	7	88%
FOG	6	75%
Source-separated commercial, institutional or residential organic wastes	5	63%
Food service waste, pre- & post-consumer	4	50%
Crude glycerin	3	38%
Retail food waste	2	25%
Slaughterhouse waste	2	25%
Wastewater solids (sludge)	2	25%

Feedstock	Number of On-Farm Facilities processing this feedstock	Percentage of On-Farm Facilities processing this feedstock*
Manure from other farms	2	25%
Crop Residue	1	13%
*Percentage calculated based on 8 farms providing data on the type of feedstocks processed.		

The top five feedstocks processed at WRRFs remained the same: FOG, food processing industry waste, beverage processing industry waste, septage and wastewater solids (sludge) from other WRRFs. The number of facilities co-digesting source-separated commercial, institutional or residential organic wastes doubled, and the number of facilities co-digesting beverage processing industry waste almost doubled between the 2017 and 2018 surveys.

Table13: Types of Food Waste and Non-Food Waste Feedstock Processed at Co-Digestion Systems at WRRFs

Feedstock	Number of WRRFs processing this feedstock	Percentage of WRRFs processing this feedstock*
FOG	48	79%
Food processing industry waste	33	54%
Beverage processing industry waste	25	41%
Wastewater solids (sludge)	18	30%
Food service waste, pre- & post-consumer	14	23%
Fruit/vegetative wastes	12	20%
Septage	9	15%
Source-separated commercial, institutional or residential organic wastes	7	11%
Slaughterhouse Waste	7	11%
Retail food waste	5	8%
De-icing fluid	4	7%
Crude glycerin	3	5%
Other (please specify) †	3	5%
Landfill leachate	2	3%
Lab (or Pharma) wastes	1	2%
Manure	1	2%
*Percentage calculated based on 61 WRRFs providing feedstock data in survey responses. †Other reported feedstocks include wastewater from cleaning of biodiesel process equipment, landfill gas condensate, and heating system waste propylene glycol.		

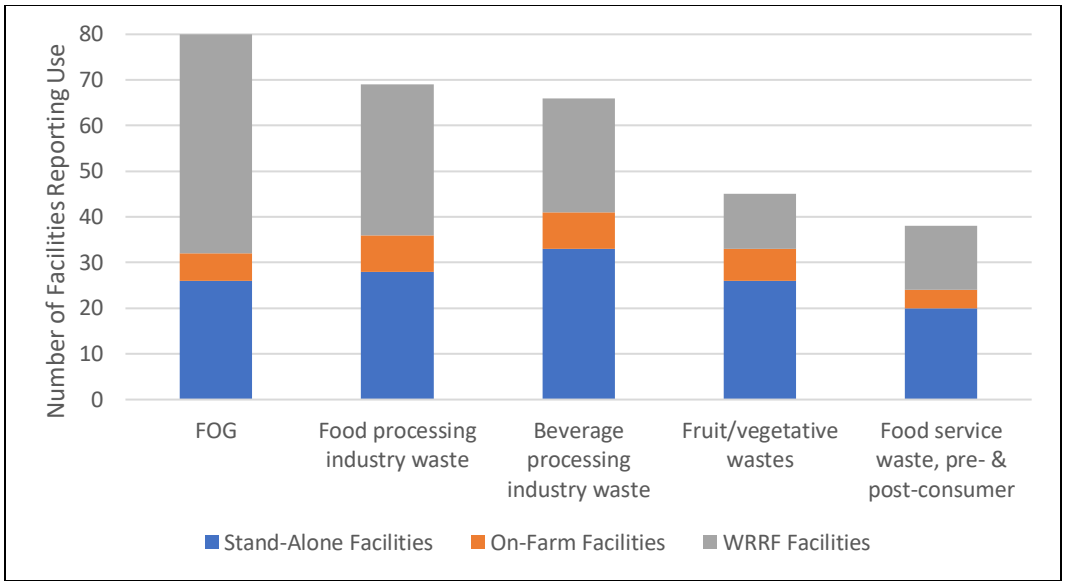

Figure 6: Top Five Feedstocks Accepted by Digesters Taking Food Waste by Digester Type

G. Feedstock Sources

Digester feedstocks come from many different locations, such as industrial, commercial, institutional, and residential sources. The survey question about feedstock sources directed respondents to identify all sources for the feedstocks that were received and processed at each facility. Some digesters have multiple sources, and some have one or just a few. Tables 14, 15 and 16 show the number of facilities that reported receiving feedstocks from each of the possible sources. Figure 7 shows the top five sources of feedstock by digester type. Respondents from all 45 of the stand-alone facilities, eight out of 10 on-farm co-digesters (80%) and 61 of 63 WRRFs (97%) provided data on the sources of feedstocks processed.

Table 14: Sources of Food Waste and Non-Food Waste Feedstock Processed by Stand-Alone Digesters

Source	Number of Facilities Receiving Feedstock from Specified Source	Percentage of Facilities Receiving Feedstock from Specified Source*
Food/beverage processors	40	89%
Grocery stores/supermarkets	20	44%
Restaurants and food service	19	42%
Industrial	17	38%
Biodiesel production	13	29%
Fruit/vegetable farms	11	24%
Livestock farms	10	22%
Corporate complex	9	20%
Retail stores	9	20%
Municipal/residential	8	18%
Sports and entertainment venues	7	16%
Schools	7	16%
Wastewater treatment plants	7	16%
Hospitality	6	13%

Source	Number of Facilities Receiving Feedstock from Specified Source	Percentage of Facilities Receiving Feedstock from Specified Source*
Farmers markets	5	11%
Laboratories/ pharmaceutical companies	4	9%
Airports	4	9%
Prisons	3	7%
Healthcare	2	4%
Other	2	4%
*Percentage calculated is based on 45 stand-alone facilities providing data on the feedstock sources.		

Table 15: Sources of Food Waste and Non-Food Waste Feedstock Processed by On-Farm Co-Digesters

Source	Number of Facilities Receiving Feedstock from Specified Source	Percentage* of On-farm Digesters Receiving Feedstock from Specified Source
Food/beverage processors	6	75%
Grocery stores/supermarkets	6	75%
Biodiesel production	4	50%
Industrial	3	38%
Restaurants and food service	2	25%
Corporate complex	2	25%
Healthcare	2	25%
Municipal/Residential	2	25%
Wastewater treatment plants	2	25%
Retail stores	1	13%
Hospitality	1	13%
Schools	1	13%
Sports and entertainment venues	1	13%
Airports	1	13%
Other livestock farms	1	13%
Prisons	1	13%
*Percentage calculated based on 8 farms providing data on the feedstock sources.		

Table 16: Sources of Food Waste and Non-Food Waste Feedstock Processed by Co-Digestion Systems at WRRFs

Source	Number of Facilities Receiving Feedstock from Specified Source	Percentage of WRRFs Receiving Feedstock from Specified Source*
Food/beverage processors	44	72%
Restaurants and food service	39	64%
Other wastewater treatment plants	19	31%
Grocery stores/supermarkets	17	28%
Industrial	13	21%
Schools	11	18%
Biodiesel production	9	15%
Sports and entertainment venues	7	11%
Retail stores	6	10%

Source	Number of Facilities Receiving Feedstock from Specified Source	Percentage of WRRFs Receiving Feedstock from Specified Source*
Fruit/vegetable farms	5	8%
Hospitality	5	8%
Airports	5	8%
Corporate complex	5	8%
Prisons	5	8%
Healthcare	4	7%
Municipal/residential	3	5%
Farmers markets	2	3%
Other	2	3%
Livestock Farms	1	2%
*Percentage based on 61 WRRFs providing data on feedstock sources.		

