



Food Waste Co-Digestion at Central Marin Sanitation Agency (CA)

Business Case Analysis Case Study

Glossary

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|---------------|--|
| BioMAT Tariff | Bioenergy Market Adjusting Tariff |
| CMSA | Central Marin Sanitation Agency |
| Cogen | Cogeneration |
| FOG | Fats, oils, and grease |
| FTE | Full-time equivalent |
| F2E | Food2Energy |
| GHG | Greenhouse gas |
| kW, kWh | Kilowatt, kilowatt-hour |
| MCE | Marin Clean Energy |
| mgd | Million gallons per day |
| MSS | Marin Sanitary Service |
| PG&E | Pacific Gas & Electric |
| PPA | Power purchase agreement |
| ReMAT Tariff | Renewable Market Adjusting Tariff (CA) |
| tpd | Tons per day |
| WRRFs | Water resource recovery facilities |

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Cover photo is an aerial view of CMSA facilities, courtesy of CMSA. Cover design by Evan Odoms.

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Central Marin Sanitation Agency Treatment Plant, Central Marin Sanitation Agency (CMSA), California

About the Agency

- Service area: several municipalities and unincorporated areas, and San Quentin State Prison, in the San Rafael and Ross Valley areas of central Marin County
- Operating since: 1979
- Wastewater customers served: 104,500
- Employees: 44
- Governance: Joint Powers Authority with four member agencies, with a six-member Board of Commissioners representing the four member agencies

About the WRRF

- Location: San Rafael, California
- WRRF operating since 1985
- Size: 7.5 mgd average dry weather plant flow (permitted dry weather flow: 10 mgd)
- Anaerobic digesters: two 130,700-cubic feet mesophilic digesters
- Food waste feedstocks: fats, oil and grease (FOG) and pre-consumer commercial food scraps
- Food waste as share of total anaerobic digestion (AD) feedstocks: 11% by volume
- Feedstock preprocessing: food scraps: Marin Sanitary Service (MSS), removes contaminants manually and with a magnet, and grinds to 1" pieces, CMSA does additional preprocessing with chopper pumps, a rock-trap grinder, and paddle finisher; FOG: CMSA does preprocessing
- Electricity provider: Marin Clean Energy (MCE)
- Biogas end use: 750-kW engine generates heat and power for internal use and CMSA sells excess electricity to MCE for \$.105/kWh; by the end of 2021, CMSA will install a new 995-kW cogeneration system to increase power deliver to MCE at a blended rate of \$0.83/kWh
- Biosolids management: Class B applied to farmland in Sonoma County (only in dry season, June-October), 43%; alternative daily cover at landfills, 27%; and Class A quality bio-fertilizer (produced at the Lystek facility in Fairfield, CA), 30%

Drivers and Goals

- Drivers: PG&E grant for feasibility study (motivated by California Greenhouse Gas Solutions Law, AB 32 (2006); Marin County's Zero Waste Goal by 2025 plus new state requirements on food scrap recycling; new state reduction goals on short-lived climate pollutants and a mandated 50% organic waste diversion from landfills
- Goals: food scrap diversion from landfills, natural gas and energy savings and energy self-sufficiency, using underutilized digester and energy generation equipment, providing a service to local solid waste hauler

Summary

The Central Marin Sanitation Agency (CMSA) manages the wastewater treatment for several municipalities and unincorporated areas, as well as San Quentin State Prison, in the San Rafael and Ross Valley areas of Central Marin County. It operates a wastewater treatment plant with average daily dry weather flow of 7.5 mgd and a peak wet-weather capacity flow of 125 mgd (daily flows have a wide range).

CMSA's road to co-digestion began in 2008 when the City Manager of San Rafael convened a meeting with Jason Dow, the CMSA general manager; Patty Garbarino, president of the nearby private solid waste hauling company Marin Sanitary Service (MSS); and Pacific Gas & Electric representatives to pursue a greenhouse gas (GHG) emissions reduction grant from Pacific Gas and Electric (PG&E) for a feasibility study to reduce GHG emissions. San Rafael obtained the grant. With a green corporate culture and seven franchise agreements covering a service area closely aligned with CMSA's service area, MSS seemed like a good partner for sustainability-oriented CMSA. Further, the opportunity seemed fortuitous for both parties. Garbarino was looking for food waste diversion opportunities to reach Marin County's goal of zero food waste by 2025, and Dow was looking for opportunities to put to beneficial use its extra digester and cogeneration engine capacity.

