

APPENDIX

*City of San Rafael – Initial Study/Mitigated Negative Declaration
Marin Sanitary Services Facility Project – 1050 Andersen Drive/535-565 Jacoby Street, San
Rafael, CA*

Source Reference 17

Marin Sanitary Service Anaerobic Digestion Project Description



ANAEROBIC DIGESTION PROJECT DESCRIPTION

Introduction

Marin Sanitary Service (MSS) is proposing to develop an Anaerobic Digestion (AD) Facility ("the project") that would be capable of processing up to 12,500 tons per year (TPY) of food waste and green waste into biogas (gaseous product generated by the degradation of organic matter under anaerobic conditions) The biogas would then be cleaned and converted into renewable energy or into biogenic compressed natural gas (CNG). The project is expected to generate up to 2.1 million kilo-watt hours (kw/hr) per year, enough to power the entire MSS facility, or produce 166,000 diesel equivalent gallons (dge) per year of CNG, enough fuel for 15 to 18 CNG-fueled collection vehicles. The project would be fully enclosed and located within the current MSS Transfer Station (MRF) for 12,500 TPY, or as a standalone fully enclosed facility smaller unit of only 5,000 TPY adjacent to the Marin Resources Recovery Center (MRRC) in the City of San Rafael. Below is a picture of a stand-alone 5,000 TPY AD Facility 4 digester operation with the combined heat and power energy unit is currently located in Marina, California. The AD Facility at MSS will be fully enclosed and the digesters and mixing hall will be under negative pressure.



Anaerobic Digestion Basics

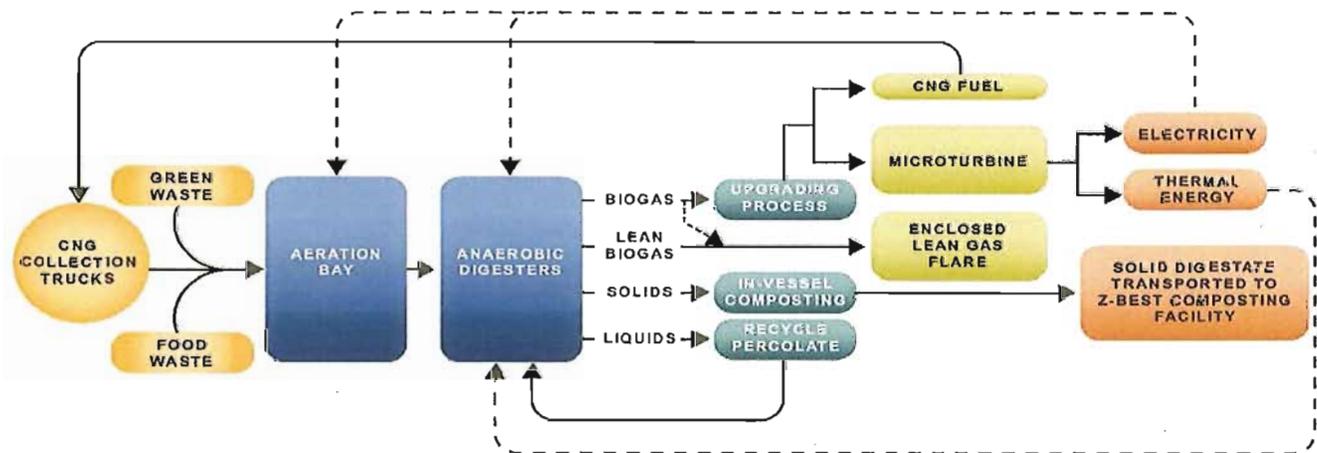
Anaerobic digestion (AD) is the biological decomposition of organic matter with little or no oxygen. The anaerobic digestion process occurs naturally in marshes and wetlands. There are a variety of controlled systems where AD technology is currently utilized in the United States including wastewater treatment facilities and dairy manure digesters and co-digesters. In other countries (primarily in Europe), AD technology is utilized to process and treat municipal solid waste (MSW) to recover energy and to reduce the volume of solid waste to be landfilled. Anaerobic digestion is considered by state regulations to be a form of composting.

AD facilities process solid waste and produce biogas and digestate (liquids and solids) in enclosed units called digesters. Within the digester, decomposition occurs in a four phases: hydrolysis, acidogenesis, acetogenesis, and methanogenesis resulting in methane, carbon dioxide, water and digestate. Digestate is the remaining solid and/or liquid residuals from the AD process that is typically taken to a permitted compost facility to be further composted.

Project System Components

The facility involves a new technology to the United States, which will employ a pre-fabricated, small-scale, dry anaerobic digestion system called SmartFerm. The SmartFerm dry AD technology is licensed exclusively in the US to Zero Waste Energy, LLC (ZWE), and a San Jose-based developer of organic waste treatment projects utilizing dry AD technology.

The AD system proposed for this project would be a dry fermentation process, using a ZWE Smartferm design, where received feedstock is subject to an inoculated percolate to promote anaerobic digestion. The generated biogas is purified and can be used in a combined heat and power unit to make renewable energy, or be upgraded to transportation fuel CNG quality using a BioCNG system, provided by Cornerstone Engineering. The compression and fueling system (also provided by Cornerstone) is designed to match up directly with the ZWE AD Facility and the BioCNG system. Thermal and electrical energy would be provided by a Capstone microturbine, which is considered Best Available Control Technology (BACT) for air emissions, or a boiler unit. Electrical power would be supplied by a combination of the microturbine and grid-supplied power.