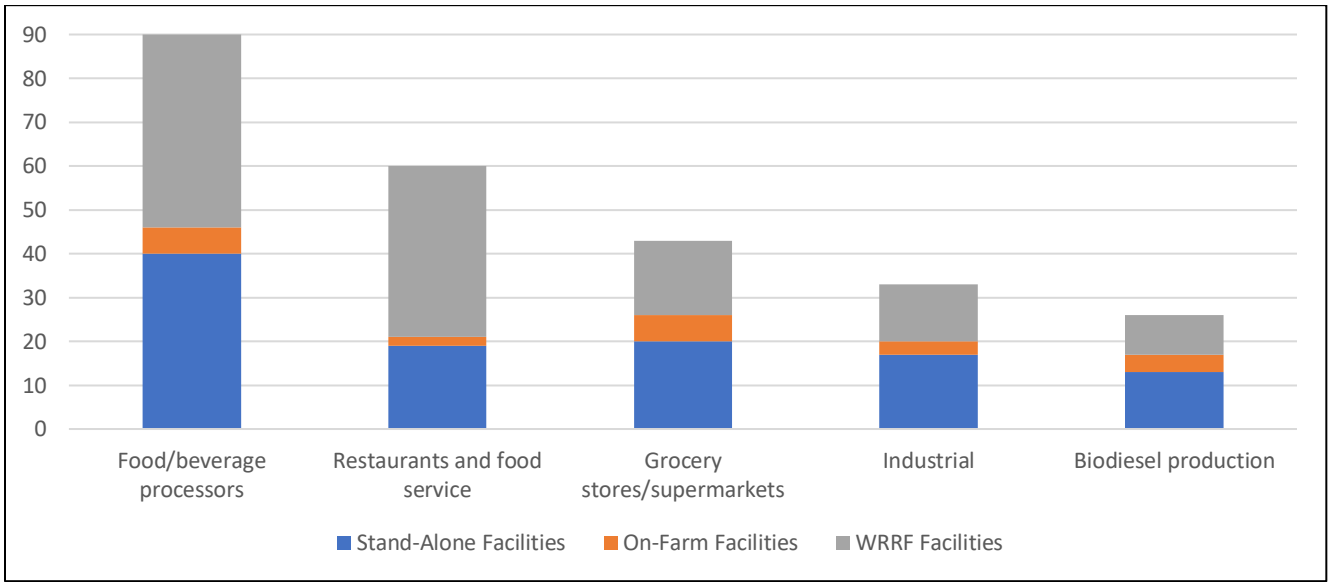

Figure 7: Top Five Sources of Digester Feedstock by Digester Type

H. Tipping Fees

Facilities can generate revenue through contracts to accept and process feedstocks by using tipping fees. Tipping fees can vary based on factors including, but not limited to, the type of feedstock; regional landfill tipping fees; and availability of organics recycling options. EPA included survey questions about tipping fees to gain a better understanding of how digesters may be using them to offset capital expenditures and maintenance costs. EPA recognizes that tipping fee data may be considered proprietary and therefore made these questions optional as part of completing the survey.

The questions on tipping fees[26] were changed for the 2019 survey. EPA asked respondents if they collected tipping fees and if they were willing to share information about the fees they collected. See Table 17 below for a summary of the tipping fee data collected.

Table 17: Reported Tipping Fee Data by Digester Type

Digester type	Number of Facilities Providing Tipping Fee Data	Number of Facilities Collecting Tipping Fees	Percentage of Facilities Collecting Tipping Fees	Highest Annual Revenue Reported 2017	Highest Annual Revenue Reported 2018	Average Annual Revenue Reported 2017	Average Annual Revenue Reported 2018	Highest/ Average Tip Fee Rate Reported per ton	Highest/ Average Tip Fee Rate Reported per gallon
Stand-alone digesters	44	27	61%	$800,000	$900,000	$390,690	$457,214	$35 per ton/ $28 per ton	9¢ per gallon/6¢ per gallon
On-farm digesters	10	9	90%	$350,000	$450,000	$185,000	$235,000	$20 per ton/ $16 per ton	N/A*
Co-digester systems at WRRFs	61	56	92%	$1,100,000	$1,200,000	$246,406	$257,414	$30 per ton/ $25 per ton	15¢ per gallon/ 7.63¢ per gallon
*No tip fee rate data reported in ¢ per gallon for farm digesters.									

In addition to the tip fee data provided in Table 17 above, many operators provided additional comments regarding the manner by which tipping fees are collected as well as their tipping fee structures. One Stand-Alone digester indicated that tipping fees vary greatly depending on feedstock type. Many WRRFs provided comments on tipping fees. These comments included:

- Certain feedstocks (e.g., FOG) could draw higher tipping fees in the 10-20¢ per gallon range, due to their biogas yield potential, while other feedstocks were of consistently lesser value (e.g., septage), drawing tip fees in the 1-5¢ per gallon range.
- A flat rate per gallon is charged without regard to strength or handling considerations. It was noted that a more sophisticated tipping fee rating system may yield higher revenues.
- Tipping fees can be based on a tier system in accordance with the volume of received. The greater the volume, the cheaper the tipping fee. After a certain volume is surpassed the tipping fee is free, but a digester with this structure can benefit from the increased biogas yield.
- Charges can vary widely based on the BOD and COD of the material received.
- Tipping fees had recently been increased to cover operation and maintenance fees for the digester.
- Tipping fees are not collected for industrial wastes but tipping fees are collected for FOG from grease traps.
- Tipping fees are determined based on a number of variables including, volume, bulk, calorie content, and types of packaging.
- Arrangements for free tipping in exchange for electricity created from the biogas are common between local food waste generators and digesters.
- In addition to tipping fees, some WRRFs charge an additional fee for overhead.
- Some WRRFs base tip fees on actual man hours and equipment time used.

[26] EPA was not able to glean much valuable information on tipping fees for the 2017 and 2018 surveys. For the first two surveys, most survey respondents for all three digester types either did not answer the questions about tipping fees, or indicated "$0.00" or "prefer not to say," as the answer. Therefore, not enough information was collected to draw meaningful or useful conclusions about tipping fees.

- For the WRRFs that accept septage as a feedstock (15%), tip fees can vary depending on the source. Fees for septage from household sources are usually lower (average 4¢ per gallon) than the fees for septage from industrial or commercial sources (average 10¢ per gallon).

I. Pre-processing

EPA asked operators if pre-processing activities were performed at their facilities. Respondents from 44 of the 45 stand-alone facilities (98%), all ten on-farm co-digesters (100%), and 61 of the 63 WRRFs (97%) provided information on whether pre-processing is conducted on the feedstocks utilized at their facility. This data documents that out of the facilities providing survey responses, 43% of Stand-Alone Digesters, 40% of Farm Digesters and 34% of co-digestion systems at WRRFs perform some type of feedstock pre-processing.

EPA also asked operators if pre-processing occurred onsite, offsite or both. Table 18 below depicts the data received by facility type.

Table 18: Reported Location of Pre-processing Activities by Digester Type

Digester Type	Number of Facilities with Pre-Processing Onsite	Number of Facilities with Pre-Processing Offsite	Number of Facilities with Pre-Processing both Onsite and Offsite
Stand-alone digesters	11	0	8
On-farm co-digesters	2	1	1
Co-digestion systems at WRRFs	10	5	6

EPA also asked operators to identify what types of pre-processing activities were performed on the feedstocks utilized at their facility. Multiple types of pre-processing can occur at any one facility. Tables 19, 20 and 21 show the number of facilities that reported the use of each type of pre-processing activity to prepare feedstocks for digestion. Third-party processing is typically conducted at an off-site location and pre-processed feedstocks are then transported to the digester in a ready-to-digest form.

Table 19: Reported Pre-processing Activities for Stand-Alone Digester Facilities

Pre-processing Activity	Number of Facilities with Specified Pre-processing Activities
Grinding and/or maceration	13
Screening for debris or sorting	11
Manual or mechanized de-packaging	10
Shredding	6
Liquid/solid separation	5
Third-Party Processing	5
pH adjustment	4
Heating	3
Centrifugal separation	2

Table 20: Reported Pre-processing for On-Farm Co-Digestion Facilities

Pre-processing/De-packaging Activity	Number of Facilities with Specified Pre-processing Activities
Manual or mechanized de-packaging	3
Screening for debris or sorting	1
Grinding and/or maceration	1
Third-Party Processing	1
Shredding	1

Table 21: Reported Pre-processing for Co-Digestion Facilities at WRRFs

Pre-processing/De-packaging Activity	Number of Facilities with Specified Pre-processing Activities
Screening for debris or sorting	12
Grinding and/or maceration	9
Third-Party Processing	5
Heating	5
Manual or mechanized de-packaging	4
pH adjustment	2
Centrifugal separation	2
Mixing	2
Liquid/solid separation	1

Unique responses for pre-processing at WRRFs included:

- Paddle finisher removes plastic and non-organics from food waste;
- FOG is partially dewatered from 15% to 35% solids offsite; and
- Addition of inoculated bacterial to FOG.

J. Operational and Design Specifications

EPA asked respondents to share information about the operational specifications of their digesters, including temperature range and whether operations were wet or dry. The temperature ranges are typically 86 – 100^{o} F for mesophilic and 122 – 140^{o} F for thermophilic. Wet and dry classifications of digesters refer to the moisture content of the feedstocks. A wet digester generally processes feedstock with less than 15% solids content, whereas a dry digester generally processes feedstock with greater than 15% solids content.

Respondents from 44 of 45 stand-alone digesters (98%), seven of 10 on-farm co-digesters (70%), and 61 of 63 WRRFs (97%) provided data on temperature range. Respondents from 44 of 45 stand-alone digesters (98%) and seven of 10 on-farm co-digesters (70%) provided data on whether their digester system was wet or dry. This question was not posed to WRRFs because all WRRF digester systems are wet. Tables 22 and 23 show the data for temperature range and wet versus dry facilities by facility type.

