



Comparison of Two Farm Digester Projects

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Overview

- Cayuga County Profile
- Project 1: Community Digester
- Project 2: Biogas Pipeline and Central Power Plant

CAYUGA COUNTY AGRICULTURE PROFILE (2008)

Statistics

- Number of Farms: 805
- Dairy cattle: 33,800 head
- Milk: 84,110,200 gallons

New York State Rankings

- 1st in corn and soybean production
- 2nd in milk production
- Cayuga County is 3rd in total agricultural value of products

Market Value of Agriculture

- All products: \$182,837,000
- All Livestock: \$129,321,000
- All Crops: \$53,516,000

Cayuga County Soil and Water Conservation District Community Digester



Project Overview

- Project Initiation: 2006 / Project Completion: 2012
- Project Purpose: Develop an economically sustainable model to address manure management issues facing Cayuga County dairies; improve water quality; improve quality of life for County residents
- Project Goal: Finance the project from savings associated with avoided costs of purchase of electricity and heat for the Soil and Water Campus; income from the sale of electricity to NYSEG Grid; income from the sale of Renewable Energy Credits; income from tipping fees from food-waste; and income from the sale of post-digested bio-solids

Project Overview - Continued

- Electric power generated by the system will be used to power the Soil and Water Campus (County Public Safety Building; Soil and Water Facilities; Home for the Elderly), 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

Project Methodology

- Approximately 35,000 gallons of manure trucked in daily from local dairy farms (initially two farms – located 7 and 12 miles from the facility will be participating in the project) and comingled with 8,500 gallons of food waste delivered from local food processing plants
- In addition, brown grease and fat sludge brought to plant in tankers for co-digestion
- Trucks delivering manure to plant will be filled with digested effluent to be returned to the farm for long-term storage and eventual use
- System is designed to include more dairy farms in the future

Anaerobic Digestion Overview

Digester Design	Pressure Differential (Hydraulic Mix)
Digester Designer	GBU Germany
Influent	Raw Manure; Food Waste; Brown Fat
Stall Bedding Material	Straw; Sawdust
Number of Cows	1,500 Lactating Cows (From 2 Farms)
Dimensions (Diameter, Height)	62.3 feet; 64.3 feet
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	Planned for Future
Biogas Utilization	633-kW Jenbacher

Digester System

- Hydraulic-mix digester system has no internal mixers and relies on pressure differentials between inner and outer tanks' gas-head space to mix and move digesting materials
- As digestion feedstock is trucked in from off-site, pretreatment systems to buffer and treat the incoming brown grease are necessary
- Equalization storage tanks 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
- Manure is unloaded with a system of pumps in the process building that can empty tankers at a rate of 500 gpm

Digester System - Continued

- Loading and unloading occur indoors to contain the delivery operations, to provide protection from the elements, and to control for 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 where they can be stored for up to 30 days
- The 170,000 gallon manure and the 40,000 gallon grease/fat equalization tanks are both heated with waste heat from the cogeneration equipment and agitated to address material sedimentation

Digester System - Continued

- 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 a specified temperature and held for at least one hour to pasteurize 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

Post- Digestion System

- Following digestion, the digestate slurry moves to the 170,000 gallon post-fermenter by gravity and 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 (this system allows the storage of biogas, rather than flaring, during engine maintenance shutdowns)
- Sediments in the digester are piped directly to a sediment recovery tank where they are 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 which allows for disruption in deliveries due to weekends, holidays or inclement weather