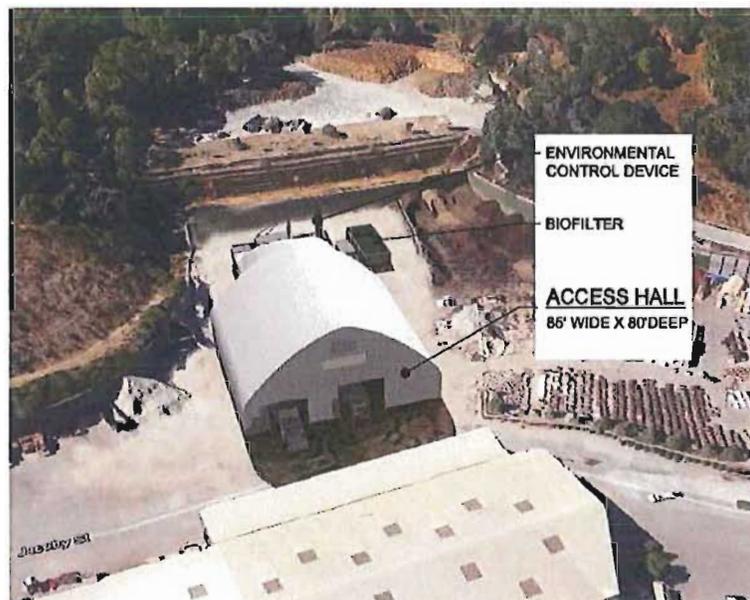
Process Description

The project operational process is summarized in the chart above and described in greater detail below:

1. Organic waste from MSS collection vehicles would be delivered to the project and placed in the enclosed aeration bay (see rendering on page 7);
2. The food waste and green waste would be blended together (approximately 67:33 ratio) in the aeration bay and loaded into the AD system for a 21-day dry fermentation process for the generation of biogas;

3. Biogas would be recovered and collected;
- 4a. Option A – Biogas to Renewable Energy to Power the MSS Facility for 5,000 tons per year:
 - Biogas would be upgraded and cleaned;
 - The upgraded biogas would be used in a combined heat and power (CHP) unit to make electricity. The electricity would be used to power the MSS Facility and net meter the surplus to the grid.
- 4b. Option B – Biogas to Combined Heating and Power for 12,500 tons per year:
 - Biogas would be upgraded and cleaned;
 - The upgraded biogas would be used in a CHP unit to make power
 - Electricity would be used to power the MSS Facility and surplus electricity would be sold and supplied to the grid.
- 4c. Option C – Biogas to transportation fuel to run CNG trucks for 12,500 tons per year:
 - Biogas would be upgraded to fuel quality (SAE J1616 Standards);
 - The upgraded biogas would be compressed and stored as CNG fuel on site;
 - The CNG fuel would be used in local CNG collection vehicles, which are fueled on site;
5. Digestate would be removed from the anaerobic digesters;
6. The digestate would then be transported to a permitted compost facility for further composting.

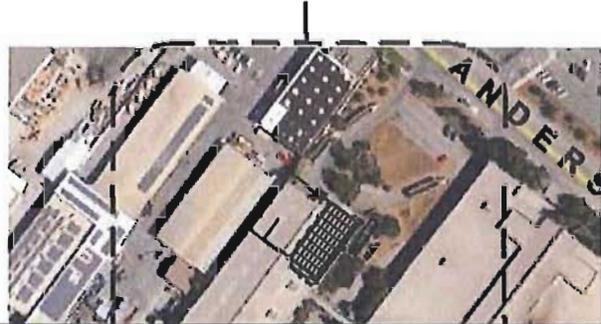
The AD Facility will receive pre and post-consumer food waste from multi-family residential, processed food waste, and co-collected residential and commercial green waste and food waste. The AD facility will be located within the MSSTS (See Site Map on page 8) or adjacent to the MRRC (see Site Map on Page 5) and will be included in the next SWFP Revision of the MSSTS. The compostable material feedstock for the AD process will generate biogas in the form of methane, biogenic carbon dioxide and trace amounts of hydrogen sulfide, oxygen and nitrogen. The resulting digestate (residual solids and liquids) from the AD process will be reduced 10% by volume, will be considered compostable, and will be transferred within 24 hours to a permitted composting facility in the area.



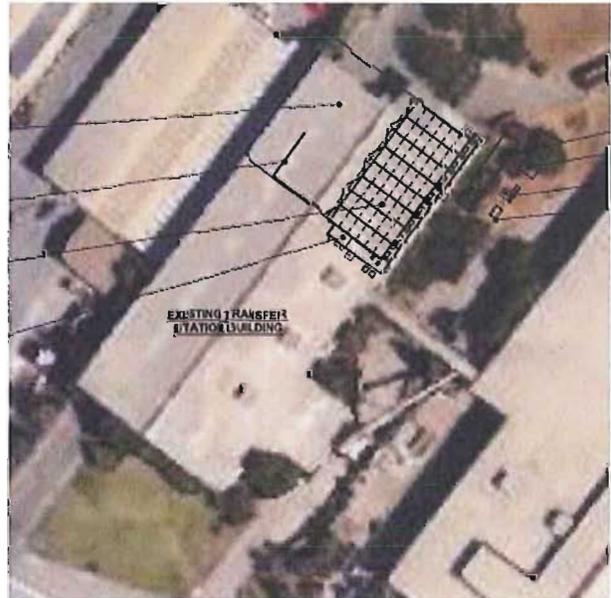
There are three options for the AD system:

Option A includes an aeration bay, 4 anaerobic digesters, a percolate tank, an environmental control device, an emergency generator and the capacity to process 5,000 tons per year (tpy) of feedstock and will be an enclosed stand-alone facility next to MRRC (see Site Map on Page 6 and the adjacent artist rendering). The AD digesters will be fully enclosed within a steel metal building where the organic waste is received in the Access Hall and mixed to a 2:1 ratio with green waste. From there, the material would be loaded into the digesters. This would generate over 15 million cf/yr of methane that would then be harnessed to produce combined heating and power.