Table 22: Reported Temperature Range Data for each Digester Type

	Temperature Range				Response Rate	
Digester Type	***Mesophilic***	***Thermophilic***	***Unheated***	***Other***	***Number of Respondents Providing Data for this Survey Question***	***Total Surveys Received***
Stand-alone digesters	22	7	13	2*	44	45
On-farm co-digesters	6	0	0	1†	7	10
Co-digestion systems at WRRFs	52	7	0	2‡	61	63
Total						

*Two stand-alone facilities indicated that they operate at both Thermophillic and Mesophillic temperatures.

†No specifics were giving regarding temperature range.

‡One WRRF stated they have one thermophilic and two mesophilic digesters; another indicated they use a two stage process: Thermophilic to Mesophilic.

Table 23: Reported Data on Wet vs. Dry Systems for each Digester Type

	Wet vs. Dry Systems		Percentage		Response Rate	
Digester Type	***Wet***	***Dry***	***Wet***	***Dry***	***Number of Respondents Providing Data for this Survey Question***	***Total Surveys Received***
Stand-alone digesters	39	5	89%	11%	44	45
On-farm co-digesters	7	0	100%	0%	7	10
Co-digestion systems at WRRFs*	--	--	100%	--	--	--
Total						

***** This question was not posed to WRRFs because all WRRF digester systems are wet.

For the 2019 survey, EPA added a question about the design of the AD facility. Respondents were asked respondents to identify the design that best fits each facilities' design type/configuration. Respondents from 34 of the 45 stand-alone facilities (76%), all five out of ten on-farm co-digesters (50%), and 60 of the 63 WRRFs (95%) provided information on the digester design type/configuration utilized at their facility. Tables 24, 25 and 26 show the number of facilities that reported each design type.

Table 24: Reported Design Type/Configuration Reported for Stand-Alone Digester Facilities

Design Type/Configuration	Number of Facilities with Specified Design Type/Configuration
Continuously Stirred Tank Reactor (CSTR)	21
Upflow Anaerobic Sludge Blanket (UASB)	2
Anaerobic Sequencing Batch Reactor (ASBR)	2
Membrane Bioreactor (MBR)	2
Single High-Solids Batch Dry Digester	2

Design Type/Configuration	Number of Facilities with Specified Design Type/Configuration
Covered Lagoon	1
Fixed Film	1
PurposeEnergy Tribrid Bioreactor	1

Table 25: Reported Design Type/Configuration Reported for On-Farm Co-Digestion Facilities

Design Type/Configuration	Number of Facilities with Specified Design Type/Configuration
Continuously Stirred Tank Reactor (CSTR)	3
Mixed Plug Flow	2

Table 26: Reported Design Type/Configuration Reported for Co-Digestion Facilities at WRRFs

Pre-processing/De-packaging Activity	Number of Facilities with Specified Pre-processing Activities
Continuously Stirred Tank Reactor (CSTR)	35
Other (please specify)	13
Plug-flow	7
Hybrid/Multi-stage	3
Fixed-Film	1
Anaerobic Sequencing Batch Reactor (ASBR)	1

Thirteen WRRFs responded that the design of their co-digestion facility was “other.” These responses are summarized below from survey responses:

- Three WRRFs specified their design as “Egg-shaped.”
- Three WRRFs specified their design as “single stage.”

The other responses included:

- FOG digested in anaerobic digesters;
- Continuously mixed and heated system;
- Continuous flow;
- Steady state anaerobic digestion;
- Combination of CSRT and Plug-Flow;
- BNR A2/O2; and
- Two anaerobic digesters operated in parallel, mixed and supplemented with recirculation pumps.

K. Biogas Production

Biogas production data was collected in, or converted to, standard cubic feet per minute (SCFM), which is the industry standard unit of measurement for biogas. The total biogas produced is summarized below as reported by facility type. SCFM was then used to estimate installed capacity in megawatts (MW), and generation potential in kilowatt-hours per year (kWh/yr) using methods described in the interactive

conversion tool[27] on EPA's Landfill Methane Outreach Program (LMOP) website. The LMOP interactive conversion tool assumes landfill gas is 50% methane. The calculation for SCFM landfill gas to MW capacity was revised for the purposes of this report to reflect that biogas tends to be about 60% methane. [28] To provide a frame of reference, EPA presents the kWh/yr values for each type of digester in terms of powering homes.[29] Table 27 and Table 28 show biogas production data by facility type for 2017 and 2018 respectively.

The biogas production amount has changed for all three digester types during the three years of data collection. Some of this change can be attributed to differences in biogas produced by the same facilities over three years, while other change is a result of different facilities responding to the survey each year. This change can be caused by facilities becoming operational or shutting down or simply not responding to the voluntary survey.

Table 27: Summary of Biogas Data Reported by Digester Type (2017)

Digester Type	Respondents Providing Data	Surveys Received	SCFM*	MW	kWh/yr (million)	Number of Homes Powered for One Year
Stand-alone digesters	36	45	6,402	20	149	12,267
On-farm co-digesters	7	10	1,042	3	22	1,811
Co-digestion systems at WRRFs	60	63	17,830	56	417	34,332
Total	**103**	**118**	**25,274**	**79**	**588**	**48,410**

* SCFM values are reported by facility operators and added together to get total SCFM for 2016 (40,304). The MW, kWh/yr, and homes powered numbers are calculated using the LMOP interactive conversion tool. These values are rounded to the nearest whole number, which accounts for the fact that the column totals may not sum.

Table 28: Summary of Biogas Data Reported by Digester Type (2018)

Digester Type	Respondents Providing Data	Surveys Received	SCFM*	MW	kWh/yr (million)	Number of Homes Powered for One Year
Stand-alone digesters	38	45	7,282	23	171	14,079
On-farm co-digesters	7	10	1,225	4	30	2,470
Co-digestion systems at WRRFs	60	63	18,686	58	432	35,567
Total	**105**	**118**	**27,193**	**85**	**633**	**52,116**

* SCFM values are reported by facility operators and added together to get total SCFM for 2016 (40,304). The MW, kWh/yr, and homes powered numbers are calculated using the LMOP interactive conversion tool. These values are rounded to the nearest whole number, which accounts for the fact that the column totals may not sum.

L. Biogas Uses

Most facilities have more than one use for the biogas, and the survey permitted multiple responses. Respondents from 42 of 45 stand-alone facilities (93%), eight out of 10 on-farm co-digesters (80%), and

[27] https://www.epa.gov/sites/production/files/2016-05/interactiveconversiontool.xls
[28] Anaerobic Digestion and its Applications, EPA, October 2015, page 9.
[29] The average home consumed 12,146 kWh of delivered electricity in 2018, the most recent date for which data is available (https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references).

61 of 63 WRRFs (97%) provided data on biogas uses. Table 29 summarizes the ways in which respondents reported using the biogas produced and Figure 8 shows the top five uses of the biogas produced at AD facilities as reported by each type of respondent.

Stand-Alone Digesters

The stand-alone digester survey asked respondents if the biogas produced was used onsite, sold, or flared. Forty-four out of 45 facilities provided responses to this question and multiple answers were permitted. The data reported show that 84% used the biogas onsite, 36% of stand-alone facilities reported that the biogas produced was flared, and 20% reported that they sold the biogas produced at their facility.

The survey also asked respondents if they were able to utilize all the biogas produced at their facility. Seventy-seven percent (77%) reported that all the biogas produced was used. For this years' survey, 23% reported that they did not use all the biogas produced. Facilities that did not use all the biogas produced uniformly reported that they flared the unused biogas.

On-Farm Co-Digesters

The On-Farm digester survey asked on-farm co-digester respondents if the biogas produced was used onsite, sold, or flared. The reported data show that 90% used the biogas onsite, 40% sold it, and 20% flared at least some of the biogas.

Co-Digestion Systems at WRRFs

The WRRF co-digester survey asked respondents if the biogas produced was used onsite, sold, or flared. The reported data show that 97% used the biogas onsite, seven percent (7%) sold it, and 66% flared at least some of the biogas. The survey also asked WRRF respondents if they utilized all the biogas produced at their facility. Sixty-one out of 63 WRRFs (97%) provided data for this question. Twenty-seven (27%) percent of the facilities reported that they used all the biogas produced onsite. The other 34% confirmed that they flared the unused biogas.