Dow and Garbarino developed the concept of a Food2Energy (F2E) program that would deliver food scraps collected by MSS to a CMSA organic waste receiving facility for processing and then anaerobic digestion. In order to get the support of the community-elected bodies that approve projects and associated rate increases, and ultimately the CMSA and MSS Boards, Dow and Garbarino dedicated a lot of time to explaining the program to stakeholders in their service areas.

With a positive conclusion from the methane capture feasibility study, the two organizations – the public wastewater utility and the private solid waste company – launched a close and successful F2E partnership. CMSA invested in a new receiving station for food waste and fats, oils, and grease (FOG), as part of a \$7.65 million project to upgrade the digesters and related equipment. CMSA financed the project with extra funds in its capital investment accounts, due to leftover monies from a prior bond issue for a wet water flow management project (and substantial investment returns on the leftover monies). The communities supported rate increases spread out over five years to pay back the bonds.

CMSA modeled its onsite treatment system on concepts from nearby co-digestion pioneer, East Bay Municipal Utility District (EBMUD). However, the partners were determined to avoid EBMUD's problems with feedstock contamination. As a result, MSS limited F2E feedstocks to pre-consumer commercial food waste, and built many features into its outreach, collection and preprocessing to produce a clean feedstock. CMSA conducts additional preprocessing onsite.

For a variety of reasons – including limited enforcement to date of the California organics recycling mandate – the quantity of food scraps has not grown to the expected scale. As a result, FOG currently represents about 85% of CMSA's co-digestion feedstocks.

After conditioning the biogas, CMSA uses it to run its cogen engine to produce electricity. The biogas displaces purchases that CMSA would otherwise make of non-renewable natural gas. Valued in terms of natural gas displacement, the energy savings are relatively low because natural gas prices are low.

With the current co-digestion program, CMSA has achieved near energy self-sufficiency. Because it still has excess digester capacity, it is planning to expand co-digestion and energy production. It has a power purchase agreement to sell renewable energy to Marin Clean Energy (MCE), Marin County's clean-energy community-choice aggregation program, and an interconnection agreement with its local utility to enable the transmission. The next step of the project is to build a second cogen engine to produce additional heat and power and to increase sales, which will require a new MCE power purchase agreement and new interconnection agreement for the additional power generation and delivery.

Project 1: Food2Energy Co-Digestion Partnership with MSS

Managing Feedstock Risks

A 2008 Methane Capture Feasibility Study, supported by a PG&E grant, concluded that an MSS and CMSA Food2Energy partnership could create a cost-effective co-digestion program to increase biogas production and facilitate its beneficial use. In 2009, CMSA and MSS developed a Food2Energy (F2E) Work Plan, which included a project outreach and education strategy, and a pre-design for the F2E facilities at MSS and CMSA. Jason Dow of CMSA and Patty Garbarino of MSS held extensive meetings with stakeholders in their service areas to explain the program. As a result, they gained the support of the community-elected bodies that approve projects and associated rate increases, and ultimately the support of their respective Boards.

At CMSA, a digester rehabilitation and upgrade project was expanded to include an organic waste receiving station. By enabling co-digestion of FOG and food scraps, the receiving station would allow the utility to leverage underutilized digester and cogeneration capacity. A further critical factor was the availability of extra funds in the capital investment accounts, due to leftover funds from a prior bond issue for a wet water flow management project (and associated investment returns). In May 2013, MSS and CMSA entered into a formal agreement to begin the F2E partnership to support co-digestion at CMSA. As part of the agreement, MSS delivers food scrap slurry solely to CMSA.