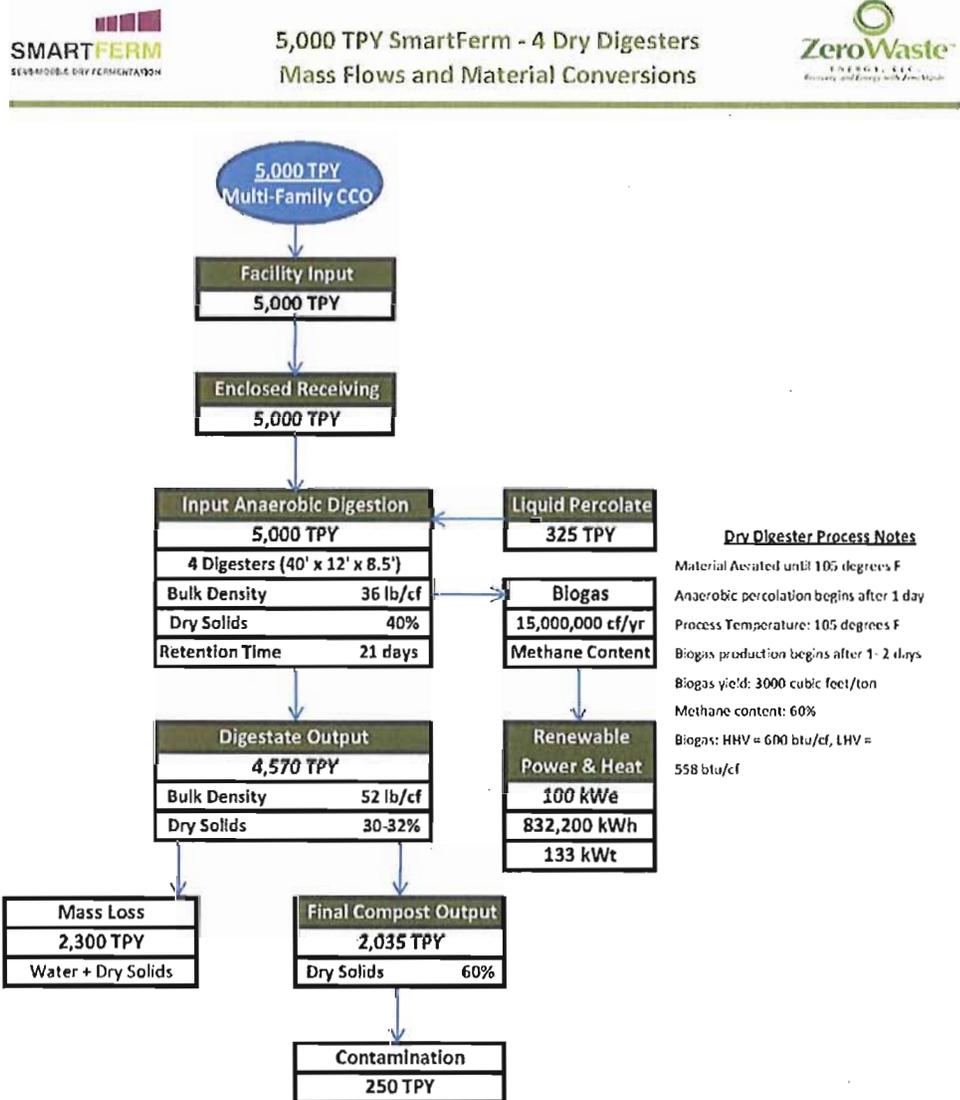
Option B includes an aeration bay and has 8 anaerobic digesters instead of 4, allowing up to 12,500 tpy of material to be processed annually. This would generate over 41 million cf/yr of methane that would then be harnessed to produce CHP. The amount of CHP generated annually at the increased capacity of Option B would be enough to support the electricity needs of the entire facility and would be fully enclosed and be located within the MSS Transfer Station (See Site Map on page 9 and shown on the adjacent graphic that shows the MSS Facility).



Option C includes the same annual capacity (12,500 tpy) and key components as Option B and differs in that the harnessed biogas would enter a biogas upgrade system and produces renewable compressed natural gas (CNG) instead of CHP. The amount of CNG generated annually would be 160,000 diesel gallon equivalent (DGE) that could be used to supply collection vehicles or other CNG vehicles in the community. The operation would be fully enclosed and located within the MSS Transfer Station.



Option A includes an aeration bay, 4 anaerobic digesters, a percolate tank, an environmental control device, an emergency generator and the capacity to process 5,000 tons per year (tpy) of feedstock and will be an enclosed standalone facility next to MRRC. The Site Layout and artist renderings are shown on pages 6 and page 7. The Mass Flow and Material Conversion chart is provided below showing the generation of 832,200 kwh per year of electricity from 5,000 tons per year of organics.





SMARTFARM (STEEL) DIGESTER PHOTOS

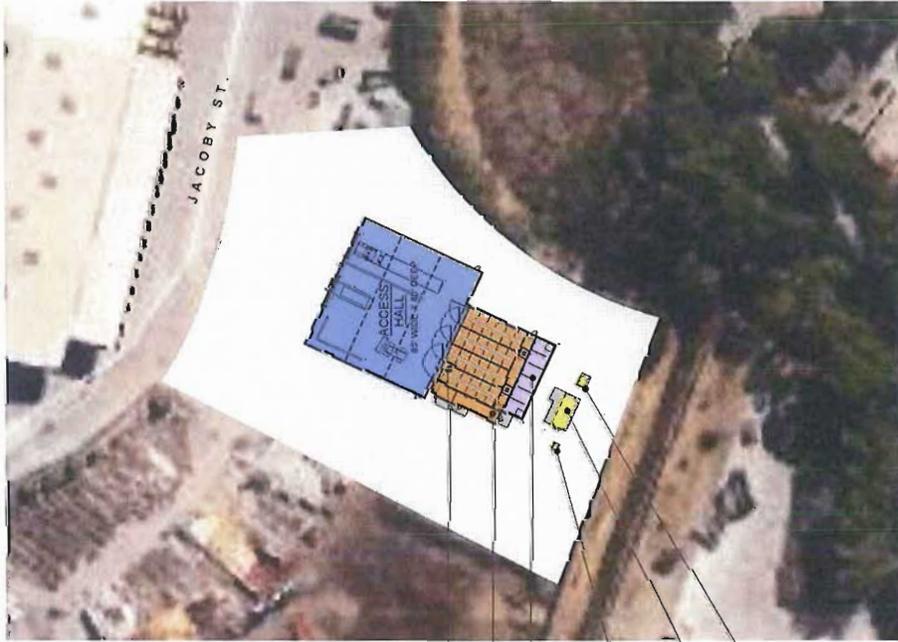


KEYMAP



LEGEND

- PROPOSED DIGESTER BUILDING
- PROPOSED EQUIPMENT COMPONENTS
- PROPOSED PERCOLATE STORAGE TANK
- PROPOSED ACCESS HALL
- PROPOSED ACCESS HALL