Table 29: Reported Uses of Biogas Produced at Anaerobic Digesters

	Stand-Alone Digesters		On-Farm Co-Digesters		Co-Digestion Systems at WRRFs	
Biogas Use	***Number of Facilities Reporting Use***	***Percentage of Facilities using Biogas as Specified****	***Number of Facilities Reporting Use***	***Percentage of Facilities using Biogas as Specified†***	***Number of Facilities Reporting Use***	***Percentage of Facilities using Biogas as Specified‡***
Produce heat and electricity (CHP)	26	62%	6	75%	47	75%
Fuel boilers and furnaces to heat digesters	9	21%	1	13%	40	63%
Fuel boilers and furnaces to heat other spaces	16	38%	1	13%	24	38%
Produce electricity (sold to grid)	16	38%	4	50%	12	19%
Produce electricity used behind the meter (including net metering)	14	33%	3	38%	17	27%
Produce mechanical power	1	2%	1	13%	4	6%
Compressed to vehicle fuels: used for company fleet/personal vehicles	2	5%	0	0%	0	0%
Renewable natural gas (inject to pipeline)	0	0%	0	0%	3	5%

*Percentage out of the 42 stand-alone facilities providing data on biogas uses.
†Percentage out of the eight farms providing survey responses.
‡Percentage out of the 63 WRRFs providing survey responses.

One WRRF facility operator responded that they were working on a combined heat and power system. The following other uses were also reported by WRRF operators:

- Heat used to heat water to maintain digester temperature;
- Used to fuel the pelletizer to produce PFRP[30] Class AA fertilizer;
- Designed to supply fuel to boiler and thermal dryer;
- Used to operate dryer furnace; and
- Used to heat a thermal paddle dryer unit to dewater/dry the stabilized biosolids.

[30] Process to Further Reduce Pathogens (40 CFR Part 503)

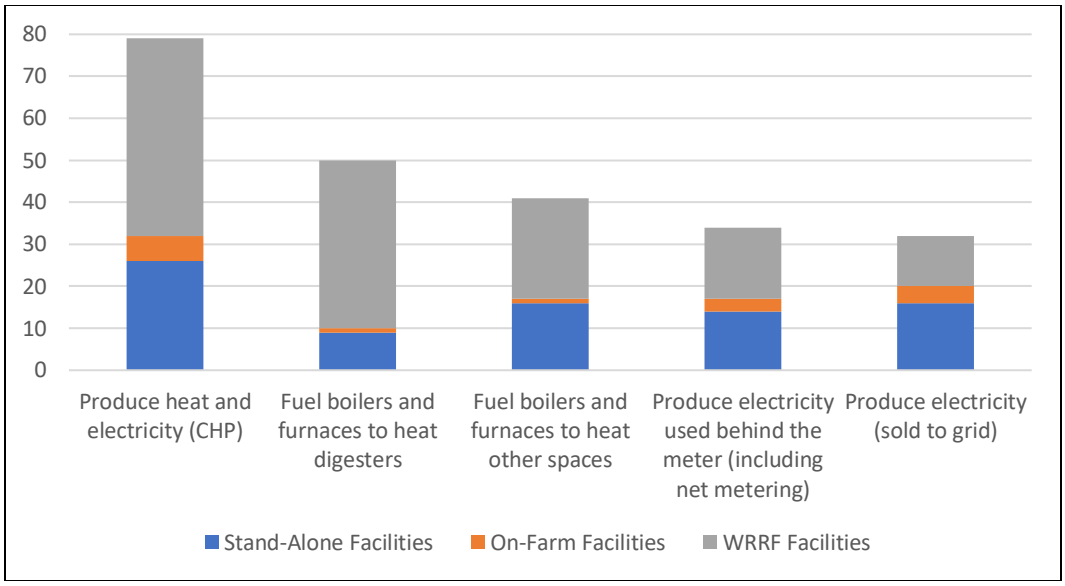

Figure 8: Top Five Uses of Biogas by Digester Type

M. Gas Cleaning Systems

The 2019 survey asked each facility type whether they had a gas cleaning system (yes or no). Respondents from 44 of 45 stand-alone facilities (98%), all 10 on-farm co-digesters (100%), and 61 out of 63 WRRFs (97%) answered this question. The data reported show that gas cleaning systems were utilized at 36 out of 44 (82%) of stand-alone food waste digesters, four out of 10 (40%) on-farm co-digesters, and 47 out of 61 (77%) digesters at WRRFs.

Each facility type was also asked what constituents were removed by their gas cleaning systems. All 36 stand-alone facilities, four on-farm co-digesters and 47 WRRFs that utilize gas cleaning systems provided data on the constituents removed by these systems. Table 30 summarizes the type and frequency of constituents removed by gas cleaning systems for each type of digester and Figure 9 shows the top five constituents removed by digester type.

Table 30: Reported Gas Cleaning Systems at Anaerobic Digesters

	Stand-Alone Digesters		On-Farm Co-Digesters		Co-Digestion Systems at WRRFs	
Constituent	***Number of Facilities Reporting Removal***	***Percentage Reporting Removal of this Constituent****	***Number of Facilities Reporting Removal***	***Percentage Reporting Removal of this Constituent†***	***Number of Facilities Reporting Removal***	***Percentage Reporting Removal of this Constituent‡***
Sulfur	23	64%	2	50%	20	43%
Moisture	22	61%	4	100%	42	89%
Siloxanes	3	8%	0	0%	42	89%
Carbon Dioxide	3	8%	0	0%	5	11%
Hydrogen Sulfide	17	47%	3	75%	32	68%
Compressed gas	3	8%	0	0%	2	4%

	Stand-Alone Digesters		On-Farm Co-Digesters		Co-Digestion Systems at WRRFs	
Constituent	***Number of Facilities Reporting Removal***	***Percentage Reporting Removal of this Constituent****	***Number of Facilities Reporting Removal***	***Percentage Reporting Removal of this Constituent†***	***Number of Facilities Reporting Removal***	***Percentage Reporting Removal of this Constituent‡***
VOCs	2	6%	0	0%	1	2%
Oxygen	2	6%	0	0%	0	0%
Nitrogen	2	6%	0	0%	0	0%
Particulates	2	6%	0	0%	20	43%

*Percentage out of 36 stand-alone digesters providing data on constituents removed.
†Percentage out of 4 on-farm digesters providing data on constituents removed.
‡Percentage out of 47 WRRFs providing data on constituents removed.

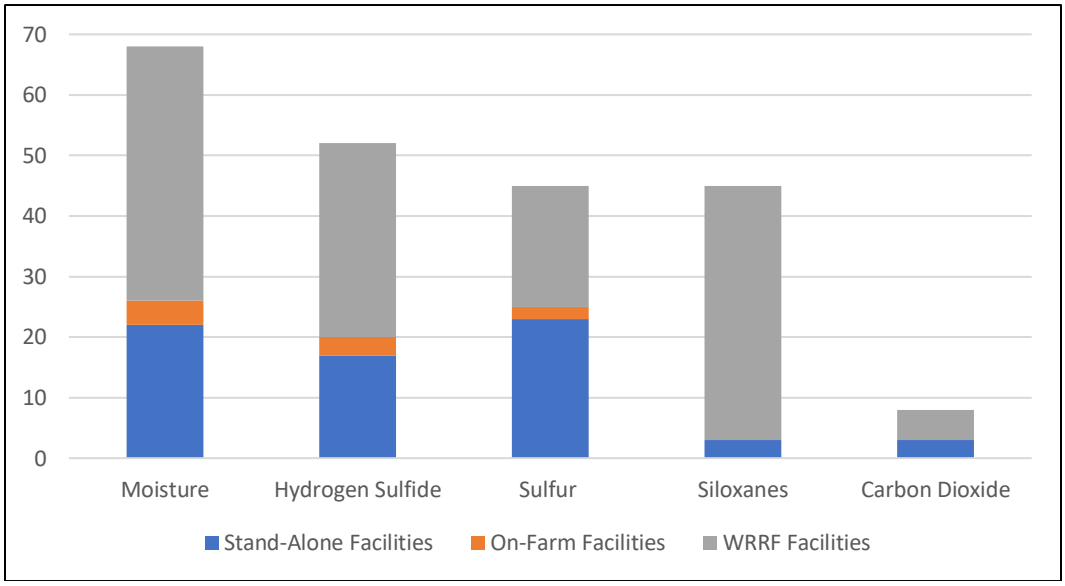

Figure 9: Top Five Constituents Removed by Digester Type

N. Solid Digestate Uses

EPA asked how facilities used the solid digestate they produce, allowing respondents to provide more than one answer. Respondents from 44 of 45 stand-alone facilities (98%), seven of 10 farm co-digesters (70%), and 55 of 63 WRRF digesters (87%) provided data on the uses of solid digestate. According to the survey responses, there are eight WRRFs that landfill all the solid digestate produced. The following uses/destinations of solid digestate were reported for the three digester types surveyed at the frequencies specified in Table 31 below. Figure 10 shows the top five uses of solid digestate by digester type.

