Executive Summary: Draft PA No. 8 – Food Waste to Energy Project

[**Note:** Kennedy/Jenks currently is conducting a Food Waste and Cogeneration Study (Study) for the City of Santa Cruz (City) Public Works Department (PW) which would be located at the City Wastewater Treatment Plant (City WWTP). Since the results of the Study are not yet available, this project assessment contains preliminary food waste to energy estimates and will be finalized with project-specific details at a later date.]

Description

A food waste to energy (FWTE) project combines organic waste from foods with wastewater solids in a wastewater anaerobic digester to produce additional biogas (additional to the biogas produced from wastewater solids alone). According to the US EPA, food waste produces approximately three times the amount of biogas compared to wastewater solids. In this project assessment, the additional digester gas would replace current natural gas use and therefore would reduce direct GHG emissions. The quantity of local source-separated food waste is estimated to be between 60 and 100 tons per week, which could produce up to 76,400 cubic feet per day (cfd) of digester gas. Depending on the extent of the PW FWTE program, all or a percentage of the available food waste and resulting GHG reduction could be credited to SCWD and/or SqCWD.

Amount of GHG Reduction

Combustion of the additional digester gas would result in a reduction of approximately 810 MT CO_2e per year and over 16,200 MT CO_2e total over the project life. Depending upon how the project is structured, the GHG offsets could benefit SCWD, SqCWD, the City PW, or all three. This project could produce up to 100% of the potential GHG reduction goals for SCWD and approximately 50% of the potential GHG reduction goals for SqCWD.

Project Life and Sustainability

A FWTE program would continue to produce biogas and provide GHG reduction for the estimated 20 year life of the project. The project would be sustained by normal maintenance and repair.

Project Cost

The average annual net cost of the project is estimated to be approximately $280,000 per year, since the capital, operation, and maintenance costs are greater than the savings from reduced natural gas use.

Table ES-1: Food Waste to Energy Project Summary

Life (yr)	Capital Cost ($)	Average Annual Net Cost ($/Yr)	Average Annual GHG Reductions (MT/Yr)	Lifecycle Energy Cost ($/Therm)[1]	Lifecycle GHG Reduction Cost ($/MT)
20	$3,750,000	$280,000	810	$1.5	$276

[1]Since this project was assumed to reduce natural gas use, the lifecycle cost is reported in dollars per therm.

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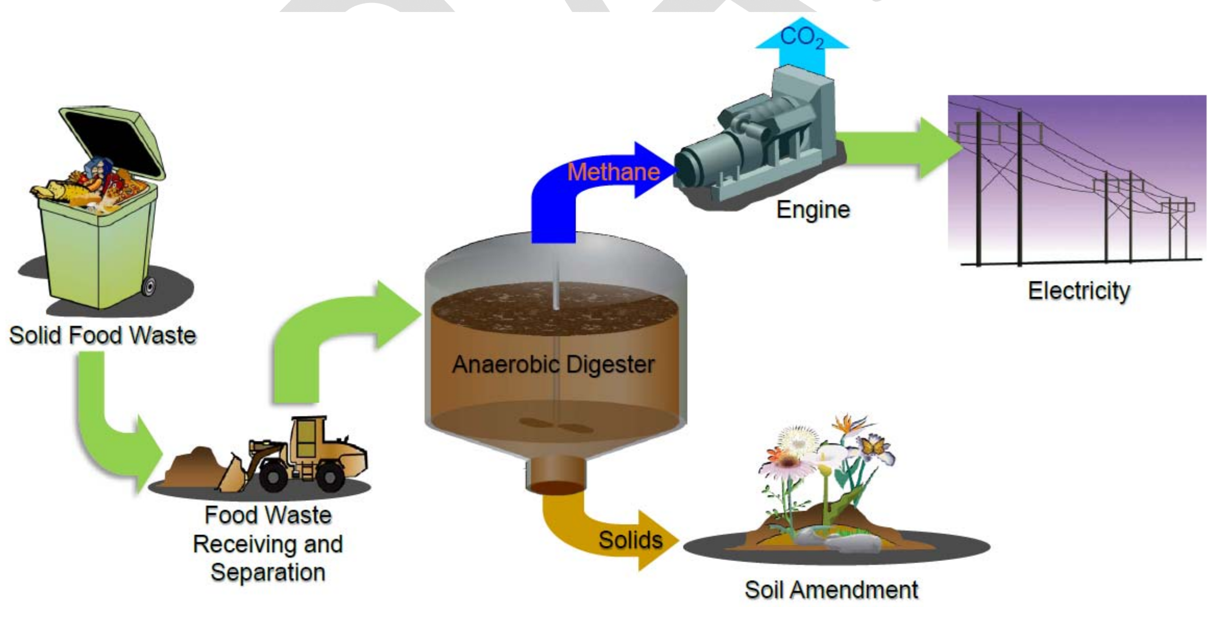
[**<u>Note:</u>** Kennedy/Jenks currently is conducting a Food Waste and Cogeneration Study (Study) for the City of Santa Cruz (City) Public Works Department (PW) to be located at the City Wastewater Treatment Plant (City WWTP). Since the results of the Study are not yet available, this project assessment contains preliminary food waste to energy estimates and will be finalized with project-specific details at a later date.]