ENLARGED PROJECT AREA SITE PLAN - 1



- DIGESTER BUILDING
16 ANAEROBIC DIGESTERS
8' WIDE X 45' LONG EACH
- MAE CONTAINER
- PERCOLATE TANK
7' WIDE X 50' LONG X 8' HIGH
ABOVE GROUND
- ENVIRONMENTAL CONTROL DEVICE
- 100 KW CHP EQUIPMENT
- EMERGENCY GENERATOR

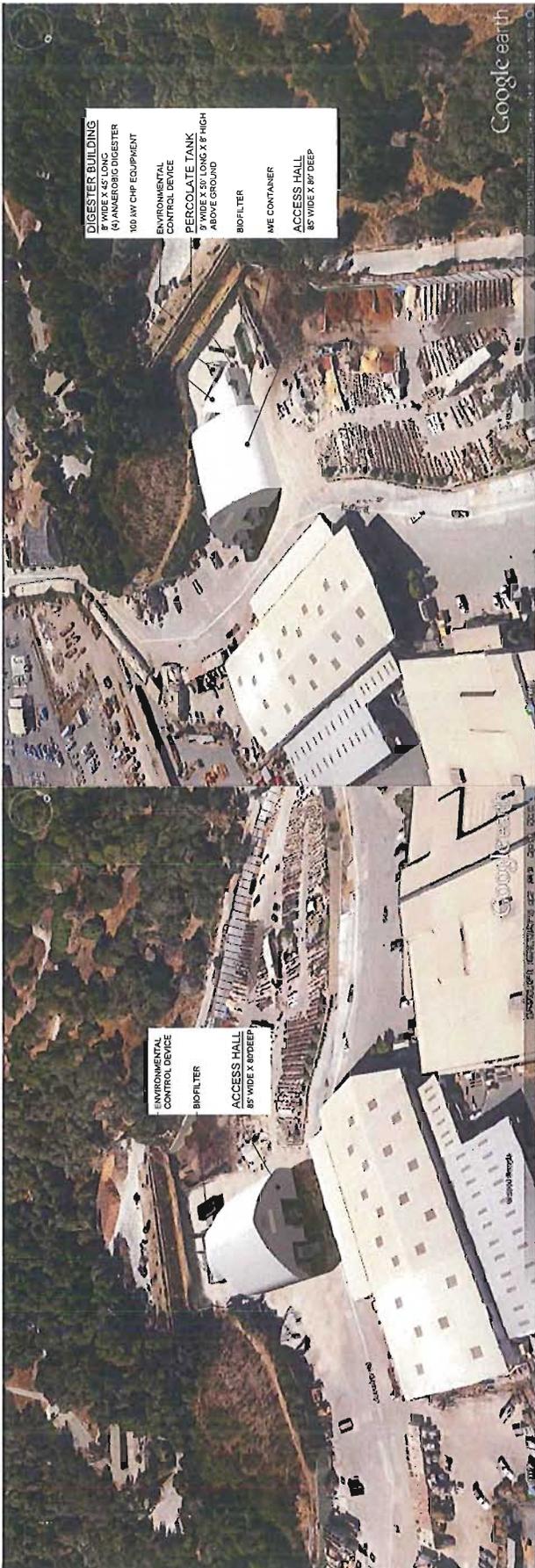


PROPOSED ANAEROBIC DIGESTION FACILITY

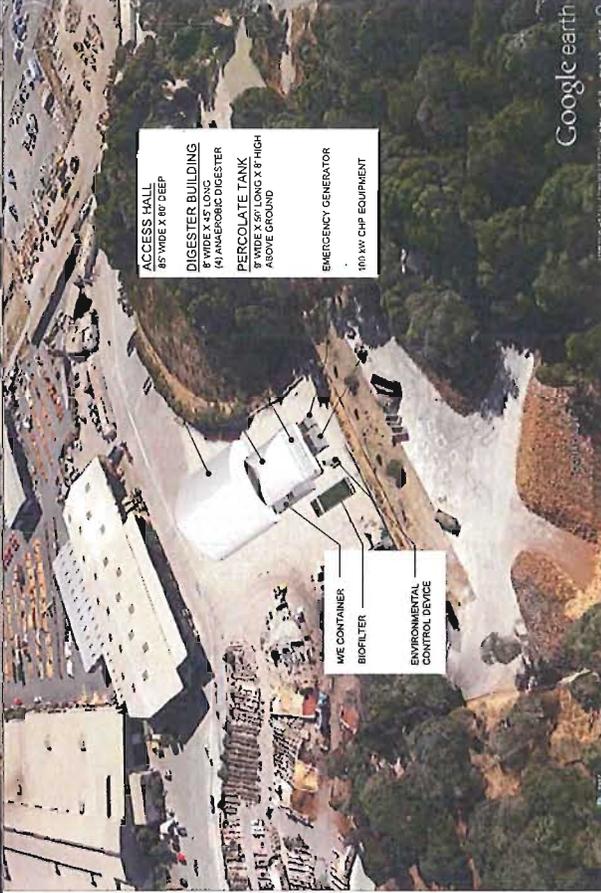
SAN RAFAEL, CA

JCS 4-8625

SITE PLAN
15 SEPTEMBER 2016



DIGESTER BUILDING
 8' WIDE X 45' LONG
 (4) ANAEROBIC DIGESTER
 100 MW CHP EQUIPMENT
 ENVIRONMENTAL CONTROL DEVICE
PERCOLATE TANK
 9' WIDE X 50' LONG X 8' HIGH ABOVE GROUND
 BIOFILTER
 MFE CONTAINER
ACCESS HALL
 85' WIDE X 80' DEEP