Stand-alone digester operators also reported the following other uses of digestate, summarized from survey responses:

- Solids get anaerobically digested (one respondent - verbatim);

- Discharged with effluent into lagoons (one respondent - verbatim);
- Digestate remains in liquid form and it is land applied (six respondents);
- No solid digestate produced (three respondents);
- Digestate is sold to start up other digesters (one respondent); and
- Spent digestate injected into landfill (one respondent - verbatim).

On-farm co-digester operators also reported the following other uses, summarized from survey responses:

- No solid digestate (only liquid), which is land-applied (two respondents).

WRRF digester operators also reported the following other uses for biosolids produced, summarized from survey responses:

- Transported to drying beds and land applied by a third-party (one respondent - verbatim);
- Used as backfill material in exhausted gypsum mines (one respondent - verbatim);
- Not de-watered on-site so unable to be reused (one respondent - verbatim);
- Reused as alternative daily cover in landfills (one respondent - verbatim);
- Lystek – Biofertilizer (one respondent - verbatim);
- Dewatered followed by thermal hydrolysis (one respondent - verbatim);
- Thickened to 4-6% solids and land applied (one respondent - verbatim);
- Onsite land disposal (two respondents); and
- Used to make Class A biosolids pelletized soil amendments (one respondent - verbatim).

Out of the responses received from WRRF digester operators, 60 facilities (95%) indicated that they produce a Class A or Class B biosolid.[31] Twenty-two percent (22%) of the responding facilities produced Class A biosolids, and 78% produced Class B biosolids.

The federal biosolids rule is contained in Title 40 of the Code of Federal Regulations (CFR) Part 503 and defines two types of biosolids with respect to pathogen reduction, Class A and Class B, depending on the degree of treatment the solids have received. Class A biosolids contain no detectible levels of pathogens. Class B biosolids are treated but still contain detectible levels of pathogens. There are buffer requirements, public access, and crop harvesting restrictions for virtually all forms of Class B biosolids.

[31] For additional information on biosolids, please see: https://www.epa.gov/sites/production/files/2018-12/documents/plain-english-guide-part503-biosolids-rule.pdf

Table 31: Reported Solid Digestate Uses

	Stand-Alone Digesters		On-Farm Co-Digesters		Co-Digestion Systems at WRRFs	
Digestate Use	***Number of Facilities Reporting Use***	***Percentage using Solid Digestate as Specified****	***Number of Facilities Reporting Use***	***Percentage using Solid Digestate as Specified†***	***Number of Facilities Reporting Use***	***Percentage using Solid Digestate as Specified‡***
De-watered and land applied	8	18%	2	29%	30	55%
Composted into a reusable/ salable product	19	43%	0	-	6	11%
Landfilled	3	7%	0	-	10	18%
Other	13	30%	2	29%	10	18%
Processed into animal bedding	2	5%	4	57%	0	-
Dried into a reusable/ salable product (e.g., fertilizer)	0	-	0	-	10	18%
Land applied as is with no dewatering or drying	0	-	0	-	7	13%
Incinerated	1	2%	0	-	-	-

*Percentage calculation based on 44 stand-alone facilities providing data on use of solid digestate.
†Percentage calculation based on 7 farms providing data on use of solid digestate.
‡Percentage calculation based on 55 WRRFs providing data on use of solid digestate.

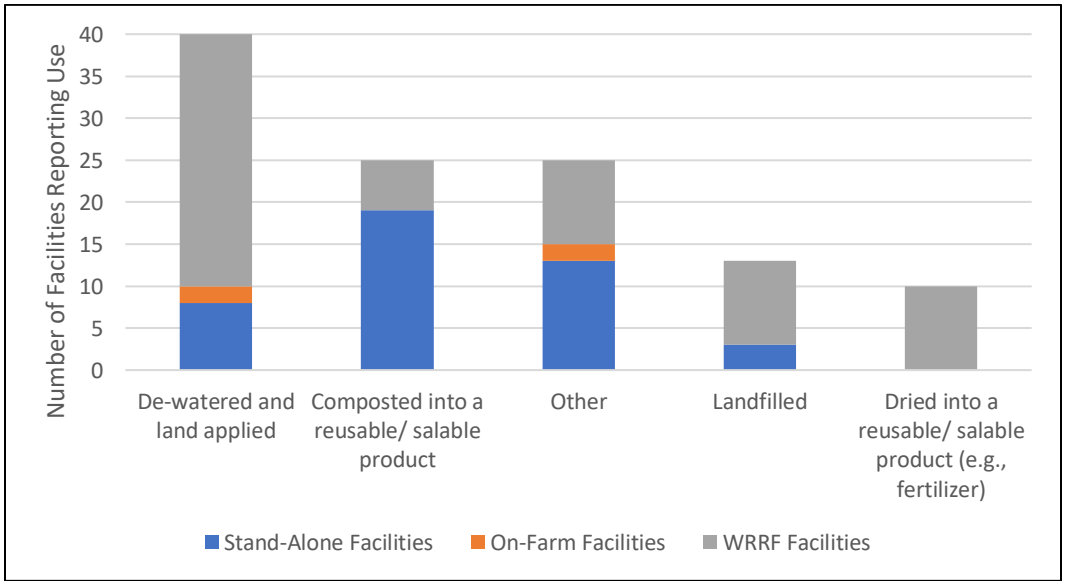

Figure 10: Top Five Uses of Solid Digestate by Digester Type

O. Liquid Digestate Uses

EPA asked how facilities manage liquid digestate, allowing respondents to provide more than one answer. Respondents from all 45 stand-alone facilities (100%), eight out of 10 on-farm co-digesters (80%), and 61 of 63 (97%) WRRFs provided data on the management of liquid digestate, as summarized in Table 32.

Of the 20 stand-alone digesters that used digestate as fertilizer via land application, only three facilities further reported processing it prior to application (15%). All eight on-farm co-digester operators responding to this question indicated that liquid digestate was land applied. None of these on-farm co-digester operators indicated that the liquid was further processed prior to application. Five WRRF digesters indicated that the liquid digestate they produced was land applied, and two of these facilities further processed it prior to application.

Table 32: Reported Liquid Digestate Uses

	Stand-Alone Digesters		On-Farm Co-Digesters		Co-Digestion Systems at WRRFs	
Digestate Use	***Number of Facilities Reporting Use***	***Percentage using Liquid Digestate as Specified****	***Number of Facilities Reporting Use***	***Percentage of using Liquid Digestate as Specified†***	***Number of Facilities Reporting Use***	***Percentage of using Liquid Digestate as Specified‡***
Recirculated through digester	9	20%	2	25%	50	82%
Reused as fertilizer via land application	20	44%	8	100%	5	8%
Discharged to a wastewater treatment plant	20	44%	0	0%	-	-
Other	8	18%	0	0%	7	11%

*Percentage calculation based on 45 stand-alone facilities providing data on use of liquid digestate.
†Percentage calculation based on eight farms providing data on use of liquid digestate.
‡Percentage calculation based on 61 WRRFs providing data on use of liquid digestate.

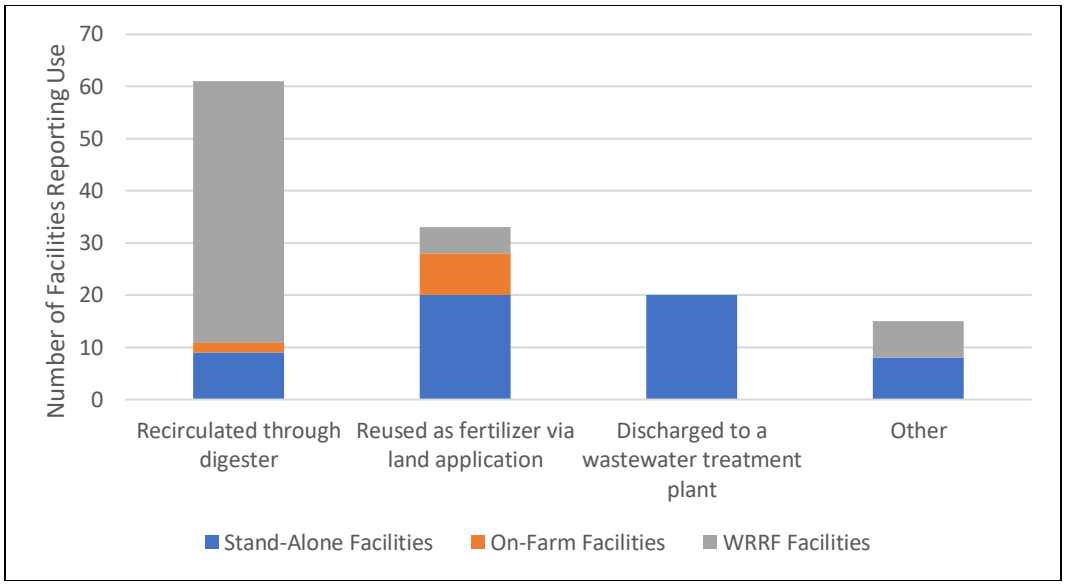

Figure 11: Uses of Liquid Digestate by Digester Type

IV. Conclusion

EPA's 2019 survey of three types of AD facilities in the U.S. (stand-alone digesters, on-farm digesters, and WRRFs) provided estimates of the number and location of facilities processing food waste in the U.S., their total amounts processed in 2017 and 2018, and their available capacity to process food waste. EPA's survey also gathered information on the non-food waste processed at these facilities, feedstock types and sources, tipping fees, pre-processing/de-packaging techniques, operational specifications, biogas production and uses, gas cleaning systems, and solid and liquid digestate uses. Lastly, EPA gathered information on facilities not yet operational, but that were anticipated to become operational in the future, which will be critical to tracking growth in capacity over time as future reports are developed.