Description

This assessment estimates the energy production and GHG reduction potential from a FWTE project at the City WWTP. Depending upon how the project is structured, the GHG offsets could benefit SCWD, SqCWD, the City PW, or all three.

A food waste to energy (FWTE) project combines high-strength organic waste from foods with wastewater solids in a wastewater anaerobic digester with excess capacity to produce biogas. According to the US EPA, food waste produces approximately three times the amount of biogas compared to wastewater solids. Benefits of anaerobic co-digestion can include enhanced biogas production, improved biogas quality, improved biosolids dewaterability, and reduced residual biosolids. As an alternative to landfill disposal, food scrap and food processing wastes are ideal for anaerobic digestion at wastewater treatment plants, assuming there is excess digester capacity. Figure 1 illustrates the FWTE process.

Figure 1: Food Waste to Energy Process



A combustion generator operating on digester gas produces emissions, including CO_2 and a small amount of other gases. However, these emissions are not accounted for as "GHG emissions" because they come from a non-fossil fuel source and are considered biogenic. The combustion generator process converts the more potent GHG (methane) to less potent GHG (carbon dioxide) while extracting energy in the process. The emissions of CO_2 (and a small amount of other gases from the digester biogas combustion generator at the WWTP) would be released with or without the digester gas combustion generator system. Therefore, the energy produced from digester methane combustion generators is considered to be “GHG-free” energy.

Kennedy/Jenks currently is conducting a Food Waste and Cogeneration Study (Study) at the City WWTP for the City PW. The purpose of the Study is to help PW to better understand the amount of food waste available, investigate location options for a food waste receiving station, create a preliminary design for a receiving station, and analyze potential generation options. The current digester mixing system must be upgraded before PW implements a food waste co-digestion program, which is more fully described in Project Assessment #5 – Improved Mixing.

Vendors

In general, food waste receiving facility designs are site specific. Land availability, waste characterization, waste hauler preferences, aesthetic concerns (visual, audible, odor related), and treatment plant configuration are some factors that are used to determine the ultimate configuration and design of the receiving facility. Several specialty engineering consultants such as Kennedy/Jenks have experience designing these types of facilities.

History and Technical Maturity

A handful of wastewater treatment plants throughout the United States have been receiving food processing wastes, such as cheese whey, food processing rinse water, and tomato paste, in liquid form for over 25 years. Due to issues with sorting, transportation, and pre-processing, food waste in solid form has not been as an attractive feedstock as liquefied food waste or fats, oils, and grease. Plants in Europe have been digesting food scrap wastes more readily over the past few years due to European policies requiring 100% diversion of organic materials from landfills. The technological capabilities to pre-process and digest food waste are well understood and well established.

The United States Environmental Protection Agency (US EPA) estimates that a total of 243 million tons of municipal solid waste (MSW) was generated in 2009. The US EPA conducted a study that found that food waste accounts for 14.1 percent of the total MSW that is generated in the United States. This represents over 34 million tons of food waste generated in 2009 alone. Currently, only about 2.5 percent of food waste actually is diverted from landfills nationwide. The majority of food waste that is diverted is used for composting, which requires large amounts of land and releases volatile organic compounds into the atmosphere.

The California Energy Commission estimated that as of 2007, there were 22 animal and food waste digester facilities in California (CEC 2010). FWTE is a relatively new technology in California; however, the technology has proven to be effective. East Bay Municipal Utility District’s (EBMUD) main wastewater treatment plant in Emeryville, California has been a pioneer in successfully co-digesting food waste for several years. EBMUD has found that food waste produces over three times as much methane as municipal wastewater solids. EBMUD uses the additional digester gas to run three dual-fuel IC engines rated at 2.15 megawatts (MW) each for a total of 6.45 MW. Powering the plant with biogas-generated electricity and using recovered heat in the digesters (cogen) saves EBMUD about $2,000,000 annually (US EPA 2011).