ACCESS HALL
 85' WIDE X 100' DEEP
DIGESTER BUILDING
 8' WIDE X 45' LONG
 (4) ANAEROBIC DIGESTER
PERCOLATE TANK
 9' WIDE X 50' LONG X 8' HIGH ABOVE GROUND
 EMERGENCY GENERATOR
 100 MW CHP EQUIPMENT
 MFE CONTAINER
 BIOFILTER
 ENVIRONMENTAL CONTROL DEVICE

PROPOSED ANAEROBIC DIGESTION FACILITY

SAN RAFAEL, CA

Option B includes an aeration bay and has 8 anaerobic digesters instead of 4, allowing up to 12,500 tpy of material to be processed annually. This would generate over 41 million cf/yr of methane that would then be harnessed to produce CHP. The amount of CHP generated annually at the increased capacity of Option B would be enough to support the electricity needs of the entire facility and would be fully enclosed and be located within the MSS Transfer Station as shown on page 9. The Mass Flow and Material Conversion chart is provided below showing the generation of 2,080,500 kwh per year of electricity from 12,500 tons per year of organics.

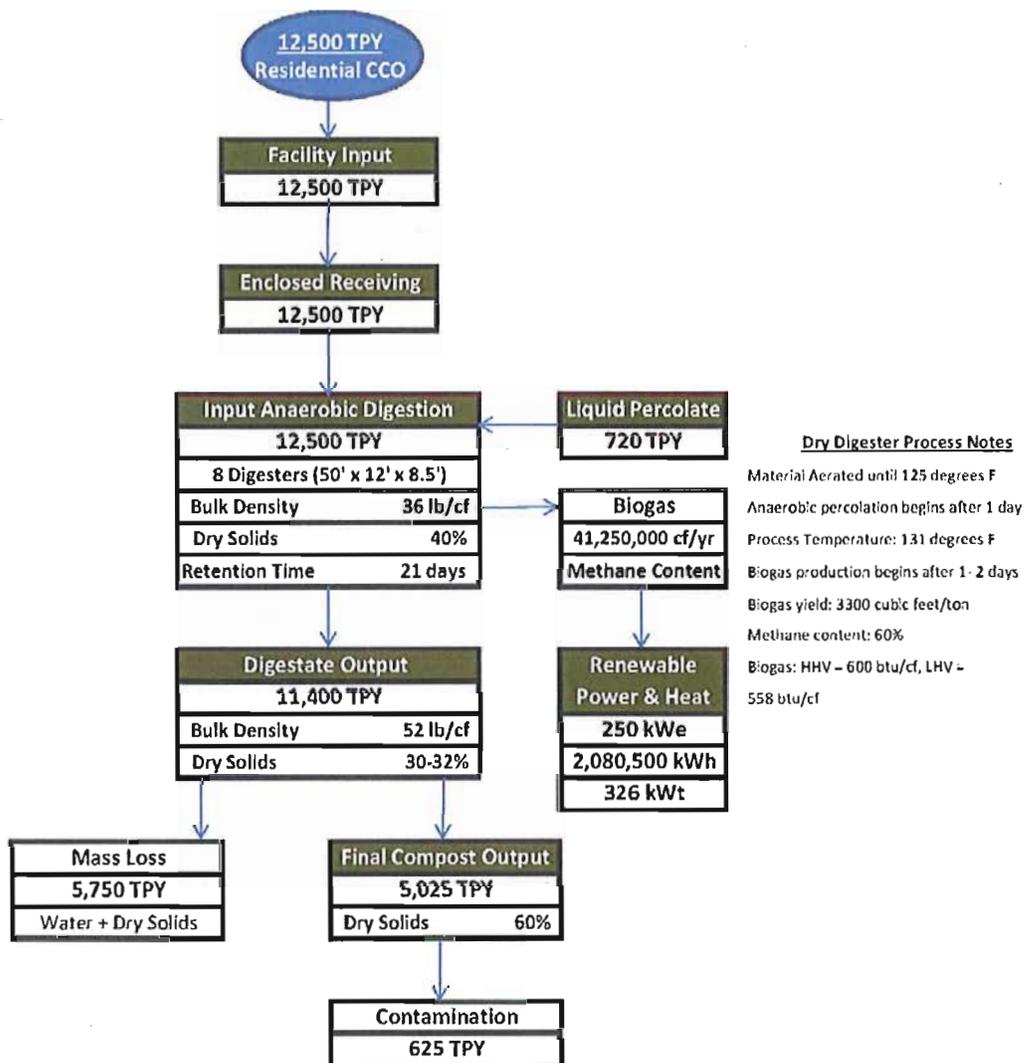


SMART FERM
REPAIRABLE DRY FERMENTATION

12,500 TPY SmartFerm - 8 Dry Digesters
Mass Flows and Material Conversions



ZeroWaste
ENERGY, LLC.
Recovery and Energy with Zero Waste





- PROPOSED CANOPY BUILDING
- REMOVAL OF EXISTING FOR PROPOSED
- PUSH WALL
- DIGESTER BUILDING
- (8) ANAEROBIC DIGESTERS @ 8' WIDE X 50' LONG EACH
- MIE CONTAINER