Strategies to Reduce Contamination

The partners identified approaches at each step of the feedstock supply chain to minimize contamination (Figure 1). In addition to extensive screening to remove contaminants, a key element was to restrict the

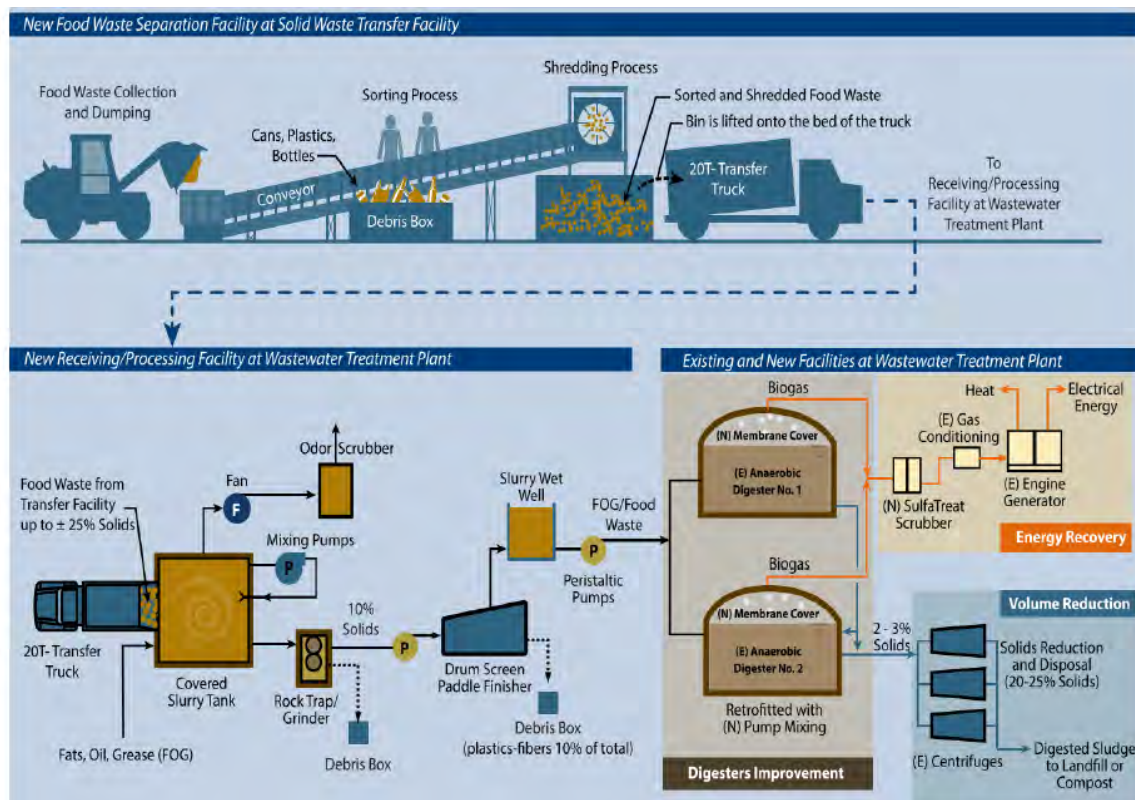


Figure 1. Marin Sanitary Service/Central Marin Sanitation Agency food scrap treatment train.
Source: Presentation. Central Marin Sanitation Agency. NACWA Energy Working Group. January 26, 2017.

F2E feedstocks to commercial back-of-the-house food scraps only, excluding post-consumer commercial and residential sources of food scraps to avoid their higher contamination levels.

MSS Strategies

MSS focuses on generators' establishments as the first line in quality control. It offers two organics recycling options. The standard one accepts comingled organics, including plant materials, food-soiled paper, and food scraps, and sends them to composting. The Food2Energy option is more restrictive: it targets large food waste generators (restaurants, delis, grocery stores), and restricts collections to back-of-the-house commercial food scraps. For commercial customers who choose to participate in F2E, MSS supplies an F2E bin, which is separate from a comingled organics bin.