Based on information received directly from facilities that responded to the 2019 survey, the total reported processing capacity for food waste at the responding AD facilities was approximately 24.3 million tons per year in 2019. The total amount food waste reported to be processed in 2017 was approximately 9.7 million tons and the total amount food waste reported to be processed in 2018 was just over 9.9 million tons.

Table 33: Summary of 2019 Survey Results

Area of Data Collection	Result
Total Processing Capacity	24,267,593 tons per year
Total Food Waste Processed (2017)	9,633,373 tons
Total Food Waste Processed (2018)	9,814,872 tons
Total Non-Food Waste Processed at Co-Digesting Facilities (2017)	1,401,160,160 gallons and 3,391,948 tons
Total Non-Food Waste Processed at Co-Digesting Facilities (2018)	1,443,485,312 gallons and 3,357,438 tons
Total Biogas Produced (2017)	25,273 SCFM
Total Biogas Produced (2018)	27,193 SCFM
Top Three States with the Most Digesters	California, Wisconsin, New York, Ohio*
Top Three Feedstock Types in 2019	FOG; Food Processing Industry Waste; Beverage Processing Industry Waste
Top Three Feedstock Sources in 2019	Food/Beverage Processors; Restaurants & Food Services; Grocery Stores/Supermarkets
Top Three Biogas Uses in 2019	Produce Heat and Electricity (CHP); Fuel Boilers and Furnaces to Heat Digesters; Fuel Boilers and Furnaces to Heat Other Spaces
Top Three Constituents Removed in 2019	Moisture; Hydrogen Sulfide; Sulfur
Top Three Uses of Solid Digestate in 2019	De-watered/dried and Land Applied; Composted into a Reusable/Salable Product; Other
Top Three Uses of Liquid Digestate in 2019	Recirculated Through Digester; Reused as Fertilizer via Land Application; Discharged to a Wastewater Treatment Plan
* New York and Ohio are tied at 9 digesters each.	

The total amount of non-food waste reported to be processed in 2017 and 2018 was just over 1.4 trillion gallons and nearly 3.4 million tons. The total amount of biogas produced in 2017 was over 25,274 SCFM and the total amount of biogas produced in 2018 was over 27,193 SCFM. Additional information on AD facilities is summarized in Table 33.

The extent to which the results of the 2019 survey can be compared with the 2017 and 2018 surveys should be caveated by the fact that the individual facilities responding from year to year are not identical. It should also be noted the facilities voluntarily chose to submit data. Due to the fact that the 2019 report had different facilities respond to the survey, the report cannot be used to express how the state of AD is increasing or decreasing. EPA will continue to gather data and seek to verify data received in 2017, 2018, and 2019 to clarify this information in these reports over time. Data collected during the 2020 survey will be summarized in a future report.

Appendix A – Operational Digesters and Co-Digestion Systems

This appendix lists the facilities for which survey responses were received in 2017, 2018, and 2019 for each digester type. The facilities that provided survey responses in 2017 were operational as of December 2017. The facilities that provided survey responses in 2018 were operational as of December 2018. The facilities that provided survey responses in 2019 were operational as of December 2019. These tables are not identical to the corresponding tables in Appendix A of the reports issued in 2018 and 2019. For this report, the tables were combined based on digester type and each table identifies each year that the facility responded. Facilities that responded to the survey in 2019 are numbered. If a facility did not respond in 2019, only the years it did respond are listed. The table descriptions are as follows:

Table 1A: Stand-Alone Anaerobic Digestion Facilities Digesting Food Waste in the U.S.
Table 2A: On-Farm Digesters Co-Digesting Food Waste in the U.S.
Table 3A: WRRF Digesters Co-Digesting Food Waste in the U.S.

Table 1A: Stand-Alone Anaerobic Digestion Facilities Digesting Food Waste in the U.S.

Stand-Alone Facility Name		Location	Year Facility Responded to Survey	Multi-Source (MS)/Industry-Dedicated (ID)/Other*
1	Ralphs Recovery System	Compton, CA	2017, 2018 & 2019	ID
2	Fairfield Brewery BTS	Fairfield, CA	2017, 2018 & 2019	ID
3	MillerCoors Brewery	Irwindale, CA	2017, 2018 & 2019	ID
	Zero Waste Energy – Monterey*	Marina, CA	2017 & 2018	
4	North State Rendering Co. Inc./John S. Ottone Renewable Energy Project	Oroville, CA	2017, 2018 & 2019	MS
5	Gills Onions	Oxnard, CA	2017, 2018 & 2019	ID
	CR&R Material Recovery Facility†	Perris, CA	2017	MS
	CleanWorld SATS (formerly Sacramento Biodigester)†	Sacramento, CA	2017 & 2018	MS
6	Kompogas SLO LLC	San Luis Obispo, CA	2018 & 2019	MS
7	Zero Waste Energy Development Company	San Jose, CA	2017, 2018 & 2019	MS
8	Blue Line Biogenic CNG Facility	South San Francisco, CA	2017, 2018 & 2019	MS
9	LA BTS	Van Nuys, CA	2017, 2018 & 2019	ID
10	Quantum Biopower	Southington, CT	2017, 2018 & 2019	MS
11	Harvest Power Orlando	Bay Lake, FL	2017, 2018 & 2019	MS
12	Jacksonville BTS	Jacksonville, FL	2017, 2018 & 2019	ID
13	Cartersville BTS	Cartersville, GA	2017, 2018 & 2019	ID
14	City of Waterloo Anaerobic Lagoon‡	Waterloo, IA	2018 & 2019	ID
15	Waste No Energy, LLC	Monticello, IN	2017, 2018 & 2019	MS
	Exeter Agri-Energy§	Exeter, ME	2017	
16	Stop & Shop Freetown Distribution Center	Assonet, MA	2017, 2018 & 2019	ID
	Garelick Farms†	Franklin, MA	2017 & 2018	ID
	Garelick Farms†	Lynn, MA	2017	ID
	Ken's Foods Inc. ¶	Marlborough, MA	2017	ID
17	CRMC Bioenergy Facility	New Bedford, MA	2017, 2018 & 2019	MS
18	Generate Fremont Digester, LLC	Fremont, MI	2018 & 2019	MS