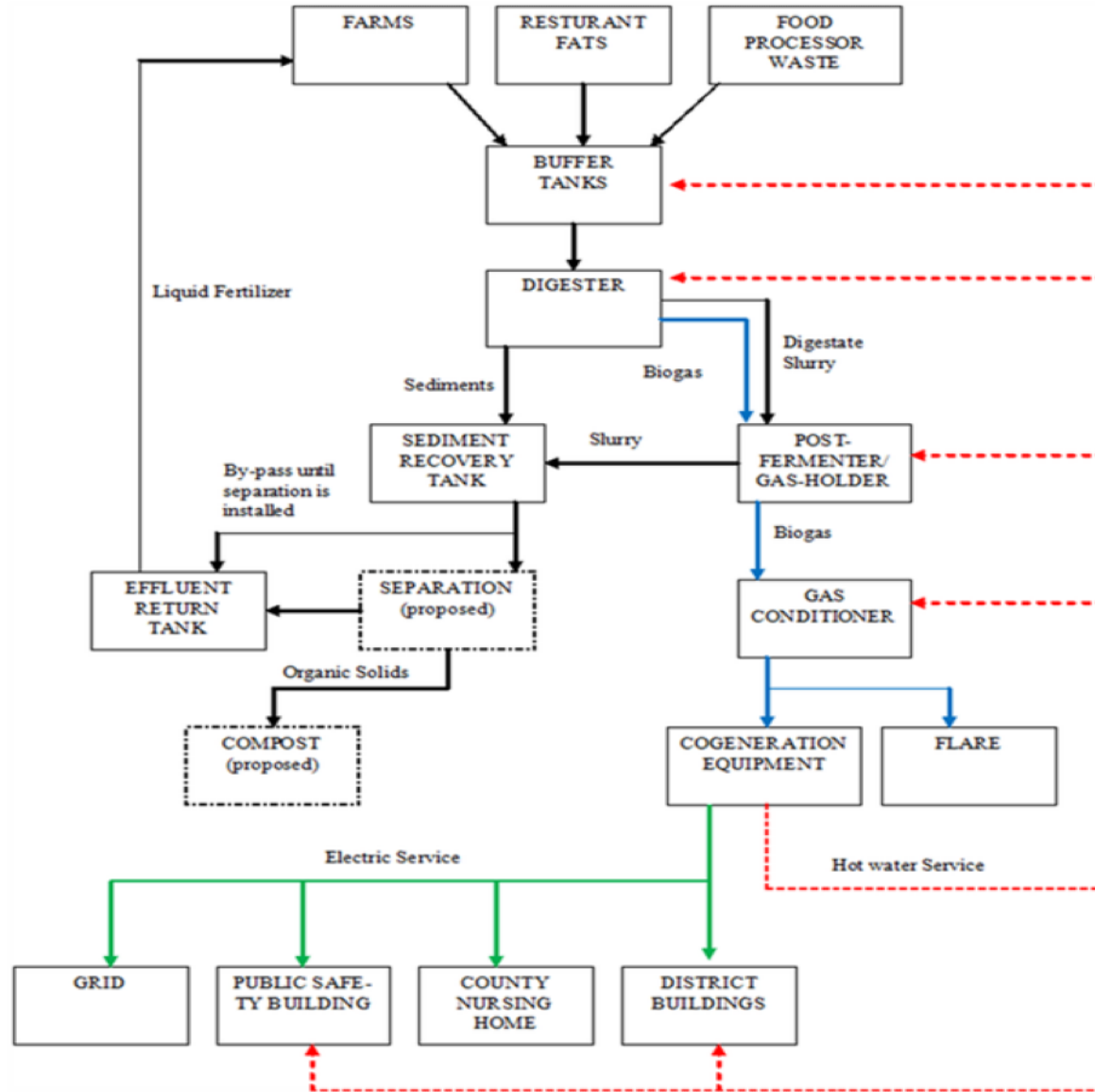
Post- Digestion System - Continued

- Future plans include the construction of a separation and composting facility where 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
- After arrival on-farm, the tankers are unloaded (gravity-flow) into storage lagoons prepared to receive this effluent
- Before combustion in the engine generator, the biogas is scrubbed using a biological system to reduce H₂S concentration from predicted levels of 4,000 ppm to 100 ppm
- The cleaned biogas is then processed further to remove moisture and prepare for its use in the cogeneration system

Post- Digestion System - Continued

- Treated biogas is piped to the 633 kW Jenbacher (JMS-312) reciprocating engine generator set, specifically designed to run on biogas (rated at 37.6% energy conversion efficiency) which provides the electrical needs of the digester plant and the County buildings located proximate to the plant
- The generator is interconnected with the NYSEG grid so any excess electricity can be supplied to the grid for sale to third parties
- A series of heat exchangers are installed to transfer heat recovered by the cogeneration system to the thermal management system to provide heat to the process vessels and the County campus buildings
- A safety flare is also installed to operate during emergencies

Cayuga County AD System Flow Diagram



Economics

- Project received a \$6.2 million American Resource and Recovery Act grant through NYS 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 Cayuga County Campus buildings
- Additional income will be derived from tipping fees for both food waste and brown fat and from brown fats
- Future income will be derived from the sale of compost and liquid effluent

