SOURCE SEPARATED FOOD WASTE FLOW TO FARM DIGESTERS

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INTRODUCTION

According to the US Environmental Protection Agency's (USEPA) annual report, *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010*,[1] a total of 34.76 million tons of food waste was generated by the residential, commercial and institutional sectors in 2010. Of that 34.76 million tons, only 2.8 percent — or 0.97 million tons — were recovered and utilized as animal feed, or composted or anaerobically digested. The USEPA's definition of municipal solid waste (MSW) does not include industrial or agricultural waste streams. Therefore the 34.76 million tons do not include residuals from food processors and manufacturers, beverage industries or agricultural operations.

In its food waste management hierarchy, USEPA lists the highest and best end uses for food waste in the MSW stream. At the top of the hierarchy is source reduction, i.e., not generating food waste in the first place, e.g., through better food purchasing practices and inventory management. Next on the list is donation of edible food, e.g., food that is close to its sell date that can be donated to food banks. After donation on the hierarchy is animal feed, followed by "industrial uses," which includes anaerobic digestion, then composting and finally, disposal.

Several factors contribute to the reality that less than 3 percent of the food waste generated in the United States is recovered. First is the lack of processing infrastructure for food waste, either via composting or anaerobic digestion. Second is relatively low landfill tipping fees that make it challenging for food waste recycling facilities to compete. Third is the potential for contamination in the food waste, primarily plastic—even when food waste is separated from packaging and there is signage on "organics only" collection containers explaining what is allowed. Contaminants are a deterrent to processing facilities (both composting and digesters).

On the other hand, a number of factors have been facilitating more diversion of source separated food waste from disposal. Many state and local government agencies have established programs to encourage source separation of food waste in the commercial and residential sectors. This includes training programs for businesses and institutions on how to separate and collect food waste from kitchens, cafeterias, restaurants and other food service establishments, as well as grocery stores and

[1] 1 USEPA. 2010. Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010.
http://www.epa.gov/ osw/nonhaz/municipal/msw99.htm.

produce terminals. As more programs have been established, haulers have responded with collection services, and processors have taken steps to be permitted to receive the feedstocks.

Also driving diversion of food waste are corporate and institutional commitments to sustainability, which include reducing waste generation and disposal, and increasing food donations and diversion to composting and anaerobic digestion. This commitment includes recognition that even though the costs to start a diversion program may be higher than what companies and institutions currently pay for disposal (and more labor may be involved for separation and collection), they are willing to take that step. Furthermore, as companies and institutions begin diversion programs, they quickly find that the decrease in frequency of trash disposal service offsets the higher costs of diversion. They also become aware of how much food is being disposed, which leads to better purchasing practices.

On the food processing side of the source separated food waste stream, industries are facing more restrictions on direct land application, or else are having to haul materials longer distances to farmland. Discharge directly to the wastewater treatment plant may be restricted, or the sewer surcharges may be costly. These trends are leading more industrial generators of source separated food waste to consider diversion to anaerobic digestion.

Finally, states are recognizing the benefits of food waste diversion, and are revising and/or creating regulations that make it easier to receive and process food waste. Increasingly, states also are establishing guidelines and permitting procedures for diversion of food waste to anaerobic digesters.

SOURCE SEPARATED MATERIALS AVAILABLE FOR AD

Source separated food waste, as distinguished from mixed waste, is material that has been separated at the point of generation, removing nonorganic items such as plastic, metal and glass. In the municipal solid waste stream (commercial, institutional, residential), source separated food waste generally falls into two categories — preconsumer and postconsumer. Preconsumer food waste is any food that has not yet been served. This includes kitchen prep waste, food that is past its sell date and prepared foods that cannot be donated. Preconsumer food waste, primarily from a regulatory perspective, is further divided into vegetative and nonvegetative (e.g., meat, dairy, fish) categories. This distinction revolves around potential pathogen and vectors in the nonvegetative stream.

