

Anaerobic Digestion at Noblehurst Farms, Inc.: Case Study (Update)

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Contents:

- Anaerobic digester overview
- Farm overview
- Digester system
- Biogas utilization
- Economics
- Lessons learned
- Contact information
- References



Anaerobic digester at Noblehurst Farms.

Anaerobic digestion (AD) overview

Digester type	Mixed
Digester designer	EnviTec Biogas
Date commissioned	2015
Influent	Raw dairy manure (~65%), pre- & post-consumer food waste, milk processing plant waste water (~35%)
Stall bedding material	Post-digested separated solids
Number of cows	1,750
Rumensin® usage	Yes
Dimensions (Diameter × H)	100 × 28 ft. (10 ft. below grade)
Cover material	Flexible membrane
Design temperature	100-104°F
Design total loading rate	48,500 gal. per day
Design treatment volume	1,336,710 gal. max
Design hydraulic retention time	27.5 d
Liquid-solid separation	Yes, post digestion, Vincent (KP-10)
Biogas utilization	Guascor HGM 240 engine-generator set (500 kW) with heat recovery
Carbon credits sold/accumulated	Yes
Monitoring results available	Yes

Farm overview

- Noblehurst Farms, Inc., managed by Robert Noble, is located in Livingston County, New York.
- The farm milks 1,750 Holstein cows.
- Digester construction began in the fall of 2014. The digester began receiving waste in Feb. 2015, and the biogas-fired engine-generator set started producing electricity in April 2015.
- Noblehurst Farms Inc. is affiliated with Noblehurst Green Energy (the AD system operator), Natural Upcycling (a food waste hauler), and Craigs Station Creamery (are partnered with the milk processing plant located on-site).

Why the new digester?

Noblehurst Farms had several reasons for building their first AD system in 2001. Of highest priority were environmental concerns, which included reducing manure-born pathogen and nutrient loading to the two watersheds the farm is sited in, both of which are primary drinking water sources for nearby communities. The farm was also trying to reduce and avoid further odor and methane emissions problems associated with long-term storages. Economic incentives of electricity savings and sales and heating savings were also of interest to the farm. See the original case study for further details (Pronto & Gooch, 2009).

The new AD system, operated by affiliate, Noblehurst Green Energy, was constructed to continue reducing the farm's environmental impact, to mitigate odor issues associated with the pressurized concrete hardtop of the current AD system, and to capitalize on external organic waste streams for co-digestion. Co-digestion of external wastes offers increased potential for electricity generation, heat production and revenue from tipping fees; the current AD system was insufficiently sized to capitalize on this potential. The affiliate, Natural Upcycling, hauls pre- and post-consumer food wastes from local sources to the new AD system for a fee competitive to landfilling, and sells recovered food packaging materials for recycling. The affiliate, Craigs Station Creamery, a milk processing plant run by a partnership of Dairy Farmers of America and eight local dairy farms, is located adjacent to the new AD system. Whey and wastewater generated by the plant are piped to Noblehurst Farms for co-digestion in the new AD system, efficiently repurposing these wastes. In return, energy generated from the biogas-fueled engine-generator set is used to operate the milk plant. Recovered heat from the engine-generator set will also be used in the milk plant.

Digester system

System and process description

The digester system has several subsystems (see Figure 1.) including:

- Manure collection and transport
- Solid organic waste collection and transport
- Sludge/liquid organic waste collection and transport
- Waste mixing system
- Waste delivery and bypass system
- Anaerobic digestion
- Digester effluent solid-liquid separation
- Separated solids handling for use as bedding