Benefits and Considerations

Benefits	Considerations
<ul style="list-style-type: none">• Potential revenue from:<ol style="list-style-type: none">1. Value-added products2. Reduction of purchased electrical and thermal energy3. Sale of excess energy• Odor control (On-farm benefit)• Nutrient conversion, allowing use by crops of a “natural” fertilizer (if effluent is spread at an appropriate time); and allowing for the retention on-farm for the appropriate time to field-apply• Pathogen reduction	<ul style="list-style-type: none">• High initial capital costs• Transportation<ol style="list-style-type: none">1. Self-trucking <u>vs</u> out-sourced2. On-farm loading / unloading3. Site Activities4. Travel Routes• Long-term sourcing of substrates• Attention to process control due to co-digestion• Administration of public funds• Municipal power project regulations

Cayuga County Soil and Water Conservation District Community Digester



Biogas Pipeline Project

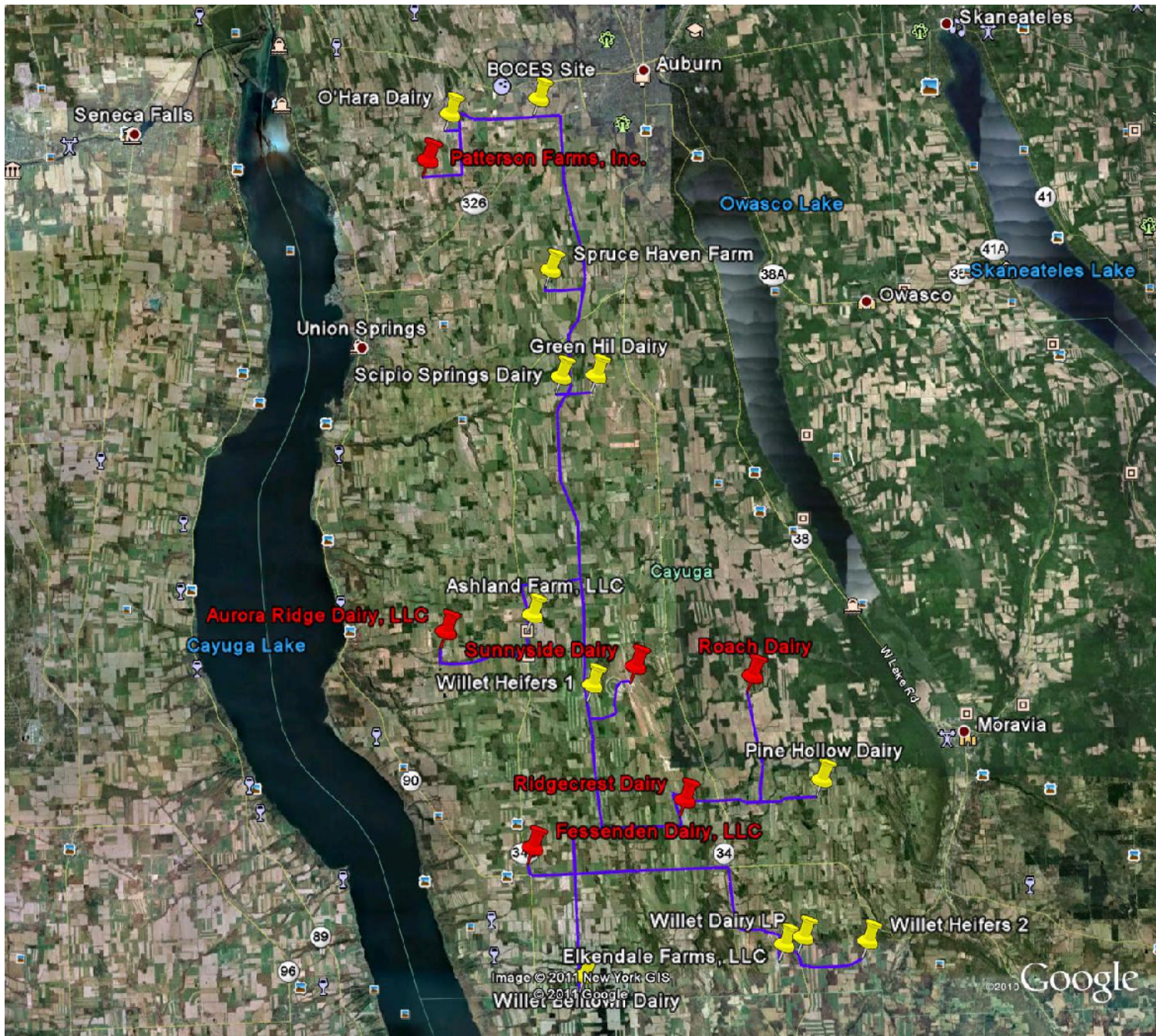
- County Entities: Planning, IDA, CCPUSA, farm co-op
- Phased approach
 - Phase 1: Fatal flaw analysis
 - Phase 2: Detailed feasibility study
- Funding from NYSERDA, USDA
- Technical analysis by SCS
- Legal analysis by Harris Beach
- Phase 1 start in August 2011

