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Anaerobic Digestion at the Cayuga County Soil and Water Conservation District's Community Digester: Case Study

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Anaerobic digestion overview

Digester type	Pressure Differential (Hydraulic Mix)
Digester designer	GBU Germany
Date Commissioned	2012, targeted for March
Influent	Raw manure, food waste, brown fat
Stall bedding material	Straw, sawdust
Number of cows	1,500 lactating cows (from 2 farms)
Rumensin® usage	unknown
Dimensions (diameter, height)	62.3', 64.3'
Cover material	Steel
Design temperature	100 F
Estimated total loading rate	40,000 to 43,000 gallons per day
Treatment volume	Main Tank- 1,000,000 gallons; Post- 200,000 gallons
Estimated hydraulic retention time	25 days + 5 days conditioning
Solid-liquid separator	Not at this time, though planned for future
Biogas utilization	633-kW Jenbacher
Carbon credits sold/accumulated	Not yet, in planning
Monitoring results to date	None

Project overview

Cayuga County Soil and Water conservation District decided to undertake a digester project in 2006. The primary motivation of the project was to develop an economically sustainable model, under the auspices of Cayuga County Soil and Water Conservation District, a Public Agency under Cayuga County, to address manure management issues facing southern Cayuga County dairies especially the small farmers, improve the water quality and improve the quality of life for Cayuga County local residents. The goal of the operation is to pay for the project using the savings from avoiding purchasing electricity and heat, income from the sale of electricity and renewable energy credits, tipping fees from food-waste and the sale of bio-solids.

Electrical power generated by the system will be used to power the District campus, with surplus power sold to the grid or a power marketer under a power purchase agreement. Heat recovered from the cogeneration system will be used to maintain the temperature of the process equipment and the excess will be transported to the public safety building to offset their purchase of natural gas for boilers.

Approximately 35,000 gallons of manure will be trucked in daily from local dairy farms and comingled with 8,500 gallons of food waste, delivered from local food processing plants. In addition brown grease and fat sludge will be brought to the plant in tankers for co-digestion. The trucks bringing manure to the plant will be filled with digested effluent to return to the farm for long-term storage and eventual use. Initially, two farms, located 12 and 7 miles away from the facility will be participating in the project. The system has been designed with further expansion in mind.