Stand-Alone Facility Name		Location	Year Facility Responded to Survey	Multi-Source (MS)/Industry-Dedicated (ID)/Other*
19	Michigan State University South Campus Anaerobic Digester[π]	Lansing, MI	2017 & 2019	MS
20	Hometown BioEnergy	Le Sueur, MN	2017, 2018 & 2019	MS
21	St. Louis BTS	St. Louis, MO,	2017, 2018 & 2019	ID
22	Merrimack BTS	Merrimack, NH	2017, 2018 & 2019	ID
23	Newark BTS	Newark, NJ	2017, 2018 & 2019	ID
24	Lassonde Pappas	Seabrook, NJ	2017, 2018 & 2019	ID
25	Cayuga Regional Digester & Bioenergy Enterprise (formerly CH4 Generate Cayuga LLC)	Auburn, NY	2017 & 2019	MS
26	AB-Inbev Baldwinsville	Baldwinsville, NY	2017, 2018 & 2019	ID
27	Buffalo BioEnergy	West Seneca, NY	2017, 2018 & 2019	MS
28	Generate Niagara Digester (formerly Niagara BioEnergy)	Wheatfield, NY	2017, 2018 & 2019	MS
29	Synergy Biogas[∴]	Wyoming, NY	2019	MS
30	Orbit Energy Charlotte	Charlotte, NC	2019	MS
31	Full Circle Recycle	Zebulon, NC	2018 & 2019	MS
	Emerald BioEnergy[≈]	Cardington, OH	2017 & 2018	MS
32	Collinwood BioEnergy	Cleveland, OH	2018 & 2019	MS
33	Central Ohio BioEnergy	Columbus, OH	2017, 2018 & 2019	MS
34	Columbus BTS	Columbus, OH	2017, 2018 & 2019	ID
	Dovetail Energy[≈]	Fairborn, OH	2017 & 2018	MS
	Haviland Energy[¶]	Haviland, OH	2017	MS
35	Campbell Soup Supply Company	Napoleon, OH	2018 & 2019	ID
	Three Creek BioEnergy, LLC*	Sheffield Village, OH	2018	MS
36	Buckeye Biogas, LLC	Wooster, OH	2017, 2018 & 2019	MS
37	Zanesville Energy, LLC	Zanesville, OH	2017, 2018 & 2019	MS
38	Stahlbush Island Farms	Corvallis, OR	2017, 2018 & 2019	MS
39	D.G. Yuengling & Son, Inc.	Pottsville, PA	2017, 2018 & 2019	ID
	Kline's Services[¶]	Salunga, PA	2017	MS
40	Orbit Energy Rhode Island	Johnston, RI	2019	MS
41	Bush Brothers and Company Process Water Recovery Facility	Dandridge, TN	2018 & 2019	ID
42	Houston BTS	Houston, TX	2017, 2018 & 2019	ID
	Vermont Tech Community AD	Randolph, VT	2017	
43	Magic Hat Resource Recovery Center[°]	South Burlington, VT	2017, 2018 & 2019	MS
	Bush Brothers & Company[¶]	Augusta, WI	2017	ID
	Montchevre – Betin[¶]	Belmont, WI		ID
44	FCPC Renewable Generation	Milwaukee, WI	2017, 2018 & 2019	MS
45	Urban Dry Digester – UW Oshkosh	Oshkosh, WI	2017, 2018 & 2019	MS

*Facility has temporarily shut down.

[†]Facility has ceased operation.

[‡]This facility was identified as a WRRF co-digestion system in 2017.

[§]This facility reported as a farm digester in 2018 and did not report in 2019.

[¶]This facility did not respond to the survey after 2017. Status is unknown.

[π]This facility did not respond to the survey in 2018.

[∴]This facility reported as a farm digester in 2017.

[≈]This facility did not respond to the survey after 2018. Status is unknown.

Stand-Alone Facility Name	Location	Year Facility Responded to Survey	Multi-Source (MS)/Industry-Dedicated (ID)/Other*
°This facility reported as a farm digester in 2018 & 2019.			

Table 2A: On-Farm Digesters Co-Digesting Food Waste in the U.S.

Farm Name		Location	Year Farm Digester Responded to Survey
	Green Cow Power	Goshen, IN	2018
	BioTown Ag	Reynolds, IN	2018
	Link Energy	Riceville, IA	2017
	Exeter Agri-Energy/Stonyvale Farm	Exeter, ME	2017 & 2018
	Kilby's Inc.	Colora, MD	2017
1	Deerfield AD1 (Bar-Way Farm)*	Deerfield, MA	2017 & 2019
2	Hadley AD1 (Barstow's Longview Farm)	Hadley, MA	2019
3	Haverhill Digester	Haverhill, MA	2019
4	Rutland AD1	Rutland, MA	2018 & 2019
	Pine Island Farm	Sheffield, MA	2017
5	Spencer's Digester	Spencer, MA	2019
	Patterson Farms, Inc.	Auburn, NY	2017 & 2018
6	Noblehurst Green Energy	Linwood, NY	2017, 2018 & 2019
	CH4/Synergy Biogas	Wyoming, NY	2017
	Kish-View Farm	Belleville, PA	2017
	Oregon Dairy	Lititz, PA	2018
	Schrack Farms	Loganton, PA	2017
7	Reinford Farms	Mifflintown, PA	2017, 2018 & 2019
	Oak Hill Farm	Nottingham, PA	2018
	Chaput Family Farms	North Troy, VT	2018
8	Vermont Technical College Anaerobic Digester†	Randolph Center, VT	2018 & 2019
	Monument Farms Three-Gen	Weybridge, VT	2017
9	FPE Renewables/Vander Haak Dairy	Lynden, WA	2018 & 2019
	Qualco Energy	Monroe, WA	2018
	Holsum Elm Dairy	Hilbert, WI	2018
	Holsum Irish Dairy	Hilbert, WI	2018
	Clean Fuel Dane, LLC	Dane, WI	2017
	Five Star Dairy, LLC	Elk Bridge, WI	2017
10	Allen Farms	Oshkosh, WI	2017, 2018 & 2019

* This farm did not respond to the survey in 2018.

†This farm digester reported as a stand-alone digester in 2017.

Table 3A: WRRF Digesters Co-Digesting Food Waste in the U.S.

WRRF Name		Location	Year WRRF Digester Responded to Survey
1	Wildcat Hill Wastewater Treatment Plant	Flagstaff, AZ	2017, 2018 & 2019
2	Fourche Creek Water Reclamation Facility	Little Rock, AR	2017, 2018 & 2019
3	Bakersfield Wastewater Treatment Plant # 2	Bakersfield, CA	2017, 2018 & 2019
4	Bakersfield Wastewater Treatment Plant # 3	Bakersfield, CA	2017, 2018 & 2019
	Delta Diablo WWTP*	Antioch, CA	2017 & 2018
5	Hill Canyon Wastewater Treatment Plant	Camarillo, CA	2017, 2018 & 2019
6	Encina Wastewater Authority (EWPCF)	Carlsbad, CA	2017, 2018 & 2019
	Joint Water Pollution Control Plant*	Carson, CA	2017 & 2018
7	Sacramento Regional Wastewater Treatment Plant	Elk Grove, CA	2017, 2018 & 2019

WRRF Name		Location	Year WRRF Digester Responded to Survey
8	Fairfield-Suisun Sewer District	Fairfield, CA	2017, 2018 & 2019
	Fresno-Clovis RWRF†	Fresno, CA	2017 & 2018
9	City of Hayward Water Pollution Control Facility	Hayward, CA	2017, 2018 & 2019
10	Napa Sanitation District	Napa, CA	2017, 2018 & 2019
11	East Bay Municipal Utility District Main Wastewater Treatment Plant	Oakland, CA	2017, 2018 & 2019
12	Silicon Valley Clean Water	Redwood City, CA	2017, 2018 & 2019
13	Oro Loma Sanitary District	San Lorenzo, CA	2017, 2018 & 2019
14	Central Marin Sanitation Agency	San Rafael, CA	2017, 2018 & 2019
15	El Estero WWTP	Santa Barbara, CA	2017, 2018 & 2019
16	Santa Rosa Regional Water Reuse Plant (Laguna Treatment Plant)	Santa Rosa, CA	2017, 2018 & 2019
	Victor Valley Wastewater Reclamation Authority†	Victorville, CA	2017 & 2018
	City of Watsonville WWTP†	Watsonville, CA	2017 & 2018
	Santa Rita Wastewater Reclamation Plant (City of Durango WWTP) †	Durango, CO	2017 & 2018
	North Regional WWTP‡	Pompano Beach, FL	2017
17	South Cross Bayou Advanced Water Reclamation Facility	St. Petersburg, FL	2017, 2018 & 2019
18	Thomas P Smith Water Reclamation Facility (TPS Treatment Plant)	Tallahassee, FL	2017, 2018 & 2019
19	F. Wayne Hill Water Resources Center	Buford, GA	2017, 2018 & 2019
20	South Columbus Water Treatment Facility	Columbus, GA	2017, 2018 & 2019
	Lower Poplar Street Water Reclamation Facility†	Macon, GA	2017 & 2018
21	Ames Water Pollution Control Plant	Ames, IA	2017, 2018 & 2019
22	Davenport Water Pollution Control Plant	Davenport, IA	2017, 2018 & 2019
23	Des Moines Metropolitan Wastewater Reclamation Authority	Des Moines, IA	2017, 2018 & 2019
24	Dubuque Water & Resource Recovery Center	Dubuque, IA	2017, 2018 & 2019
25	Downers Grove Sanitary District Wastewater Treatment Center	Downers Grove, IL	2017, 2018 & 2019
26	Rock River Water Reclamation District	Rockford, IL	2017, 2018 & 2019
27	Urbana & Champaign Sanitary District	Urbana, IL	2017, 2018 & 2019
28	West Lafayette Wastewater Treatment Facility	West Lafayette, IN	2017, 2018 & 2019
29	DLS Middle Basin Wastewater Treatment Plant	Overland Park, KS	2017, 2018 & 2019
30	Greater Lawrence Sanitary District	North Andover, MA	2017, 2018 & 2019
31	Lewiston-Auburn Water Pollution Control Authority	Lewiston, ME	2017, 2018 & 2019
32	Delhi Charter Township Wastewater Treatment Plant	Holt, MI	2017, 2018 & 2019
33	Flint Biogas Plant	Flint, MI	2018 & 2019
34	St. Cloud Nutrient, Energy and Water Recovery Facility	St. Could, MN	2018 & 2019
35	City of Springfield Southwest Wastewater Treatment Plant	Springfield, MO	2017, 2018 & 2019
	Theresa Street WRRF§	Lincoln, NE	2017
36	Joint Meeting of Essex & Union Counties	Elizabeth, NJ	2017, 2018 & 2019
	Village of Ridgewood Water Pollution Control Facility*	Glen Rock, NJ	2017
	Rahway Valley Sewerage Authority†	Rahway, NJ	2018