A dedicated MSS outreach coordinator works closely with generators, starting with an assessment as to which organics option is right for each generator. The coordinator organizes the official enrollment in the F2E program, provides staff training and monitoring, and provides re-training over time as needed. Another element promoting the quality of generators' participation is a dedicated rear-loader garbage truck. Though the rear-loaders are more expensive, MSS chose this model so that the driver can inspect loads as he empties the bins into the truck hopper; the driver notes any contaminants and communicates this back to the outreach coordinator, who follows up with the responsible generator. MSS has dropped a few participants due to repeated quality problems, but its focus is on retraining any customers with repeated contamination episodes, so that all provide clean materials. As a result of this first line in quality control, the MSS material delivered to the transfer station has a low level of contamination.



Figure 2. After an initial screening for contaminants on the MSS tipping floor, food scraps are loaded onto a conveyor belt for additional removal of contaminants. Source: MSS.

The second line in quality control is the processing onsite at the MSS transfer station. Staff first pick out contaminants on the tipping floor, and then send the material on a conveyor belt past a manual picking station line with two sorters who remove plastics, metals, etc. and past a magnet that removes any remaining ferrous metal. In the final stage, the scraps go into a grinder that produces pieces no bigger than 1" square. The processed scraps then are put into an airtight 20 cu. yd. container and hauled to CMSA, about a mile away.

CMSA Strategies

The third line of quality control is at CMSA, where the food scraps are mixed with FOG to create a slurry, and then further processed with a rock trap/grinder, followed by a drum screen paddle finisher. The resulting slurry (with up to 10% solids) is pumped into the digester.

The paddle finisher is able to remove small contaminants like twist-ties and food stickers; nearly all reject material is organic and fibrous and is composted. When the paddle finisher was first installed, CMSA planned to mix digested sludge with the slurry to warm it to prevent coagulation, which would have made the material unsuitable for composting. CMSA decided not to use this practice so MSS can take the rejected fibrous material to the composting facility they use for their comingled organics collection, WM Earth Care.

Strategies to Generate a Consistent Quantity of Supply

CMSA and MSS are also concerned with generating a consistent supply of quality feedstock. One key element is the level of services provided by the F2E coordinator, who actively recruits participants and provides guidance for enrollees. Another element is pricing. CMSA charges MSS a tip fee that is lower than the tip fee MSS pays for landfilling waste, a saving that MSS passes on to its customers. F2E collection is also partially subsidized by garbage collection fees. (Traditional recycling is fully subsidized by garbage collection fees.)

As a result, the fees MSS charges for F2E commercial collections, which vary by container size and service frequency, average less than 50% of the garbage rates. Over 90% of enrolled customers are able to realize cost-savings by removing their food waste from their landfill containers. Small customers who already have the minimum level of landfill service do not see cost savings but support the program because they recognize the positive environmental impacts outweigh the program cost.

The MSS Outreach Coordinator works closely with the customers the first few weeks on program implementation to determine the best container size and frequency of pickup; during this time, the fee for the program is waived. When the program started, MSS offered F2E pickup service three days per week, but quickly ramped up to offer up to 6 days per week of service. However, five years into the program MSS supplies 8 tons per day (tpd) of food scraps, about half the feasibility study estimate that 15 tpd was available. Part of the difference is because the feasibility study estimate included both pre- and post-consumer food, whereas MSS subsequently decided to exclude post-consumer waste to avoid its higher contamination levels. MSS also cites the currently limited enforcement of the current organics diversion mandate as another reason. It estimates that as of June 2019, approximately half of its commercial customers met the total municipal solid waste (MSW) generation threshold of 4 cu. yd. for coverage under the recycling mandate and about 25% were compliant with AB 1826. Contrary to expectations, MSS finds that the non-compliant organizations include some of the largest sources.

As a result, CMSA also accepts FOG, which now represents about 85% of food waste feedstocks based on volume, and about 65% based on tipping fee revenues. While FOG greatly increases biogas production, CMSA acknowledges a concern that the FOG supply is not guaranteed because haulers have a number of

options in the area, and are unwilling to make contractual commitments in order to be able to respond quickly if their economic opportunities change.

Project Impacts and Risk Management

Operational Impacts

Operational Upsets

CMSA has not experienced operational upsets with its co-digestion.