Digester System

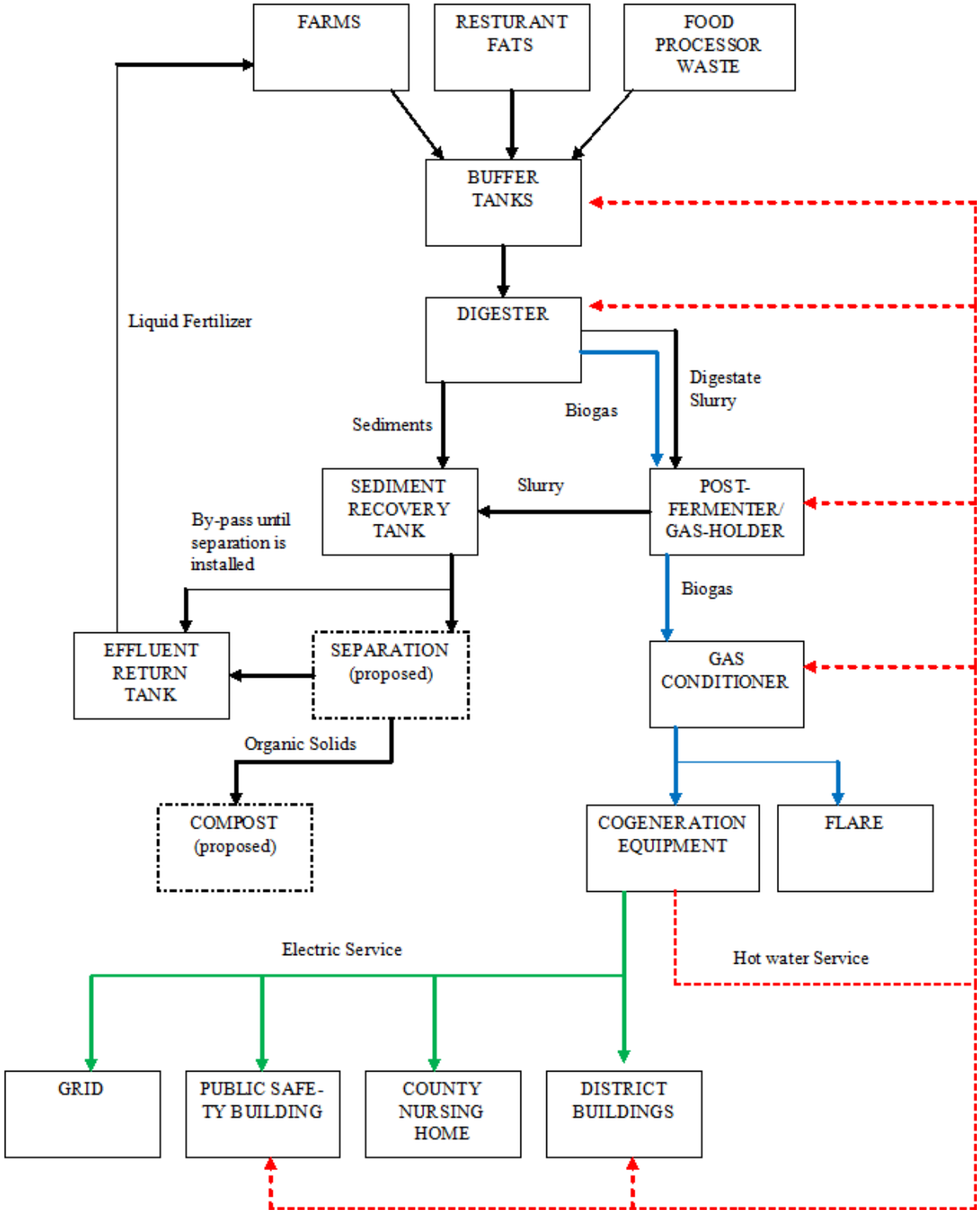

Figure 1. Cayuga County SWCD AD system flow diagram
System and process description

The hydraulic-mix digester system selected for the Cayuga County Digester is unique in the United States, but used in Europe. It has no internal moving mixers, and relies on pressure differentials between the inner and outer tanks gas head space to mix and move the digesting materials. The system is designed to process solids concentrations up to 18%.

Because digestion feedstock is trucked in from off-site, pre-treatment systems to both equalize (buffer) and treat the incoming brown grease material are necessary. The equalization storage tanks also allow for continuous operation during weekends, holidays and challenging transportation periods. Manure is trucked in several times per day in two 4,500 gallon tanker trucks, owned by the project (Figure 2). Manure is unloaded with a system of pumps in the process building that can empty the tankers at a rate of 500 gpm. By having the loading/unloading station indoors, the delivery operations are contained and protected from the elements. This also provides a future opportunity to control the release of odors to the environment. Manure and food waste are routed to the manure equalization tank where they can be stored for up to 5 days. Brown greases and fat sludge are routed to a separate grease/fat equalization tank that can store material for up to 30 days.

Figure 2. 4,500 Gallon tanker truck used for hauling manure to site and digested effluent from site

The 170,000-gallon manure and the 40,000-gallon grease/fat equalization tanks are both heated with waste heat from the engine-generator set, and agitated to address material sedimentation. Feedstock from the manure equalization tank is automatically fed to the digester 10 to 16 times per day. Material from the grease/fat equalization tank is pumped into a 500-gallon sanitation tank, where it is heated to the specified temperature and held there for at least one hour to pasteurize it against pathogens. After the material has been sanitized it is dosed into the feed line of the digester, where it is mixed with the inflowing manure.

Following digestion, the digestate slurry moves to the 170,000-gallon post-fermenter by gravity. Here, the digestate slurry is allowed to stabilize while it continues to off-gas. The biogas from

the digester is also vented to the post-fermenter, where it is stored in the 25,000-cubic foot gas-holder membrane and supplied to the cogeneration system, as needed. The biogas storage system is the first of its kind in New York State and allows the system to store biogas, rather than flare it, during engine maintenance shutdowns.