WRRF Name		Location	Year WRRF Digester Responded to Survey
37	Landis Sewerage Authority	Vineland, NJ	2017, 2018 & 2019
38	Newtown Creek Wastewater Resource Recovery Facility	Brooklyn, NY	2017, 2018 & 2019
39	LeRoy R. Summerson Wastewater Treatment Facility	Cortland, NY	2017, 2018 & 2019
40	Gloversville Johnstown Joint Wastewater Treatment Facility	Johnstown, NY	2017, 2018 & 2019
	City of Watertown Pollution Control Plant[‡]	Watertown, NY	2017
41	City of London Wastewater Treatment Plant	London, OH	2017, 2018 & 2019
42	City of Newark Wastewater Treatment Plant	Newark, OH	2019
43	City of Wooster Water Resource Recovery Facility	Wooster, OH	2018 & 2019
44	Gresham Wastewater Treatment Plant	Gresham, OR	2017, 2018 & 2019
45	City of Pendleton Wastewater Treatment Facility	Pendleton, OR	2017, 2018 & 2019
46	Clean Water Services - Durham Advanced Wastewater Treatment Facility	Tigard, OR	2017, 2018 & 2019
47	Hermitage Municipal Authority	Hermitage, PA	2017, 2018 & 2019
48	Derry Township Municipal Authority	Hershey, PA	2017, 2018 & 2019
49	Milton Regional Sewer Authority	Milton, PA	2017, 2018 & 2019
50	New Castle Sanitation Authority	New Castle, PA	2017, 2018 & 2019
51	Mauldin Road Water Resource Recovery Facility	Greenville, SC	2017, 2018 & 2019
52	Southside Wastewater Treatment Plant	Dallas, TX	2017, 2018 & 2019
53	Waco Metro - Area Regional Sewage System	Waco, TX	2017, 2018 & 2019
54	North River Wastewater Treatment Facility	Mt. Crawford, VA	2017, 2018 & 2019
55	Opequon Water Reclamation Facility	Winchester, VA	2017, 2018 & 2019
56	Village of Essex Junction Water Resource Recovery Facility	Essex Junction, VT	2017, 2018 & 2019
57	Appleton Wastewater Treatment Plant	Appleton, WI	2017, 2018 & 2019
58	Fond du Lac Regional Wastewater Treatment & Resource Recovery Facility	Fond du Lac, WI	2017, 2018 & 2019
59	City of Kiel Wastewater Facility	Kiel, WI	2017, 2018 & 2019
60	MMD South Shore Water Reclamation Facility	Oak Creek, WI	2017, 2018 & 2019
	City of Port Washington Wastewater Treatment Plant[†]	Port Washington, WI	2017 & 2018
61	City of Rice Lake Wastewater Treatment Plant	Rice Lake, WI	2017, 2018 & 2019
62	Stevens Point Wastewater Treatment Plant	Stevens Point, WI	2017, 2018 & 2019
63	City of West Bend Wastewater Treatment Plant	West Bend, WI	2017, 2018 & 2019
	Wisconsin Rapids Wastewater Treatment Facility[†]	Wisconsin Rapids, WI	2017 & 2018

*Facility has temporarily shut down.

[†]This facility did not respond to the survey after 2018. Status is unknown.

[‡]This facility did not respond to the survey after 2017. Status is unknown.

[§]Facility has ceased operation.

Appendix B – Digesters and Co-Digestion Systems Under Development or Temporarily Shut-Down

This appendix lists the stand-alone facilities and co-digestion systems at WRRFs that are under development and temporarily shut down. No on-farm co-digesters have been identified that are currently under development. The lists in Table 1B and 2B are current as of December 2018. The table descriptions are as follows:

Table 1B: Stand-Alone Anaerobic Digestion Facilities in the U.S. that are Under Development or Temporarily Shut Down
Table 2B: WRRF's with Co-Digestion Systems in the U.S. that are Under Development or Temporarily Shut Down

Table 1B: Stand-Alone Anaerobic Digestion Facilities in the U.S. that are Under Development or Temporarily Shut Down

	Stand-Alone Facility Name	Facility Status	Location
1	Zero Waste Energy - Monterey	Temporary Shut-Down	Marina, CA
2	Agromin Organic Recycling Compost Facility	Planning stage; Design stage; Permitting Process	Oxnard, CA
3	ReSource Center (Formerly Tajiguas Resource Recovery Project)	Planning stage; Design stage; Permitting Process	Santa Barbara, CA
4	BTS Biogas LLC - Maryland Food Center	Under Construction	Jessup, MD
5	Linden Renewable Energy	Planning stage; Design stage; Permitting Process	Linden, NJ
6	Napoleon Biogas	Temporary Shut-Down	Napoleon, OH
7	Three Creek BioEnergy, LLC	Temporary Shut-Down	Sheffield Village, OH
8	Point Breeze Renewable Energy	Planning stage; Design stage; Permitting Process	Philadelphia, PA
9	Freestate Farms Integrated Facility	Planning stage; Design stage; Permitting Process	Manassas, VA

Table 2B: WRRF's with Co-Digestion Systems in the U.S. that are Under Development or Temporarily Shut Down

	WRRF Name	Facility Status	Location
1	Delta Diablo WWTP	Temporary Shut-down	Antioch, CA
2	Joint Water Pollution Control Plant	Temporary Shut-down	Carson, CA
3	South Slope Wastewater Treatment Plant	Planning stage; Design stage; Permitting Process	Moline, IL
4	Kinross Township Wastewater Treatment Plant	Under Construction	Kincheloe, MI
5	Western Lake Superior Sanitary District	Planning stage; Design stage; Permitting Process	Duluth, MN
6	Village of Ridgewood Water Pollution Control Facility	Temporary Shut-down	Glen Rock, NJ
7	City of Rome Water Pollution Control Facility	Under Construction	Rome, NY

Appendix C – Digesters and Co-Digestion Systems that have Ceased Operations

This appendix lists the facilities for each digester type that have either ceased operations or are not going to be completed. This list is current as of December 2019.

Table 1C: Facilities that Have Ceased Operation or are not going to be Completed in the U.S.

Stand-Alone Digesters		
	Digester Name	**Location**
1	CR&R	Perris, CA
2	CleanWorld SATS (formerly Sacramento Biodigester)	Sacramento, CA
3	Heartland Biogas	LaSalle, CO
4	Turning Earth	Southington, CT
5	Garelick Farms	Lynn, MA
6	Gloucester City Organic Recycling	Marlton, NJ
7	JC-Biomethane Biogas Plant	Junction City, OR
Farm Co-digestion Systems		
	Digester Name	**Location**
8	Zuber Farms	Byron, NY
9	George Deruyter Dairy	Outlook, WA
10	Wild Rose Dairy	LaFarge, WI
11	Central Sands Dairy	Nekoosa, WI
WRRF Co-Digestion Systems		
	Digester Name	**Location**
12	Hyperion Treatment Plant	Playa Del Rey, CA
13	Theresa Street WRRF	Lincoln, NE
14	Metropolitan Syracuse Wastewater Treatment Plant	Syracuse, NY
15	Struthers Wastewater Treatment Plant	Struthers, OH
16	Janesville Wastewater Treatment Plant	Janesville, WI
17	Sheboygan Wastewater Treatment Plant	Sheboygan, WI

Appendix D – Survey Questions

This appendix provides the lists of questions asked via a survey for each digester type regarding their use of food waste and food-based materials as a feedstock. EPA distributed the surveys via email directly to facility contacts, when known, and made the survey available on EPA's website.

Survey 1: Stand-Alone Anaerobic Digestion Facility Survey Questions
Survey 2: On-Farm Digester Survey Questions
Survey 3: Co-Digestion Systems at Water Resource Recovery Facilities Survey Questions