Biosolids

Production of biosolids may have increased, but any effect is hard to quantify due to the many factors causing variability. CMSA sends its Class B biosolids to a diversified set of uses, in accordance with restrictions set by California regulations, and anticipates maintaining a comparable allocation across the uses if the quantity increases. In the face of tightening California restrictions on biosolids uses, CMSA recently has begun sending a portion of its biosolids to the Lystek facility in Fairfield, CA, where it is turned into a liquid agricultural fertilizer. The remainder is applied to nearby farmlands in the dry season or sent to landfills as alternative daily cover in the wet season. For 2019, the projected allocations are 27%, 43%, and 30%, respectively.

Biogas and Electricity Generation

The co-digestion project increased annual biogas production up to 230% of prior production levels. Daily biogas production varies, depending on delivered organic waste volumes, and can exceed 350,000 cu. ft./day. Biogas is sent through the Biorem SulfaTreat scrubber to remove H₂S, a dryer to remove moisture, and then another media scrubber to remove siloxane, before going to a 750kW internal combustion engine generator to produce electricity and heat. The cogeneration system is very reliable and well maintained, with its equipment receiving regular preventive maintenance per the manufacturers' recommendation.

Downtime for unplanned corrective maintenance is normally low. For example, in 2020 the system was offline for five individual days during the year to troubleshoot various issues and make repairs. When the cogen engine is down, the biogas goes directly to heat CMSA's two hot water boilers and additional electricity is purchased from MCE to meet the facility's needs. Otherwise, waste heat from the cogen system heats the digesters. Before co-digestion, biogas powered the facility up to 8 hours per day when the cogen system was operating. Now biogas powers the facility 23 hours per day on average when the cogeneration system is running.

Regulatory Compliance

CMSA has not experienced any issues with compliance with its water permits. CMSA conducted an analysis on the environmental impacts of running a biogas-fueled combined heat and power (CHP) engine and found no significant impact that would compromise compliance with California air emissions standards.

Financial Impacts

MSS

MSS spent \$530,000 on upgrades to their facilities and purchased two rear-loader trucks (at a total cost of around \$275,000). Yearly operational costs (excluding loan repayment costs) are \$499,000. Currently, three FTEs work in the program: one driver, one outreach coordinator, and one FTE sorter/processor.

On a per ton basis, commercial food waste is more expensive to collect relative to commercial garbage by about 30% and relative to mixed organics (for composting) by about 10%; only commercial recycling has higher per ton collection costs, primarily due to the lower density of the collections. When disposal/processing costs and recycling material sales revenues are factored in, food waste collection is the most expensive per ton waste stream, and commercial recycling becomes the least expensive.

The capital costs of the F2E program were covered by a 0.22% increase in base fees for all customers. About 65% of the operating costs are covered by subscription fees for the F2E program, which vary with container size and service frequency. The remaining costs are subsidized by garbage rates. (As noted above, no fee is charged for traditional recycling in the MSS service areas; program costs are entirely subsidized by the garbage rates.)

CMSA

Investment Costs

CMSA incurred \$2 million in costs for the organic waste receiving station, which includes a 30,000-gallon tank, mixing pumps, rock trap grinder, paddle finisher, and odor control system. This investment was bundled within a \$7.65 million investment package of digester upgrades, including new flexible membrane covers, pump mixing systems, and hydrogen sulfide scrubbers. CMSA covered the investment costs for the whole package from its capital investment accounts, including funds left over from a prior bond issue for a wet water management project, and the investment returns from those funds.



Figure 3. Truck offloading FOG at CMSA Organic Waste Receiving Facility. Source: CMSA.

Operating Revenues and Costs

CMSA charges MSS a fee of \$24.27 per ton for food waste (as of 2020), which is lower than the fee that MSS pays for landfill disposal. CMSA calculates that this is equivalent to \$.101/gallon, based on its lab measurements indicating that one gallon of food slurry weighs 8.34 lbs. (The fee is adjusted each year using the San Francisco Bay Consumer Price Index.) The CMSA ordinance fee schedule for FOG (effective as of November 2019) charges a sliding scale tipping fee for daily delivery volumes, which declines from \$.06/gallon for the first 1500 gallons to no charge above 15,000 gallons.