- Separated liquid long-term storage and pivot field application system

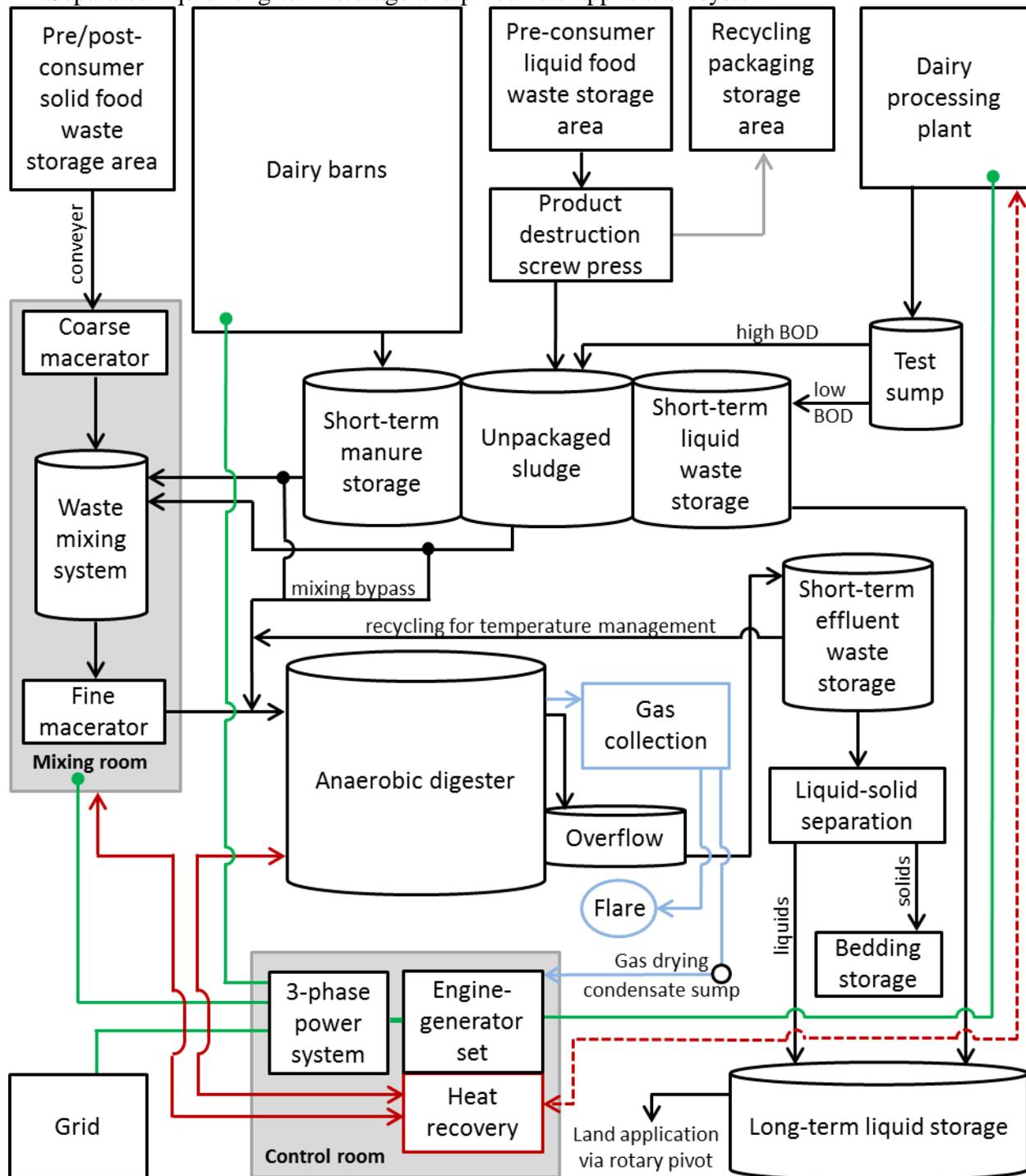


Figure 1. Schematic of Noblehurst Farm waste management, anaerobic digester, combined heat and power generation and usage systems. Flows for organics/wastes are in black, recycled materials are in grey, biogas is in blue, electricity is in green, recovered heat is in red and the dashed line is an unfinished connection.

Liquids and solids process description

The AD system co-digests three waste streams (manure, solid, and sludge/liquid organic wastes) each with unique pre-processing. *Manure* is scraped from each freestall barn to a central below-grade channel, where it flows by gravity to a collection pit (~ 28,000 gal. capacity) located between the barns and the digester mixing room. Barn manure and a portion of the liquid effluent from the solid-liquid separation system is mixed in this pit to obtain a ~10% slurry to facilitate pumping to the mixing room and AD system.

Solid organic wastes (e.g. culled/spoiled fruits, vegetable, and food scraps) are stored on an uncovered concrete pad. A conveyer built into the pad is loaded with a skid-steer and transfers these materials to a coarse macerator in the mixing room. The conveyer can hold enough solid organic waste to prepare multiple batches of co-digestate.

Sludge/liquid organic wastes consist of milk plant and pre-consumer food wastes. Whey and wastewater from the milk plant are pumped to a BOD sump near the mixing room. High BOD (> 8,400 mg O₂ per liter) wastewater is transferred to a pre-digestion, short-term storage tank; low BOD wastewater is diverted to a long-term earthen storage for recycling to crop land. Pre-consumer food wastes are manually de-packaged, processed with a product destruction screw press, and pumped to the pre-digestion, short-term storage tank.

These three waste streams are loaded into the EnviTec automated mixing system (Figure 2.) in precise mass-based ratios. A batch (8,000 lbs.) is mixed, sent through a fine macerator and pumped into the digester every 25 minutes. At night, to avoid required conveyer loading and problems with foreign object clogging the fine macerator, solid organics are not fed to the digester and mixing bypasses are used to directly feed manure and sludge/liquid organic wastes into the digester.

The mixed-flow anaerobic digester is a circular, partially below-grade tank (1,336,710 gal.) constructed of interlocking concrete pre-stressed wall panels, seated in a cast-in-place concrete floor. The walls are wrapped with R-19 fiberglass insulation and covered with painted, corrugated metal panels. The digester has a conical-shaped flexible fabric top. Four adjustable impellers are used to mix the system.