Reliability and Operational Complexity

The reliability of a FWTE project can depend on the quality, quantity and consistent availability of food waste streams, which is currently being investigated in the Study. The challenges of creating energy from food waste relate to the receiving, conditioning, and feeding of the food waste into the anaerobic digester. Unfortunately, food wastes can have significant quantities of unsuitable material such as plastic and metals, which could harm waste treatment plant mechanical equipment. In general, source separated food wastes are most desirable since this type of waste requires minimal processing at the wastewater treatment plant. Once the food waste is sorted, it is important that it is metered into the digester to prevent an upset of the biological treatment process due to over-feeding.

A FWTE program should have a modest impact on operations. Impacts come from the construction, operations and maintenance of the receiving station, administration of the food waste program, and the O&M of the generation equipment. The receiving station could require an area for the hauler interconnection equipment and the drive-up pad. The receiving station and generation equipment pads would be modest in size. Careful consideration must be given to the design to minimize impacts on existing plant operations. The receiving and odor control equipment will require frequent cleaning and periodic maintenance.

There also is a risk that haulers could bring in toxic or other undesirable materials to the facility that could harm the digestion process. This risk can be mitigated either by clear rules, strict manifest requirements for waste haulers, and/or sampling of the waste received. Testing of the sampled waste usually is not done unless a hauler created a problem with the digester. However, this sampling technique has been used by other agencies as an effective risk management tool.

Project Life and Sustainability

A FWTE program would continue to produce biogas and provide GHG reduction for the estimated 20 year life of the project. The project would be sustained by normal maintenance and repair.

Local Considerations

Economic

Collection of local food waste as a separate waste stream than garbage could provide some additional long-term services jobs.

Environment

Air: Impacts to air quality related to receiving and processing food waste should be minimal. The most notable impact would be potential odor emissions from the food waste receiving area. Odor emissions can be mitigated by containing the receiving area in a building, and using equipment that minimizes the possibility of odor emissions. Food waste that is typically disposed of at the City's Resource Recovery Facility on Dimeo Lane would instead be transported to the WWTP for processing and digestion. By having a receiving station that is centrally located, implementation of this project would result in a reduction in air pollution and GHG emissions from hauling a slightly shorter distance. For a conservative estimate, this assessment does not account for these reductions.

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Land: As compared to alternative disposal methods, receiving food waste at a wastewater treatment plant will require less land than landfill disposal or composting. Land requirement for the receiving facilities at wastewater treatment plants is relatively small (roughly 0.5 to 1.0 acre, including paved receiving area). There is also a co-benefit of extending the life of the local landfill. The facility would be located at the City WWTP, so there should be no additional land impacts.

Water: There are no anticipated water quality impacts, but the project will use a modest amount of process and clean-up water. Water usage for a waste receiving facility is minimal and is typically used for wash down and dilution liquid for food waste (approximately 2,000 gallons per day). This water can be treated effluent from the wastewater treatment plant. Impacts to surrounding surface water features should be minimal since run-off from the receiving facilities is contained and typically routed back to the plant for treatment.

Noise: Noise can be a concern for the receiving station, since the WWTP is located near a residential community, but can be mitigated by enclosing the area or providing a sound wall. Noise on surrounding surface streets could increase from additional truck traffic. If noise on surrounding surface streets is a concern, restricted hauling times can mitigate the impact. Potential noise from pre-digester food processing/grinding pumps would be confined to the WWTP site.

Aesthetic/Visual: Visually, the receiving area will not stand out from other industrial systems at the WWTP, creating little to no impacts. If aesthetics does become an issue, equipment can be screened or enclosed.

Waste by-product: The waste product that is generated from digestion of food waste is typically dewatered for further processing or disposal. Processed/digested food waste would have a smaller volume than raw food waste and could be used as a soil amendment.

Energy Savings and GHG Reduction

Based on a recent survey of local food service establishments (FSEs), the quantity of source-separated food waste is estimated to be between 60 and 100 tons per week based on a seasonal average (slightly more during the summer, slightly less during the winter). This estimate includes local FSEs and additional food waste potentially available from other sources, such as UC Santa Cruz. Kennedy/Jenks' Waste-to-Energy Model estimates that approximately 76,400 cubic feet per day (cfd) of digester gas can be created from 100 tons of food waste per week. This amount of gas is sufficient to generate approximately 160 kW of electricity, assuming an internal combustion (IC) engine with a 35% electrical efficiency.

The additional digester gas generated by the food waste could directly offset all or a portion of natural gas currently combusted in the existing engines, or could supply fuel for a new generator that could be installed by SCWD and/or SqCWD. The first scenario would directly offset the amount of natural gas currently combusted in the existing engines, whereas the second would offset the amount of electricity that SCWD and/or SqCWD purchase from the grid.