Postconsumer food waste is comprised of food that has been served but not consumed, e.g., plate scrapings, salad bar contents. It typically is regulated as nonvegetative. Finally, many source separated food waste diversion programs include soiled paper and wet and/or waxed corrugated cardboard.

While the USEPA distinguishes between food waste from the residential, commercial and institutional sectors and food waste from the industrial and agricultural sectors, most state regulatory agencies have not designed their permits in the same way. Typically, vegetative food processing residuals fall into a similar category as vegetative preconsumer food waste from the MSW stream. For example, a composting facility permitted to receive source separated, preconsumer vegetative materials can receive produce waste from grocery stores and potato peels from a food processor. In fact, many composters prefer the "industrial" materials because they have little to no contamination and can be immediately incorporated into composting operations.

Anaerobic digestion facilities are tapping into many of these same source separated food waste streams. They are able to benefit from many years of outreach, education and training on source separation procedures as well as establishment of collection and hauling services — primarily developed for diversion to composting. The challenge, however, is that the much of this material requires preprocessing before it can be added to anaerobic digesters (unless a higher solids AD technology is utilized).

Quantification of Source Separated Food Waste Streams

Quantifying how much source separate food waste is available for diversion by various sectors is not an exact science. The data available is typically based on waste characterization studies, such as sorting and weighing food waste from a cross section of generators. In terms of the commercial sector, a June 2006 waste characterization study by Cascadia Consulting Group, prepared for the California Integrated Waste Management Board (now CalRecycle) focused on waste disposal and diversion for selected industry groups, including food service and grocery stores.[2] The following is a summary:

- Full service restaurants generate 4,400 lbs waste/yr/employee (after recycling) of which 66% are food scraps.
- Fast food restaurants generate 4,250 lbs waste/yr/employee (after recycling) of which 52% are food scraps.
- Grocery stores generate 4,750 lbs waste/yr/employee (after recycling) of which 65% are food scraps.
- Large hotels generate 3,900 lbs waste/yr/employee (after recycling) of which 44% are food scraps.

Biomethane Potential of Food Waste

Scientific literature typically reports yield of biomethane in terms of methane yield per dry weight of volatile solids. It is commonly recognized that food waste has about double the methane yield per pound of volatile solids than dairy manure (15.0 ft^3/lb VS

[2]California Integrated Waste Management Board. June. 2006. Waste Disposal and Diversion Findings for Selected Industry Groups. http://www.calrecycle.ca.gov/publications/Disposal/34106006.pdf

vs 7.0 ft^3/lb VS). In a study on pretreatment of municipal solid waste prior to anaerobic digestion, Zhang et al reported that food waste has 511 ml/g volatile solids, or a methane content of 9,630 ft^3/dry ton.[3] This is equivalent to 64% methane content.

A fact sheet prepared by Washington State University Extension, "Anaerobic Co-Digestion On Dairies in Washington State," cites an economic analysis of an anaerobic digester facility installed on a 700-cow dairy in northwest Washington.[4] "….co-digestion with 16% organic wastes more than doubled biogas production and almost quadrupled annual digester revenues compared to a manure-only baseline, with 72% of all receipts directly attributable to the addition of organic wastes."

A 2011 report by David Paul Rosen & Associates, *Anaerobic Biodigester Financial Feasibility Assessment*, conducted for the Washington State Housing Finance Commission, calculated that the average electricity output from manure alone is 0.25 kW/cow.[5] Adding 10% food waste by volume is estimated to increase electrical production by 25%. Adding 20% food waste by volume is estimated to increase electrical production by 50%.

Costs To Accommodate Source Separated Food Waste

Unlike some industrial or agricultural food processing residuals that are in a slurry form when delivered to a farm digester, source separated organic wastes arrive in a solid or semi-solid state. In order to be loaded into the digester, these materials must be preprocessed to reduce the solids content. This can entail capital expenditures on the part of the farm, however these costs can be offset by anticipated revenue from tipping fees as well as increased biogas production.