The system was designed to handle 425,000 lbs. of influent per day. Noblehurst Farms maintains the digester at approximately 1,080,000 gal. and co-digests an influent consisting of 65% manure (~ 40,000 gal. per day) and 35% pre/post-consumer food and milk plant wastes. The digester is operated at ~103°F with a biogas headspace pressure of 0.0555 psi and a ~21 day retention time.



Figure 2. EnviTec automated mixing system

Effluent from the AD system overflows into a collection tank and is pumped to a short-term storage. In the winter some of this effluent is recycled to help maintain digester temperature. From the short-term storage, the effluent is pumped to the solid-liquid separation system (see Pronto & Gooch, 2009); solids are recycled for bedding and liquids are pumped to the long-term earthen storage. This storage is connected to a center pivot irrigation system for summer applications.

Combined heat and power generation

Hydrogen sulfide scrubbing takes place within the digester vessel gas headspace; ambient air is injected into the digester headspace to achieve an O₂ concentration of 0.5-0.6% facilitating microbial oxidation and hydrogen sulfide abatement. Desulfurized biogas is passively dried as it cools in below-grade plumbing used to transport the biogas to the engine room. The slope of the plumbing allows condensate to be collected in a sump. The biogas is combusted in a Guascor HGH 240 engine equipped with a Martin Machinery 500 kW generator (Figure 3.). The system is operated between 440 and 450 kW. Electricity is net-metered and used to power the farm, AD system, mixing and control rooms, and the Craigs Station Creamery milk plant. Recovered heat is used to heat the digester, the mixing and control rooms. A hot water line is run to the adjacent milk processing plant for future use. With minimal maintenance and utility disruption the system has to date experienced a 98.6% uptime, resulting in a capacity factor of 0.89.



Figure 3. Guascor HGH system.

Economics

Costs

The total capital cost of the AD system was approximately \$3,500,000. A breakout of these total costs is:

- Construction/installation of the AD system (concrete floor and walls, wall insulation and panels, cover, impellers, gas collection and flare system, organic waste pre-processing equipment (conveyer, de-packaging, macerators), automatic mixing system, pumps and plumbing): \$2,000,000
- Site work: \$250,000
- Technical building (mixing room, control room, engine room, recycled materials storage): \$250,000
- Biogas utilization system (blower, gen-set, heat recovery system): \$400,000
- Engineering consultation: \$150,000
- Wiring and electrical interconnection: \$400,000
- Food waste pre-digestion, short-term storage tank: \$30,000
- Miscellaneous costs: \$20,000

Incentives, Income & Savings

Several grants helped subsidize the costs of the system. Under the NYSERDA - PON 2684 program, the farm received \$1,250,000 in capital incentives. Performance payments not to exceed \$73,000 per year for 10 years will be paid to the farm based on the contracted capacity of 440 kW. Additionally, \$500,000 from the USDA REAP program and \$50,000 from National Grid's Agribusiness Productivity program also helped support construction of the project.

Income from the processing of food wastes have been a major driver of the Noblehurst Farms business model, with the intension of achieving a 50/50 split between electricity/energy revenue and food waste tipping fees.

As a separate business from the farm and milk processing plant, Noblehurst Farms and Craigs Station Creamery pays for electricity as a customer of Noblehurst Green Energy.

Lessons Learned

Noblehurst Farms report several advantages to the new EnviTec anaerobic digester system. Odor issues related to the previously used concrete hard top digester design have not occurred. The EnviTec system's innovative approach to reducing biogas H₂S has replaced the need for high maintenance scrubbing systems. Use of buried gas lines has replaced the need for gas drying systems. System automation, and in particular the use of an automatic scale to precisely mix materials, has significantly improved process control of co-digesting various organic wastes.

One problem noted by Noblehurst Farms with the new anaerobic digester system was getting the EnviTec systems to communicate successfully with the Martin Machinery engine-generator set. It took several months for engineers from both companies to successfully integrate the systems. Since then there have been few issues.

In addition, Noblehurst Farms reports the following lessons have been learned as a result of constructing and managing their AD system.

Co-digestion of imported organic waste has significantly improved biogas production and affiliated power and heat generation. To circumvent the transportation problems identified in the centralized feasibility study (Jewell et al., 1997), the Craigs Station Creamery dairy processing facility, was located on Noblehurst Farms dairy near the anaerobic digester so whey/plant wastewater could be directly plumbed into the system and electricity and heat could be directed back. A BOD testing sump ensures waste with low biogas generation potential is not fed into the digester.

While bringing in pre/post-consumer food waste also help improve system outputs, these feedstocks have created some new management problems. With solid food wastes, there are new labor requirement to load the conveyer and remove foreign objects such as forks which can clog the fine macerator. The uncovered storage is all susceptible to snow management and feedstock freezing and may require construction of a building.

With sludge/liquid food wastes, there are also labor and storage problems. Packaged foods and drinks must be de-boxed and de-packaged with a product destruction screw press before they can

be used for anaerobic digestion, creating some backlog. Improved storage and additional labor will be needed to keep pace with delivery of these materials.

Contact Information

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