INSTITUTE FOR LOCAL GOVERNMENT℠
Promoting Good Government at the Local Level

Anaerobic Digestion

What is it and Who is Doing it?

Introduction

As local agencies work to meet the state's goal of diverting 75 percent of California's waste from disposal in landfills by 2020, they are turning to innovative technologies like anaerobic digestion to convert waste into energy as well as reduce greenhouse gas emissions that contribute to climate change. This issue brief provides an overview of some of the technical and financing factors that local officials and staff should consider in determining whether anaerobic digestion is an appropriate approach to meet their goals for diverting waste, producing renewable energy and reducing greenhouse gas emissions.

What is Anaerobic Digestion?

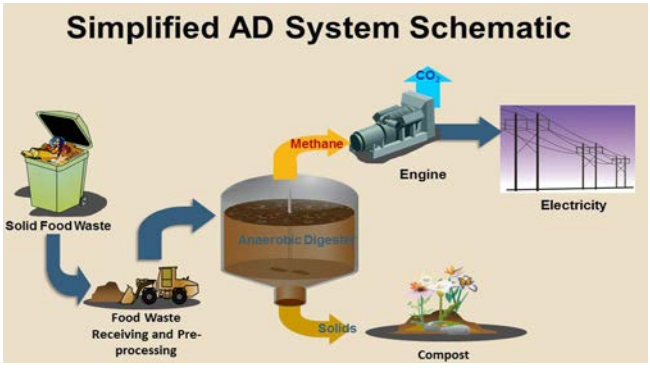

Image courtesy of Central Marin Sanitation

Anaerobic digestion is a natural process where bacteria breaks down organic materials such as food scraps, green waste, and other organic materials into "biogas" and fertilizer. It takes place in an oxygen-free environment in an enclosed container, or a natural environment sealed off from the air, such as a marsh, bog or wetland.

The "biogas" can be captured, processed into renewable natural gas (biomethane), and used. Cities and counties across California are developing facilities that will harness this natural process to produce renewable energy from waste, as well as compost for fertilizer.

What Goes In?

Organic material such as food waste or green waste (for example, yard trimmings).

The character of this "feedstock" (a term for what material goes into a process, or what "feeds" it) varies significantly and the technology used at a facility will dictate things like moisture content and "high solids" vs. "low solids." High solids anaerobic digestion, or "dry digestion," is composed of 25 percent to 35 percent solid materials and typically uses a mixture of green waste and food waste as feedstocks. Low solids, or "wet digestion," is generally composed of less than 15% solid content and processes a higher proportion of wetter material such as food and beverage wastes. The moisture content of the feedstock can often be modified to match the facility's technology.

What Comes Out?

Energy ("biogas" and/or electricity) and fertilizer.

Anaerobic digestion creates a product called "biogas," which is primarily methane and carbon dioxide. Biogas is upgraded to biomethane by removing carbon dioxide and impurities. Biomethane can be used as a transportation fuel in compressed natural gas (CNG) vehicles or used in fuel cells, turbines or internal combustion engines to generate electricity.

Anaerobic digestion also produces a substance called "digestate," which is the solid and liquid residual remaining after the organic material has been processed (or digested). The solid digestate can be composted after the addition of bulking material such as wood waste or green waste. The digestate's liquid portion has high nutrient content and may be processed for use as a fertilizer.

Existing Anaerobic Digestion Uses

Anaerobic digestion in the United States is used at wastewater treatment facilities, often called Publicly-Operated Treatment Works, and at dairies to reduce the volume of sludge or manure and generate energy products such as electricity and heat. Anaerobic digestion of municipal solid waste is a recent development in the United States, but is more established in Europe.

Where Is It Done?

Usually with other waste recovery facilities to increase efficiencies.

Anaerobic digestion facilities can be stand-alone facilities, or located at landfills, composting or material recovery (recycling) facilities or wastewater treatment plants.

The size of anaerobic digestion facilities varies depending upon the location, the feedstock and the end-use of the biogas or digestate. Small pilot facilities generally can process about 15 tons per day, while medium size facilities can generally process about 100 tons per day and larger facilities about 250 tons per day.