Ideally, digester developers and owners would like to secure multiyear contracts to receive source separated food waste, but generators and/or the haulers may be reluctant to commit to a certain price (per ton or per gallon) as the solid waste disposal market is highly competitive. Another consideration for the farms is having some storage capacity for these food wastes if the digester is down for maintenance or repairs.

Reinford Farm in Mifflintown, Pennsylvania, receives 60 to 70 tons/week of commercial food waste primarily from Walmart and Sam's Club stores in the region

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[3] Zhang, R., J. Rapport, P. Gikas, B. Zhu, B. Jenkins, J. Lord and C. Choate. Pretreating MSW Prior To Anaerobic Digestion. BioCycle. 50-4:20-

[4]Anaerobic Co-Digestion on Dairies in Washington State. Washington State University Extension Fact Sheet (FS040E)

[5]Washington State Housing Finance Commission. 2011. Anaerobic Biodigester Financial Feasibility Assessment. David Paul Rosen & Associates.

which it processes with manure from about 500 cows. Walmart associates are trained to separate packaging from the food waste, which consists primarily of nonedible produce and bakery waste, and a small amount of dairy. The food waste is stored in 3- and 4-cubic yard locked receptacles, and hauled about once a week to Reinford Farm.

The food waste is emptied into a holding pit and then loaded into a grinder designed and built by Reinford. (It is a forage chopper that was revamped to grind food waste.) The food waste is ground for 30 to 45 minutes and then added to a concrete influent tank where it is mixed with manure. The mixed materials, at about 14 percent solids, are gravity-fed through a six-inch pipe into the digester every four hours for 15 minutes.

Haulers who deliver source separated food waste to dairy farms for co-digestion note that it is optimum to have the ability to observe the loads prior to preprocessing in order to remove any contaminants. Having a visual inspection pit enables the driver to pull out contaminants. Locating the unloading area and/or pit where the truck has adequate room to raise the trailer is also critical, as is having easy in and out access to the unloading area. To eliminate the need to preprocess on the farm, some haulers are evaluating the feasibility of either having a grinder installed on the truck, or else having a centralized transfer station where source separated food waste can be processed prior to delivery to the farm.

Brubaker Farms near Mount Joy, Pennsylvania receives preprocessed food waste from the dining hall at nearby Elizabethtown College, which it adds to its digester. At the college's main Marketplace Dining Facility, a revolving carousel delivers students' trays to the kitchen, where staff scrapes the food waste into a grinder — basically an industrial-sized garbage disposal. Processing is helped along by a recirculating stream of water. The pulped food waste slurry from approximately 2,400 meals served daily travels through 2-inch copper piping to an extractor, where it is pressed to 80 percent solids. These are placed into 32-gallon toters for a twice-weekly haul to Brubaker Farms. The recirculating grey water from the pulping process is changed with fresh water daily at an appointed shutdown time and gets pumped to an outside holding tank where it is mixed with the fats, oils and grease (FOG) also generated by the cafeteria. That mixture is pumped twice weekly through a 1.5-inch pipe (insulated and encased in a 6-inch pipe) into a mobile 1,200-gallon tank mounted to the front cargo area of a box truck. That leaves room for the six to eight toters — weighing about 200 pounds each — of pulped and separated solids.

The farm receives about $400/month in tipping fees. A 25,000-gallon reception pit holds food waste from Elizabethtown College as well as what Brubaker refers to as "spot loads" of rejected milk from other area dairies and food processing waste from local manufacturers including candy rinse water and chocolate. About 725 of 800 total milking cows along with 500 heifers of varying ages supply the digester with approximately 22,000 gallons of manure daily. The manure gets delivered to a twin 25,000-gallon reception pit and then goes into the digester four times daily via a Vaughn chopper pump. The food waste gets added to the manure right before the Vaughn unit

pumps it into the digester. The reception tanks are rarely full, and therefore can accommodate several truckloads of food waste at one time if needed.