Assuming the additional gas offsets natural gas, the natural gas savings resulting from use of the additional digester gas is approximately 15,300 million BTU per year (MMBtu/yr), or 153,000 therms. Combusting the additional digester gas would also result in a reduction of approximately 800 metric tons of *non-biogenic* CO_2 (MT CO_2e) per year, as summarized in Table 2. Depending upon how the project is structured, SCWD and/or SqCWD could take credit

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for some or all of the GHG offsets. This project could produce up to 100% of the potential GHG reduction goals for SCWD and approximately 50% of the potential GHG reduction goals for SqCWD.

Table 2: Energy Savings and GHG Reduction from a Food Waste to Energy Project

Average Annual Energy Savings (kWh/yr)	Annual GHG Reduction (MT CO_2e/yr)	Lifetime GHG Reduction (MT CO_2e/yr)
0	810	16,200

Cost

With proper maintenance of piping, equipment, and controls, a FWTE receiving and processing facility is estimated to operate for 20 years or more. Anaerobic digesters, which are not included in the capital cost estimate for this project, have life expectancies of 30 or more years. The IC engines recently underwent a major overhaul and, along with associated support systems, should have a life expectancy of at least 10 years.

Capital Cost: The 100 tons per week (14 tons daily average) of food waste quantified in the section above would likely arrive at the WWTP during 3 or 4 days per week, rather than on a daily basis due to MSW collection schedules; therefore, the receiving station would be sized to accept up to 50 wet tons per day of food waste. The capital cost of the project is based on locating a facility at the WWTP sized to receive source-separated food scrap and processing waste with minimal contamination. In general, this would include a storage tank, metering and mixing pumps, food waste grinder, glass-lined ductile iron pipe, odor scrubber, waste measuring equipment, and concrete receiving area for truck unloading. The probable cost has an accuracy of plus 50 percent to minus 30 percent.

O&M Cost: It is anticipated that staffing may permanently increase by one-FTE employee to operate and maintain the receiving facility at the WWTP. Receiving equipment and pumps would require daily to weekly maintenance. In addition, a portion of the material received would have to be screened out of the system prior to digestion (due to plastics, metals, etc.) and would need to be disposed of at a landfill. The screened material is anticipated to account for 10% of the overall material received and current disposal fees at the landfill are $75/ton. Tipping fees are not included in this analysis, since it has not yet been determined how disposal costs would be structured. In addition, operating a food waste receiving program would require additional staff for program administration.

Incentives: The funding incentives for installing a waste receiving facility are generally geared to the ultimate use of the digester gas that is produced. The improvements directly associated with waste receiving (i.e. pumps, tanks, and site improvements) are not eligible for incentives. However, energy efficiency incentives could be used to lower the cost of project components, such as premium efficiency pumps and motors.

Waste receiving can generate funds through tipping fees, which are charged to the haulers who use the waste receiving station. However, considering PW owns and operates MSW hauling for the service area, a reduction in tipping fees is not applicable for this FWTE program. If waste from outside of the PW MSW collection area is allowed, associated tipping fees may provide added revenue. Table 2 presents a summary of the program costs.

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Table 3: Estimated Costs for Food Waste to Energy Project

Life (yr)	Capital Cost ($)	Avg Annual Net Cost ($/Yr)	Lifecycle Energy Cost ($/Therm)[1]	Lifecycle GHG Reduction Cost ($/MT)
20	$3,750,000	$280,000	$1.5	$276

[1] Since this project was assumed to reduce natural gas use, the lifecycle cost is reported in dollars per therm.

Summary of Advantages and Disadvantages

Adding a food waste receiving system would allow SCWD and/or SqCWD to take advantage of excess digester capacity to generate renewable energy. Below is a summary of advantages and disadvantages of adding food waste.

Advantages:

- Additional biogas production to produce "GHG-free" energy.
- Optimized use of excess digester capacity.
- Reduced truck traffic to nearby landfills.
- Takes advantage of existing process and infrastructure at the WWTP.
- Diverts food waste from landfills and sewer systems.
- Potential to create local food waste collection jobs.

Disadvantages:

- Increased loading on digesters.
- Increase in O&M costs.
- High capital expenditures.
- Potential odor concerns.
- Potential operational impact from haulers if receiving station not designed correctly.
- Requires on-going set-up and oversight of a FWTE project.

References

California Energy Commission. "Waste to Energy (WTE) & Biomass in California." Updated May 2010. http://www.energy.ca.gov/biomass/

City of Santa Cruz, "Characterization of Disposed Waste for the Year 2009." April 2010.

U.S. Environmental Protection Agency. "Turning Food Waste into Energy at the East Bay Municipal Utility District (EBMUD)." Updated June 2011. http://www.epa.gov/region9/waste/features/foodtoenergy/ebmud-study.html and http://www.epa.gov/region9/organics/ad/EBMUDFactSheet.pdf

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