What is Compost?

At the simplest level, the process of composting consists of combining organic matter (usually a mixture of food waste and green waste) with oxygen and water and allowing bacteria, fungi, and other micro-organisms to break down the materials over a period of weeks or months. Modern composting is often more complex, but either way the result is a material that can then be used to add nutrients and microbial activity back to the soil in gardens, landscaping, horticulture and agriculture.

Anaerobic Digestion and Greenhouse Gas Emissions

Local jurisdictions that have anaerobic digestion projects in their communities have seen a number of benefits including landfill disposal cost savings, the ability to meet greenhouse gas reduction goals and state waste diversion goals and requirements, increased community pride and recognition of their role as an environmental leader.

When considering an anaerobic digestion facility, communities have the option to produce electricity or natural gas with heat as a co-product. Electricity can be used to power the facility or exported to the electrical grid. Natural gas can be used to fuel natural gas vehicles, including solid

waste and recycling trucks, delivery trucks, passenger vehicles and buses. Either energy choice will generate a revenue stream which can help offset the costs of building an operating the facility.

Anaerobic digestion facilities reduce or displace greenhouse gas emissions through:

- Reducing the amount of organic material put in landfills (and thereby avoiding methane emissions which are 25 times more potent greenhouse gas than carbon dioxide),
- Using biomethane to produce electricity, displacing fossil fuels,
- Using biomethane as a transportation fuel, displacing fossil fuels, and
- Creating compost.

Biomethane produced from anaerobic digestion facilities has a lower *carbon intensity* than transportation fuels such as diesel.[1]

Case Example: Sacramento[5]

Hailed in 2013 as the largest anaerobic digestion system of its kind in North America, the Sacramento BioDigester started in 2012 with the capacity to process 10,000 tons of food waste per year and was expanded to four times that size in early 2015. The 40,000 ton input capacity includes food waste from area restaurants, food processors, hospitals, international airport, elementary schools and supermarkets.

The 730,000 gallons of biofuel produced annually are used at an onsite fueling station to fuel all of the natural gas trucks of the local trash and recycling collection fleet (24 of 55 trucks), as well as a portion of the city's and county's waste fleets, security cars, California State University Sacramento commuter buses (6 buses), two local catering companies and local school buses (exclusive contract with Sacramento School District's 6-12 buses, backup provider for Elk Grove's 6-12 buses). The waste gas (not clean enough to use for transportation fuel) is used to produce one million kilowatts of electricity which powers both the facility and the fueling station. The digestate is used to produce eight million gallons of organic soils and fertilizers for Sacramento area farms.

The project was undertaken as a partnership between CleanWorld and Atlas Disposal, and began as a proposal for repurposing an under-utilized waste transfer station owned by the county. CleanWorld and Atlas Disposal each received grants from the California Energy Commission and Recycled Market Development Zone loans from CalRecycle to help fund the digester and fueling station.

What is *Carbon Intensity*?

The term carbon intensity refers to the amount of carbon, by weight, emitted per unit of energy consumed.[2] For example, biomethane used as a transportation fuel for agency fleets or to generate electricity results in low carbon intensity because it emits less carbon on a life cycle basis.

Biomethane is also a component of California's Low Carbon Fuel Standard Program, which is intended to lower the greenhouse gas emissions from petroleum-based transportation fuels.[3] Within the Low Carbon Fuel Standard Program the carbon intensity of "High Solids Anaerobic Digestion" is considered negative,[4] meaning that it "displaces" more greenhouse gas emissions than it generates. Fuels such as this are referred to as "carbon negative" and can be produced or purchased by producers of petroleum-based fuels to reduce the overall carbon intensity of their products to levels required by the Low Carbon Fuel Standard.

Encouraging Anaerobic Digestion Projects in California Communities

Communities that have already built anaerobic digestion facilities, including those within the Monterey region, say that their businesses and residents are proud of their ability to keep food and yard waste out of their landfill, and they push for more work that will show that their community is playing an important role as an environmental leader.