In 2020, the water resource recovery facility (WRRF) earned an average of around \$156,000 in tip fees, and accrued around \$162,000 in savings of avoided natural gas purchases as a result of co-digestion.

The plant has experienced increased equipment maintenance, but has not needed to hire additional staff to implement the program. The plant does weekly preventive maintenance for pomace bins, the equipment area and the rock trap grinder; monthly maintenance for the pumps and paddle finisher; and

quarterly cleaning of the receiving station tank. It has also experienced unplanned maintenance of the feed pump hoses, averaging 6 hose replacements per year for a total of \$12,000 in repairs.

As of 2020, increased annual operating revenue and avoided natural gas expenses (\$318,000) exceed increased annual operating costs (\$183,000).

Project 2: Expanding Co-Digestion and Generating Energy Sales

By 2020, CMSA had achieved near energy self-sufficiency with its current scale of co-digestion. Noting that they still had excess digester capacity to take advantage of, the WRRF staff began to explore new ways to create value from biogas that could be produced with additional co-digestion. However, because its air permit does not allow it to flare biogas except in emergency circumstances, CMSA's first priority was to establish its ability to export to the grid. In 2019, CMSA completed on-site electrical system improvements required in its PG&E interconnection agreement, and then received Permission to Operate allowing CMSA to delivery power to the PG&E utility grid. CMSA interconnection improvements cost around \$100,000 for design and installation, and were completed in March 2019.

A related priority was to establish a long-term contract with a favorable feed-in tariff for the sales to the grid. In negotiating tariff options, CMSA confronted various challenges. Because its engine had been installed in 2005, CMSA was not eligible for the highest-value option, the 12.7c/kWh Bioenergy Market Adjusting Tariff ("BioMAT Tariff"), set up under CA Senate Bill 1122, which added an additional 250 MW of capacity for investor-owned utilities (IOUs) to offer feed-in tariff Power Purchase Agreements (PPAs).

The remaining options were the 8.923c/kWh Renewable Market Adjusting Tariff ("ReMAT Tariff") offered by PG&E, and a 10.5c/kWh tariff offered by MCE, its local Community Choice Aggregation program. (California AB 117 created the non-profit Community Choice Aggregation programs, allowing groups of communities to purchase power on behalf of their residents and businesses, with automatic enrollment and an opt out option.) Completely supported by revenues rather than taxpayer subsidies, MCE has structured the feed-in tariff program to allow renewable energy generators to enter into 20-year contracts with a fixed price per kWh generated. MCE's allocation was 15 MW of projects. Eligible projects are sized at 1 MW or smaller. CMSA qualified under the base load-energy price schedule, which is lower than the peak-energy supply schedule, and higher than the intermittent one. Further, the only constraint on the MCE tariff was a self-specified maximum for annual sales. In contrast, the PG&E ReMAT tariff came with requirements for specified quantities of energy supply, with penalties for under-delivery and non-payment for over-delivery (as did the BioMAT tariff).

As a result, CMSA inked a PPA to sell electricity to MCE at \$.105/kWh, and began selling MCE renewable energy in May 2019 through the approved PG&E interconnection agreement.

CMSA is looking to maximize its power output by procuring new sources of organic waste in order to take advantage of the MCE tariff agreement. Before embarking on a feedstock marketing program, its first priority is to understand how much additional capacity the digester has to accept volatile suspended solids (VSS) without triggering digester upsets. In fall 2019, they installed and began operating two 600-gallon pilot digesters to conduct digester testing through March 2021. Results of the testing are so far very promising, showing a food waste/FOG slurry can be fed at a 60% VSS loading rate without digester upsets.

For preventive maintenance, CMSA has completed an overhaul of its existing engine. In addition, it has completed the design and awarded a construction contract for a new, higher efficiency 995 kW cogeneration system that will be operating by the end of 2021. The new cogen facility will increase the potential for power production. In the near term, the new engine would be the primary engine and the existing engine would be the backup. A Clean Water State Revolving Fund loan with 75% loan forgiveness

funded the planning and pre-design of the new cogeneration system. Design and construction will require a \$6 million investment, which will be funded by capital reserves.