Proposed Project Overview

- Planning, design, permitting, financing, construction and operation of a biogas pipeline, distribution and delivery systems
- Transmission and delivery of biogas produced by various dairy farms within the County to a centralized location.
 - CCIDA industrial park
 - Adjacent to an educational facility operated by the Cayuga-Onondaga BOCES
- Goal: provide clean, renewable energy to industrial park customers

Proposed Project (cont.)

- Farmers: produce biogas via on-farm anaerobic digesters and inject the biogas into a dedicated pipeline
- Preliminary site plan: 24 farms
- Main pipeline: south to north for 20 miles
- Numerous spurs or laterals: generally running east and west for a combined 10-plus miles



Study Area Farms

- 24 dairies at the start
- Six have operating anaerobic digesters
 - Manure alone
 - Manure with substrate to enhance the biogas generation
- Three have plans to construct digesters.

Typical Dairy Farm



Existing Digester



Existing Flare



Existing Engine



Phased Approach

- Phase 1: Fatal flaw analysis
- Phase 2: Detailed feasibility study
 - Biogas estimates
 - Energy market analysis
 - Pipeline alignment, sizing, construction
 - Energy production
 - Site considerations
 - Permitting
 - Financial analysis
 - Structure and public meetings

Phase 1: Technical Feasibility

- USEPA AgSTAR Database
 - 186 AD systems operating at commercial livestock farms
 - 168 systems: generate electrical or thermal energy from the captured biogas
 - 25 systems in NY; second-most behind WI
- Established and mature technology available

Phase 1: Economic Feasibility

- High-level economic pro forma
 - Pipeline alignment and length
 - Power plant site
 - Biogas estimates
 - Condensate management, H₂S scrubbing, compressor stations
 - Power plant configuration
 - Electric and thermal revenues: BOCES, milk processing plant, cheese facility

Pipeline Route



IDA Site



Farms Not Considered

- No data was available
- Located at significant distance from the potential route of the main biogas pipeline
- No interest in the Proposed Project
- 7 of 24 farms dropped from the project

Net Metering

- Certain electric customers who generate renewable energy
- Rate credit for excess renewable energy generated that is not used
- Farmer's energy bill is credited for the excess amounts of electricity produced
- Historically, “net metering” required or allowed the use of only one physical electric meter

Remote Net Metering

- New law: effective June 1, 2011
- Certain agricultural utility customers
- Net metering credits
 - Meters at any property owned or leased by the farmer within the same utility service territory and load zone.
 - Generate excess electricity at one location and use the credits at another location.
- Incentive for farmers to maximize use of biogas to produce electricity and to use the net metering credits throughout its farm operation

Biogas Estimate

- Animal information
 - Dairy operators.
 - Absent operator data, estimates from the County's database, the NYSERDA website, the EPA AgSTAR, and Cornell University.
- Substrate data: Food waste as a proxy
- For the dairies that already have digesters, we discounted the biogas used in the existing combined heat and power units

Biogas Estimate (cont.)

- Overall biogas production set to 50 m³/tonne of manure/substrate mixture.
- Manure at 9 percent dry matter will produce an average of 27.5 m³/tonne.
- With high-grade substrate, about 75 m³/tonne.
- Existing digesters (manufactured by GHD and RCM) not designed to operate w/ substrate

Biogas Results

- With 17 farms and after discounting any existing biogas use, 2600 scfm to the pipeline.
- Net metering at the same level as existing farms, 1700 scfm.
- If no substrate, 800 scfm.
- If no substrate and use of remote net metering, no biogas to the pipeline.

Fatal Flaw

- Remote net metering law
- Eliminate or curtail the injection of biogas into the proposed pipeline
- Dairy farmers
 - Maximize and offset their farm operations energy costs (at an estimated 10 cents per kWh)
 - Meet their on-site power demands without the use (and risk) of digester substrates



Thank You!

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