- BIOFILTER
- CHP UNIT
- ENVIRONMENTAL CONTROL SERVICE
- EMERGENCY GENERATOR



KEYMAP



SMARTTERM (STEEL) DIGESTER PHOTOS

ENLARGED PROJECT AREA SITE PLAN - 1



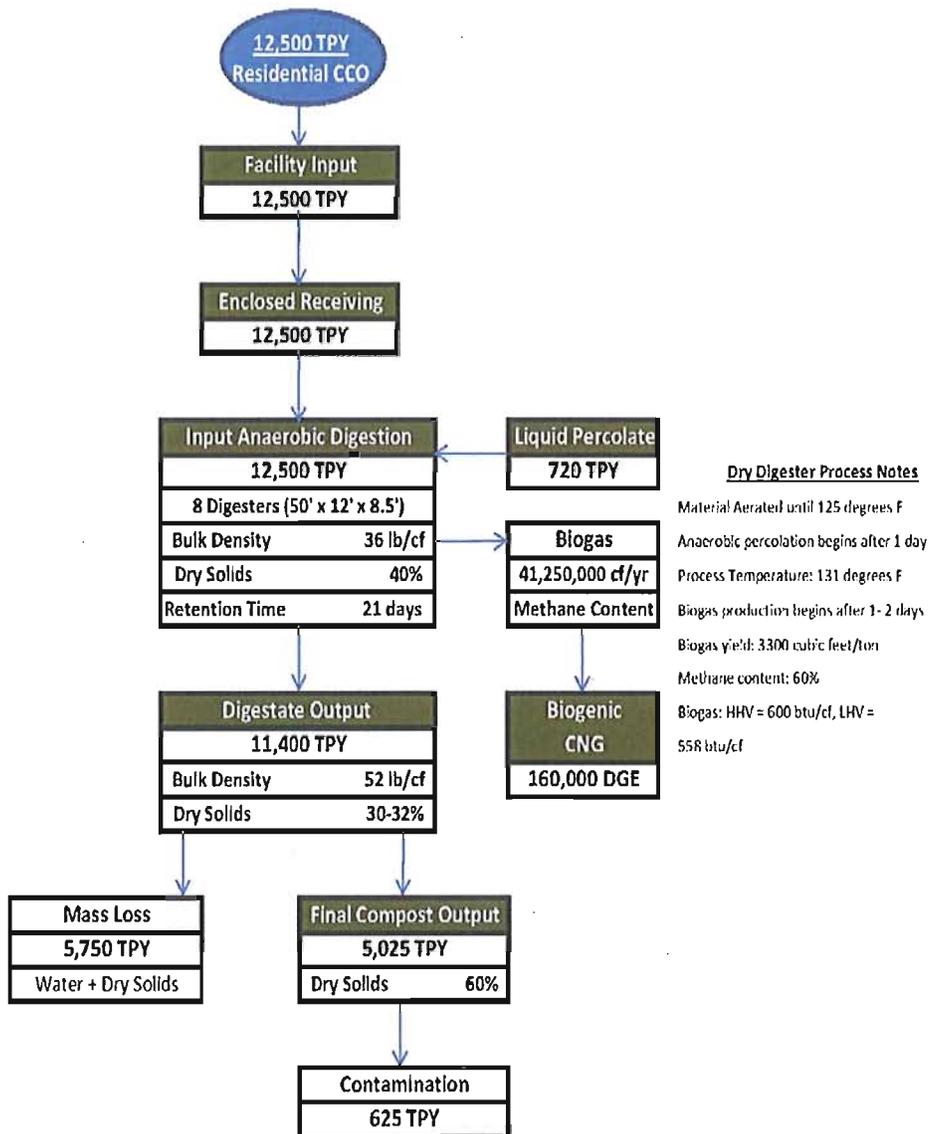
PROPOSED ANAEROBIC DIGESTION FACILITY

SAN RAFAEL, CA

Option C includes the same annual capacity (12,500 tpy) and key components as Option B and differs in that the harnessed biogas would enter a biogas upgrade system and would produce CNG instead of CHP. The amount of CNG generated annual would be 160,000 diesel gallon equivalent (DGE) that could be used to supply collection vehicles or other CNG vehicles in the community and would be fully enclosed and be located within the MSS Transfer Station.