Increasingly, farm digesters are being designed with capacity to receive source separated food waste streams, as well as other high strength organics such as ethanol thin stillage, glycerin, and food processing residuals. For example, a community digester constructed near Waunakee, Wisconsin in Dane County installed a stand-alone substrate tank to receive fats, oils, grease and other high strength organic wastes that are blended with the raw manure and added to the digester tanks. The facility is designed to receive about 8,000 gallons/day of food waste and other substrates, which are expected to increase biogas production by 50%.

PERMITTING CONSIDERATIONS

Farm digesters processing only manure often are regulated under CAFO rules, and/or within a state's Department of Agriculture. Source separated food waste from the municipal solid waste stream is typically regulated under a state's solid waste management rules. Agricultural and industrial food processing residuals can fall within agricultural, solid waste and/or wastewater rules.

Recently, the USEPA AgSTAR website added a page on State Permitting Requirements for anaerobic digesters.[6] The table is divided into air, solid waste and water permits. In Washington State, for example, AD systems that contain at least 50 percent manure and no more than 30 percent other organic waste may operate under an exemption from solid waste handling permits. Systems not subject to the exemptions must obtain a permit.

In Michigan, if a material other than manure is added to the AD system, authorization may be required before composting or land applying the solids; each operation is encouraged to work with the Michigan Department of Environmental Quality to determine what might be required. Some materials are exempted from permitting including food processing residuals, syrup from ethanol production and grease trap wastes that do not contain septage and fish wastes. To be exempt, the anaerobic digester must accept less than 20% other organics.

In Ohio, AD systems accepting manure only and less than 25% by volume of organic wastes can be permitted through the Ohio Department of Agriculture, as long as the facility complies with its nutrient management plan. Approved organic materials include preconsumer food wastes, grease trap wastes and similar organics. For AD systems processing more than 25% of other organic wastes, the Ohio EPA becomes involved in the permitting process and a separate permit may be required.

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[6]USEPA. 2011. State Permitting Requirements; (http://www.epa.gov/agstar/tools/permitting.html).

Massachusetts has a draft rule out for public comment that will create regulations for anaerobic digesters processing source separated food waste. A draft circulated in the summer of 2011 establishes a new exemption from site assignment for anaerobic digesters receiving source separated organics. (Normally, a solid waste facility is required to obtain site assignment from the local board of health, and a solid waste permit from the Massachusetts Department of Environmental Protection.) Three categories of digester facilities were proposed:

- Farm AD Unit: exempt from solid waste regulations as long as complies with Department of Agricultural Resources regulations.
- Non-Farm Unit: obtains Permit By Rule if <60 tons/day and complies with performance standards.
- Non-Farm Unit > 60 tons/day taking source separated organics must apply for recycling, composting or conversion permit that would exempt unit from site assignment and solid waste permitting. Would need to obtain permit to manage SSO.

CONCLUSIONS

The high energy content of source separated food waste from the municipal, industrial and agricultural sectors makes these organic wastes good feedstocks for anaerobic digestion. Public and private sector interest in diverting source separated food waste from disposal in landfills is contributing to establishment of collection programs. The potential for contamination of source separated food waste — primarily from the commercial (e.g., foodservice), institutional and residential sectors — is a deterrent to accepting these feedstocks at anaerobic digesters, as contaminants can cause mechanical breakdowns and add labor to pick contaminants out of incoming feedstocks. Furthermore, source separated food waste typically requires particle size reduction prior to addition to the digester.

At the same time, anaerobic digesters that receive source separated food waste typically receive a tipping fee, and benefit from increased biogas production. It is becoming more common for digesters being built today to include receiving and or storage capacity for source separated food waste and other substrates.

Recognition of the “biogas boost” from food waste — as well as the tipping fee revenues — is attracting other digester facilities to build capacity to receive these feedstocks. This includes existing municipal wastewater treatment plants and new commercial, non-farm digesters. This has the potential to increase competition for source separated food waste.