Figure 4. New Jenbacher Cogeneration Engine awaiting installation, with existing engine in background.

Source: CMSA.

Lessons Learned

Creating Value and Managing Risks

Central Marin Sanitation Agency has embraced an expanded vision as “an industry leader ... providing innovative, efficient, and sustainable wastewater services, capturing and utilizing renewable resources, and delivering renewable power.” Co-digestion is an important element of its efforts to recover renewable resources and deliver renewable power. To support food scrap generators facing new organics recycling mandates, CMSA partners with MSS, a local sustainability-oriented solid waste firm supplying preprocessed food scraps.

To date, CMSA has been able to achieve close to energy self-sufficiency with co-digestion. As CMSA focuses on expanding its capacity for co-digestion and energy production, it will be able to increase operating revenues by selling excess electricity production.

Stakeholder Risks

CMSA and MSS worked in partnership from the beginning to develop and promote the program, recognizing that the project would involve a big commitment of time and money. Together, they

conducted extensive outreach to stakeholders in their service areas in order to get the support of the community-elected bodies that approve projects and associated rate increases. With their support, both Boards approved the project. Staff from both organizations were involved with the project as it developed. Neither facility experienced any concerns from neighbors.

Operational Risks

The F2E partnership was very focused on avoiding issues that EBMUD has faced with contaminated food waste feedstocks. The partnership instituted multiple levels of quality control, starting with limiting feedstocks to pre-consumer commercial food scraps, followed by preprocessing at MSS, the option for testing by CMSA prior to acceptance, and further preprocessing at CMSA. Because the supply of food scraps from MSS service areas has not achieved anticipated levels to date, FOG is currently the dominant food waste. CMSA is able to do FOG preprocessing onsite, because it designed the receiving station it built in 2012 to enable co-digestion to accommodate both FOG and food scrap slurries. To reduce supply risks with FOG feedstock, for which haulers are unwilling to sign long-term contracts, CMSA instituted a tiered fee structure that reduces tipping fees for higher volumes delivered.

CMSA has tailored its operations and maintenance routines to manage co-digestion. Redundancy in equipment, such as spare feed pump hoses, helps to keep the program running smoothly in the case of equipment failure.

Financial Risks

CMSA was able to finance the initial investment from internal funds previously raised in a bond issue, and pay it back through rate increases approved to fund the repayment. MSS has mitigated its financial risks by relying on fees paid by its subscribers.

As it moves into sales of electricity to the grid, CMSA is mitigating energy price risk with a long-term feed-in tariff contract.

Replicability

Key conditions that enabled CMSA's success with co-digestion include California's environmental policy landscape and the presence of a nearby solid waste partner committed to sustainability to develop the food scrap recycling component (F2E) of CMSA's co-digestion program. Also important has been the availability of funds. The initial stage of the project used capital account funds that were left over from a prior bond issue, substantially augmented by high interest returns on the leftover monies; the Boards of the communities in its service area had previously agreed to raise rates to cover repaying the bonds. CMSA will finance the new cogen engine by issuing revenue bonds.

MSS considers its model to be replicable. Critical to its success are its focus on providing service to F2E generators, keeping costs down, and coordinating closely with CMSA. Efficient routing is the key to keeping costs down: the MSS Route Manager works with the MSS Outreach Coordinator to provide a level of customer service that benefits the generators and results in efficient routing. MSS also highlights the contribution of the weekly communication between CMSA and MSS.

Underlying factors important to its success include the California recycling mandate, which creates the customer base (though it could be strengthened with enforcement) and MSS's exclusive franchises for commercial service, which result in more efficient collection routes relative to open hauling. Another valuable factor is the highly coincident service areas, which means that any program's financial benefits from lower wastewater fees affect their shared customers.

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Figure 5. CMSA anaerobic digesters, and hydrogen sulfide media filters that remove hydrogen sulfide from the biogas before it is sent to the cogeneration engine. Source CMSA.



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