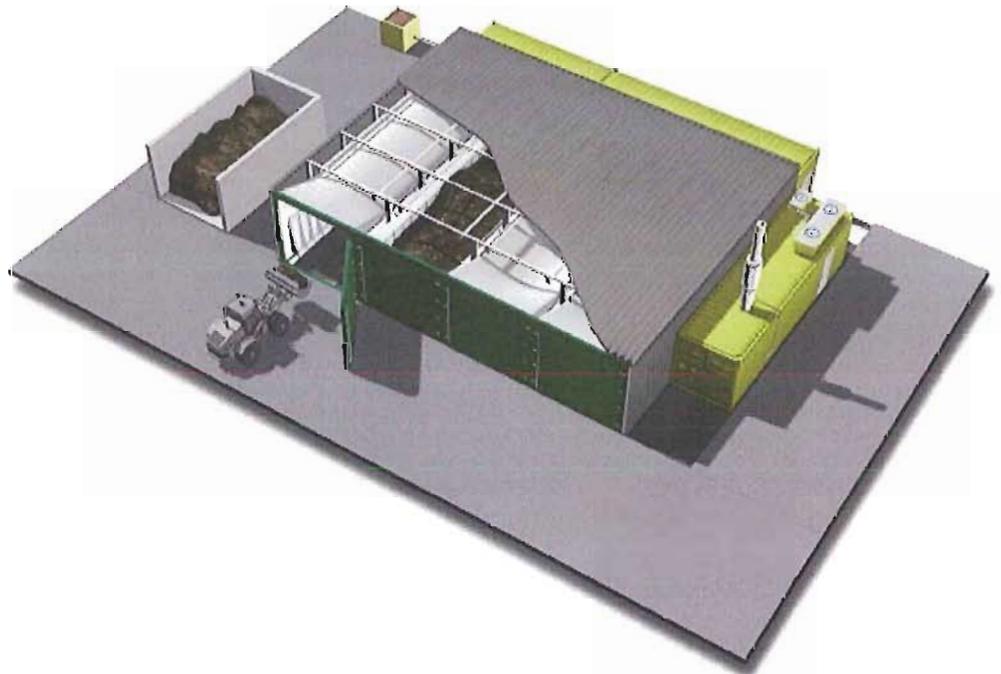


12,500 TPY SmartFerm - 8 Dry Digesters Mass Flows and Material Conversions



The purpose of aeration (for up to one day) of the blended materials would be to initiate aerobic composting and rapidly increase the temperature of the material to 120 to 130°F. Then, heated liquid percolate would be circulated through the organics to initiate and promote anaerobic digestion. The liquid percolate would be the liquid by-product of previous AD cycles and serves to inoculate and increase the moisture content. The aeration bay could theoretically store up to 6 days of material in case of contingency, but will generally store feedstock for up to 48 hours. The feedstock is mixed within the aeration bay with a front-end loader to achieve an optimal blend of approximately 67% food waste and 33% green waste. Because the dry fermentation process requires that there be structure and porosity in the mixed feedstock to allow percolate to seep through the mass, no pre-processing of the yard debris is necessary. The aeration bay has a rolling door that closes when being loaded and is on negative air for odor control. The blended feedstock is then transferred by a bucket loader to one of the AD units for a period of 21 days. It may take an average of two days to fill an AD unit.

A wheel loader will transport the waste from the aeration bay into one of the digesters to begin the three-part AD process. In the start-up phase, the digesters are sealed and the waste is initially treated aerobically using an in-floor aeration system, which is activated immediately after the digester door is sealed. The aeration system pumps air into the organic waste material which creates aerobic digestion conditions to



self-heat the material up to process temperatures. Temperature is measured with thermocouple devices located in each digester. During this phase, no biogas is produced and exhaust air is treated in an acid scrubber which removes ammonia. Following this, the air is treated by a humidifier then finally a biofilter which removes the particulate material, volatile organic compound (VOCs) and odor compounds. When thermophilic temperature is reached (approximately 120 to 130 degrees Fahrenheit [°F]), aeration ceases and anaerobic conditions are created as the aerobic microbes consume the available oxygen in the digester. This initial startup phase of the process lasts for approximately 12 hours; the fermentation phase begins once the start-up phase is complete.

Following the initial aeration of the organic material, thermophilic anaerobic conditions are maintained and percolation begins. This is known as the fermentation phase. Under anaerobic conditions, the organic waste is finely sprayed with conditioned process water containing the thermophilic microorganisms ("percolate") that decompose the waste and produce biogas. This percolate is pumped in a

closed loop between the digesters and the heated and insulated percolate tank located beneath the digester area. Percolate is sprinkled on the material on a daily basis for approximately 20 days causing the production of biogas. The percolate is collected in a drainage system, screened for solids in a specially designed weir called a “sandtrap” and gravity fed into the percolate tank where it is recharged with the thermophilic organisms required for digestion. In addition, high quantities of organic acids, which arise during the beginning of the process, are stored and degraded in the percolate tank to ensure proper pH balance.

The required thermophilic process temperature in the digesters is maintained through accurate process control of temperature and flow of percolate in the percolate tank. For this function the percolate tank is externally heated by the burner/boiler system and insulated. The production of biogas begins quickly after percolation. Biogas is primarily composed of approximately 60% methane and 35 to 40% carbon dioxide (CO₂), in addition to small quantities of hydrogen sulfide, oxygen and nitrogen. The biogas is collected in an exhaust port on the back wall of each digester and stored in an external double-membrane biogas storage bladder located on the roof of the AD system. Stored biogas is available for later use in the CNG fuel production or is generated as electricity and thermal energy through the CHP process. The shut-down or “termination phase” of a digester generally commences six (6) hours or less before the digester hatch is opened. The process is as follows:

- Termination of percolation.
- Introduction of fresh air through the in-floor aeration system to terminate anaerobic digestion process and preserve carbon for composting.
- Purged air and biogas mixture are removed via a dedicated fan located in the mechanical room.

Exhausted purge biogas is collected in the biogas collection system until methane content reaches 22 percent at which point the purged biogas is combined with some of the stored biogas and sent to the burner/boiler system. When the methane content of the digester purge air decreases to 1 percent, the burner/boiler operation is terminated and the air is flushed to the acid scrubber, humidifier, and then to the biofilter. The stored biogas will be routed either to CHP or to a BioCNG biogas conditioning system. The BioCNG unit will process up to 100 standard cubic feet per minute (scfm) of biogas to produce up to 160,000 diesel gallon equivalents (DGE) of BioCNG annually. Following the termination phase of the process, the digestate is removed from the anaerobic digesters and transported immediately to a designated compost facility. Ammonia and odor will be controlled by an acid scrubber, humidifier, and biofilter and negative air flow employed when digester doors are opened.

With Option A and B, the biogas would be sent to a Combined Heat and Power Cogeneration System to the facility to generate renewable energy. 2G Cenergy manufactures the cogeneration system to provide a fully containerized system, complete with controls, monitoring, and metering systems included. This project is designed to operate 24 hours a day, 7 days a week, with the exception of routine maintenance of the systems. The project is comprised of an activated charcoal gas filtration system, biogas fueled reciprocating internal combustion engine, synchronous electric generator, and control equipment. At 12,500 TPY, the electric generation from the project would be used to offset existing on-site MSS Facility loads and net meter the surplus to the grid. The Mass Flow Diagram for the 12,500 TPY AD unit inside of the MSS Transfer Station and the 5,000 TPY unit next to MRRC is attached to generate renewable energy, where one or the other is being proposed as part of this project where this environmental analysis reflects the 12,500 TPY option as part of Option A.