The sediments in the digester are piped directly to a sediment recovery tank. These are then remixed with the digestate slurry from the post fermenter and pumped to the 170,000-gallon effluent tank for delivery away from the site. The effluent storage tank can hold 5 days of digestate slurry or separated liquids. The storage allows for disruption in deliveries due to weekends, holidays or inclement weather. The material in the effluent storage is typically returned to the participating farms on the same trucks that are used to pick up the manure from the farm (to avoid having trucks travel empty).

Future plans include the construction of a separation and composting facility, where the digestate slurry and sediments would be separated into solids and liquids and the solids processed further to produce bio-solids for sale to third parties. The liquid would then be returned to the effluent tank to be stored for shipping back to the farms.

After arrival on-farm, the tankers are unloaded (gravity-flow) into the storage lagoons prepared to receive this effluent. The trucks are then loaded with fresh manure from the on-farm manure storage tanks before traveling back to the plant.

Before combustion in the engine generator, the biogas is scrubbed using a biological system to reduce the H_2S concentration from predicted levels of 4,000 ppm down to 100 ppm. The process byproducts are elemental sulfur and sulfates. The cleaned biogas is then processed further to remove moisture and prepare it for use in the cogeneration system.

Treated biogas is piped to the 633-kW Jenbacher (JMS-312) reciprocating engine generator set, specifically designed to run on biogas (rated to have a 37.6% energy conversion efficiency), provides the electrical needs of the digester plant (station service) and the County buildings located on the county campus near the plant; the public safety building, the nursing home, the District office building, maintenance shop and the Sheriff's training building. The generator is interconnected with the NYSEG grid so that any excess can be supplied to the grid for sale to

third parties. A series of heat exchangers are installed to transfer the heat recovered by the cogeneration system to the thermal management system that provides heat to the process vessels and the County campus buildings.

A safety flare that is installed in the plant operates during emergencies and burns off any excess biogas from the plant.

Economics

The project received a $6.2 million American Resource and Recovery Act grant through the New York State Environmental Facilities Corporation and an additional $3.5 million in federal and state grants and aid, resulting in a total capital cost of at least $9.7 million.

The project will sell excess power to NYSEG under a power purchase agreement. In addition waste heat from the engine generator will be used to offset heating costs of the district buildings. When the system is up and running additional income will come from tipping fees for both the food waste and brown fats.

Benefits and Considerations

Benefits

- Potential revenue from:
  1) Value-added products
  2) Reduction of purchased thermal and electrical energy
  3) Sale of excess energy
  4) Food waste tipping fees
- Odor control (on-farm benefit)
- Nutrient conversion, allowing use by plants as a natural fertilizer, if effluent is spread at an appropriate time
- Pathogen reduction

Considerations

- High initial capital and/or high operating costs
- Transportation
  - Self-trucking vs. Outsourced
  - On farm loading/unloading
  - Site Activities
  - Travel routes
- Long-term sourcing of co-digestion materials
- Careful attention to process control due to co-digestion
- Grants
  - Adminstration
  - Rules
  - Made-In-America restrictions
- Municipal Project which entail
  - Purchasing Regulations
  - Permitting, local codes
  - Valuing shared benefits
  - Prevailing wages

Lessons Learned

The following lessons learned were reported by the Cayuga County SWCD.

Use existing technology. By installing the engine-generator set in the process building a large expense was incurred installing custom piping to move biogas, hot and returned water. Some of this expense could have been avoided if an engine generator set in a self-contained container was used.

The system was originally conceived as an "island" where power would be produced and used on the campus. By hooking up to the grid the operation is subject to utility restrictions and is required to go off-line in power outages. Interconnection agreements take time and effort.

However, islanded electrical operation with a biogas plant requires 1) sophisticated load controls, and 2) consideration of the fuel source and its availability.

The trucks used to haul manure and effluent were purchased due to the difficulty in securing a lease agreement. Leasing companies were unwilling to lease larger tanker trucks to the operation without proof of driver experience.

Municipal projects are more expensive, due to purchasing restrictions, prevailing wages, construction requirements.

When possible, electrical aggregation should be a first step to lower the energy costs.

WHO TO CONTACT

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