Cities and counties that have been successful in implementing anaerobic digestion facilities in their communities cite the following lessons learned on implementation:

- Pre-zone or permit land for composting/anaerobic digestion to reduce local permitting delays.
- Consider what outputs will work best for your community – biogas or electricity.
- Find the right size facility for your community to balance supply and demand and make the most of operational efficiencies from size.
- Establish an understanding of major barriers (air quality regulations, neighboring jurisdiction concerns, etc.) or community concerns (noise, traffic, air quality, etc.) ahead of time.
- Consider buying natural gas trucks in anticipation of biogas production.

Anaerobic Digestion Facility Program EIR Available

In 2011, the California Department of Resources Recycling and Recovery (CalRecycle) issued the final programmatic Environmental Impact Report (Program EIR) for Statewide Anaerobic Digester Facilities for the Treatment of Municipal Organic Solid Waste.[6] According to CalRecycle, the Program EIR assesses the environmental effects that may result from the development of anaerobic digestion facilities in California.[7] Future facilities can use the Program EIR as a basis for the environmental review of their individual projects to reduce the analysis needed each time, though it does not completely remove the need for individual environmental review.

Case Example: Monterey Regional Waste Management District[8]

Located just north of the City of Marina, the facilities of the Monterey Regional Waste Management District (the District) now includes a new pilot project. Operational since March of 2013, this small anaerobic digestion facility features a 5,000 ton input capacity and produces approximately 100 kW of electrical energy annually. This first in California "dry fermentation" anaerobic digester is fueled with a mix of 70% food waste from area restaurants and college campuses, and 30% yard trimmings.

The project is in the middle of its initial phase as a 5-year pilot project. The District explored anaerobic digestion as a method for processing the increasing volume of food waste received at the site and the desire of the local hospitality industry to keep this material out of the landfill and put it to better use. Zero Waste Energy (ZWE), LLC, was looking for an opportunity to prove the practicality of their new technology. The District agreed to host the pilot project and provide the site on land previously zoned for a composting facility. In exchange ZWE provided the "SmartFerm" system for a 5 year term without requiring the $3 million purchase upfront. The District pays ZWE a fee on each ton of material processed and ZWE receives the revenue from electricity sales which supply the neighboring waste water treatment plant.

The gas produced by the process serves as fuel for an engine generator producing 100 kW of electricity. The electrical output sold "over the fence" is enough to replace 10 percent of the energy needed to run the adjacent waste water treatment plant. The digestate produced by the facility is given to a private firm who rents part of the district's land for an on-site composting facility. This private firm is then responsible for all the marketing and sales, mostly to local vineyards, of the resulting compost.

Jeff Lindenthal, the Monterey Regional Waste Management District's Director of Community Programs, says that the business community was instrumental in making this project a success and were the driving force behind getting food scraps out of the landfill and into compost. They are, "proud to know that their food waste is going to a state of the art facility where the methane is being converted into electricity for local use." The District worked cooperatively with the hospitality industry to create an "Organics to Energy" brand and an informative website which showcases the project and the participating hospitality businesses sending their food waste to the program.

Financing Options

As with most recycling facilities, a new anaerobic digestion facility needs a source of funding for the site, construction and installation of the equipment. Because these are one-time costs, there are numerous grant programs through the state and regional agencies that can be used to cover these costs. Long-term costs are often similar to fees charged at landfills, and therefore can often be covered with existing methods. For an overview of financing options available see: www.ca-ilg.org/document/financing-recycling.

Case Example: Perris[9]

Construction is underway as the City of Perris aims to build the largest anaerobic digestion facility in the world. Phase one will be completed by October 1, 2015, with three additional phases (each of the equal size) already permitted on the 52 acre site.