With Option C, biogas would be sent to a BioCNG system (see picture) that would upgrade the biogas to fuel quality (about 99% methane) and produce a waste gas of 40% methane. The waste gas would be used to operate a microturbine or boiler unit. The heat from the microturbine or boiler unit would be used to heat the percolate and maintain the organics at thermophilic (>122°F) temperatures. The fuel quality biogas would be compressed and stored and would be used to fuel CNG vehicles. The biogas from this AD system would have a methane content of about 60% and would be generated at a rate of 3,300 cubic feet per ton of waste. The biogas cleanup system would use an Air Liquide MEDAL membrane system to produce a fuel flow that is approximately 99% methane. The published Low Carbon Fuel Standard (LCFS) pathways for biogas to CNG assume that a two-stage membrane system is used, which recovers 90% of the methane in the biogas. The Mass Flow Diagram for the 12,500 TPY AD unit inside of the MSS Transfer Station is attached to produce CNG as part of Option B.



After a retention time of about 21 days, biogas generation would be exhausted and the digestate would be removed from the AD system. Exhaust air streams that would be treated in the biofilter include aeration bay exhaust air, digester start-up and termination air. Notably, there would also be an enclosed lean gas flare (LGF), which would destroy low quality lean biogas (methane content below 20% and higher than 1%) generated towards the termination of the AD process cycle, when the majority of the biogas generation has been exhausted. The LGF would be intermittently operated 3 to 4 hours per digester termination, which would occur every 2.5 to 3 days.

Power Supply

The total electrical load of the project would be about 150 kW, including the AD system, biogas upgrading and fueling system, and the microturbine processor. There would also be a requirement for thermal energy to heat the AD system. The waste gas from the biogas cleanup system would be used in a microturbine to generate both electrical and thermal energy. The microturbine is about 28% efficient, and the biogas flow to the microturbine would generate about 73.3 kW of electric power (55.3% of the total), as well as more than sufficient thermal energy to satisfy the process requirements. This is based on a stainless steel heat transfer module, rather than copper, due to concerns about corrosion. The balance of electrical requirements (59.4 kW) would be satisfied with grid supplied power. If the microturbine is down for repair or maintenance, grid-supplied power would provide all of the electricity and thermal energy to the system until the microturbine is operational.

Co-Product Generation

Solid digestate would be produced through the AD system, which would be taken to a permitted compost facility and would ultimately be used as a soil amendment. As stated above, the organic waste feedstock for this AD system would be a 67:33 blend of food and green waste, with an average moisture content of 60%. The weight of digestate would be about 10% less than the as-received feedstock.

Renewable Energy Production

The annual CNG methane production is estimated at 2.1 million kilo-watt/hour per year, which is expected to offset the current MSS Facility load of 1.4 to 1.6 million kilo-watt/hour per year, and net meter the surplus to the grid.

Fuel Production

The annual renewable energy generation is estimated at 41,250,000 cubic feet, which is expected to offset the use of approximately 166,000 gallons of diesel fuel

Project Construction Activities

The components of the system would be provided by at least three vendors, Zero Waste Energy for the anaerobic digestion component, Cornerstone Engineering for the biogas upgrading and fueling system and Capstone Turbine Corporation would furnish the microturbine for the renewable energy generation or 2G Cenergy for the CHP unit. A goal of the project is to demonstrate the construction of an entirely modular, small-scale, biofuel production facility with the system components designed to integrate and complement each other. Ease of construction with complementary system components that can easily be scaled up to larger facilities is a key goal of this project.

Construction activities associated with the project would be minimal based on the modular technologies incorporated into the design. Construction is anticipated to occur over a 2- to 3-month period, which would include disturbing an area of less than 1.0 acres and export of 2,500 cubic yards during preliminary earthwork and grading for the location next to MRRC.

Project Objectives:

Project goals and objectives are to promote sustainability in the community, while addressing global environmental concerns, including:

- Help MSS meet their WasteNot goals of zero waste by 2025
- Assist in meeting CalRecycle Strategic Directive 6.1: Reduce the amount of organics in the waste stream by 50 percent by 2020.
- Support Assembly Bill 32 (AB 32), the California Global Warming Solutions Act of 2006, greenhouse gas (GHG) reduction measures related to the use of anaerobic digestion:
 - Measure E-3. Achieve a 33 percent renewable energy mix by 2020. (AD facilities produce biogas which is a renewable energy source.)
 - Measure RW-3. High Recycling/Zero Waste. (Anaerobic digestion is one of five subcategories listed under this measure.)

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- Meet the Low Carbon Fuel Standard (LCFS), which requires a 10% reduction in the carbon intensity of fuel by 2020. The use of CNG fuel produced from biogas reduces the carbon intensity by 62% from diesel.
 - Support mandated commercial recycling pursuant to AB 341 and local government plans.
 - Support mandated organics recycling pursuant to AB 1826.
 - Provide digestate to be composted and used as a soil amendment, contributing to the reduction of CO₂ and agricultural water runoff.
 - Commercialize a technology that can be replicated at a local level throughout the state.

Other Public Agencies whose Approval is Required (e.g., permits, financing approval, or participation agreement. Indicate whether another agency is a responsible or trustee agency):

The Solid Waste Facility Permit (SWFP) would need to be revised to accommodate the change in operations to add the AD Facility and CNG Production Facility at the MSS Transfer Station. The Project proponent will need to file the application with the Marin County Environmental Health Services, acting as the Local Enforcement Agency (LEA), for the California Department of Resources Recycling and Recovery (CalRecycle). The LEA issues the SWFP Revision, and CalRecycle needs to concur with the SWFP Revision.

The Combined Heat and Power (CHP) Cogeneration System would convert biogas to energy. The Bay Area Air Quality Management District (BAAQMD) will need to issue an Authority to Construct and a Permit to Operate (ATC/PTO).

The CNG Production Facility would convert the excess waste gas from the biogas clean-up process in a microturbine to generate electricity to run the facility. The Bay Area Air Quality Management District (BAAQMD) will need to issue an Authority to Construct and a Permit to Operate (ATC/PTO) the microturbine. The BAAQMD considers microturbines to be BACT. In addition to the microturbine, the BAAQMD will need to issue ATC/PTO for the lean gas flare, the acid scrubber, and the biofilter.