Developed by a private firm, CR&R Incorporated, each phase of this facility will process 83,000 tons of organic waste per year from curbside collection of "green material" and food scraps (for a total of 335,000 tons/year). Each phase will produce an amount of biogas equivalent to more than 1 million gallons of gasoline each year, enough fuel for 70 collection vehicles. The quality of the fuel has already been approved for pipeline injection, so that extra fuel produced can be sold elsewhere.

Mike Silva, Project Manager at CR&R, praises the support they received from the city and community from the very beginning, "The number one thing is that you have got to have the support of the community. The rest is all technical: getting your permits, dotting your i's, crossing your t's. If you don't have the support of the community all the rest is a waste of time."

The first two phases have been partially funded by grants from the California Energy Commission, South Coast Air Quality Management District, and CalRecycle.

Advice and Lessons Learned

The following are key lessons learned and suggestions from experts and project developers based upon their experience. The information was gathered from informal conversations, interviews, and written materials.

- Consider what space needs the facility will require, and where it will fit.
- When possible, co-locate with other facilities, such as landfills, material recovery facilities, compost facilities or waste water treatment plants.
- Consider using biogas as a transportation fuel for agency fleets to save money and reduce greenhouse gas emissions.
- Determine what type and quantity of feedstock is available and projected for the future when determining technology and size.
- Have a contract that includes a guaranteed feedstock to help secure financing.
- Just because a project works in one area does not mean it will work in a different area. Different landfill tipping fees, air district permit requirements and other factors may impact the technical and economic feasibility of proposed projects.
- Determine specific desired outcomes (electricity, fuel, compost, etc.) and how they impact the type of technology (wet vs. dry, high vs. low solids) and feedstock (clean vs. contaminated, greenwaste vs. food waste, etc.) when designing and placing the facility.

Conclusion

Solutions, such as anaerobic digestion, can help cities and counties meet the state's ambitious waste diversion goals and generate benefits such as greenhouse gas emissions reductions and new revenue streams. More information on anaerobic digestion strategies and funding and siting recycling infrastructure and facilities can be found in ILG's newest resource center: www.ca-ilg.org/recycling-resource-center.

Resources to Learn More

CalRecycle Anaerobic Digestion Resource Page

Program Environmental Impact Report (EIR) for Anaerobic Digestion Facilities. CalRecycle.

Composting and Anaerobic Digestion Waste Management Working Papers for Updated AB 32 Scoping Plan. September 2013. Prepared by CalRecycle.

Permitting Tool Kit for Food Waste Anaerobic Digestors Humboldt Waste Management Authority. March 2013.

California Energy Commission Anaerobic Digestion Resource Page

California Air Resources Board Low Carbon Fuel Standard Program

Low Carbon Fuel Standard for High Solids Anaerobic Digestion Pathway

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Endnotes

[1] "Composting and Anaerobic Digestion", CalRecycle, September 2013. http://www.calrecycle.ca.gov/actions/Documents%5C77%5C20132013%5C935%5CComposting%20and%20Anaerobic%20Digestion%20FINAL.pdf

[2] U.S. Environmental Protection Agency Green Power Glossary. www.epa.gov/greenpower/pubs/glossary.htm#a

[3] *See* California Air Resources Board www.arb.ca.gov/fuels/lcfs/lcfs.htm and California Energy Commission www.energy.ca.gov/low_carbon_fuel_standard/.

[4] The carbon intensity of High Solids Anaerobic Digestion derived biomethane is -34.7g CO2e/MJ (or, negative 34.7 grams of carbon dioxide equivalents per per megajoule. A joule is a measurement of energy. *See* Air Resources Board Low Carbon Fuel Standard at http://www.arb.ca.gov/fuels/lcfs/121514hsad.pdf.

[5] www.cleancitiessacramento.org

[6] *See* www.calrecycle.ca.gov/swfacilities/compostables/AnaerobicDig/PropFnlPEIR.pdf.

[7] *See* "Program Environmental Impact Report (EIR) for Anaerobic Digestion Facilities" for more information at www.calrecycle.ca.gov/swfacilities/compostables/AnaerobicDig/default.htm.

[8] www.organicstoenergy.org

[9] www.eisenmann.us.com