Anaerobic Digestion at Wagner Farms: Case Study

Updated June 2024 by Isaiah Guenther, Jason Oliver, and Lauren Ray

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Figure 1. Wagner Farms' primary digester.

Summary

Primary digester type	Complete mix
Date commissioned	October 2010
Primary digester designer	CH Four Biogas, Inc. (formerly Genesys)
Dates refurbished	2019 - 2024
Influent	Raw manure and pre-consumer food waste
Stall bedding material	Post-digestion separated solids with hydrated lime
Number of cows	400
Primary digester dimensions	52.4 ft diameter, 19.8 ft height
Primary digester total volume	320,000 gal
Primary digester working volume	280,000 gal
Additional digester dimensions	14.6 ft diameter, 12.0 ft height
Additional digester total volume	60,000 gal
Additional digester working volume	50,000 gal
Digester temperature	Mesophilic (98-99°F)
Cover material (primary digester)	EPDM 60 mil flexible membrane
Hydraulic retention time (HRT)	Varies
Solid-liquid separation	DODA screw press separator, post digestion
Biogas utilization	300 kW engine-genset (Martin Energy Group)
Carbon credits sold/accumulated	No
Original system case study	https://hdl.handle.net/1813/65732

Overview

Wagner Farms milks approximately 400 cows and grows 1,000 acres of crops in Poestenkill, Rensselaer County, NY. Their primary anaerobic digester (Figure 1) and system (Figure 2) was originally commissioned in 2010 and is one of the smallest among those on New York State dairy farms. It has served Wagner Farms as an important source of economic diversification, as they currently have no plans to expand their herd. They have also valued the digester's contributions to environmental stewardship in the local community. This case study highlights the anaerobic digester to energy system refurbishments and expansion (Figure 3) that Wagner Farms began implementing in 2019. A case study of their original system was written in 2014 and can be found at the link in the summary section.

Original Digester System

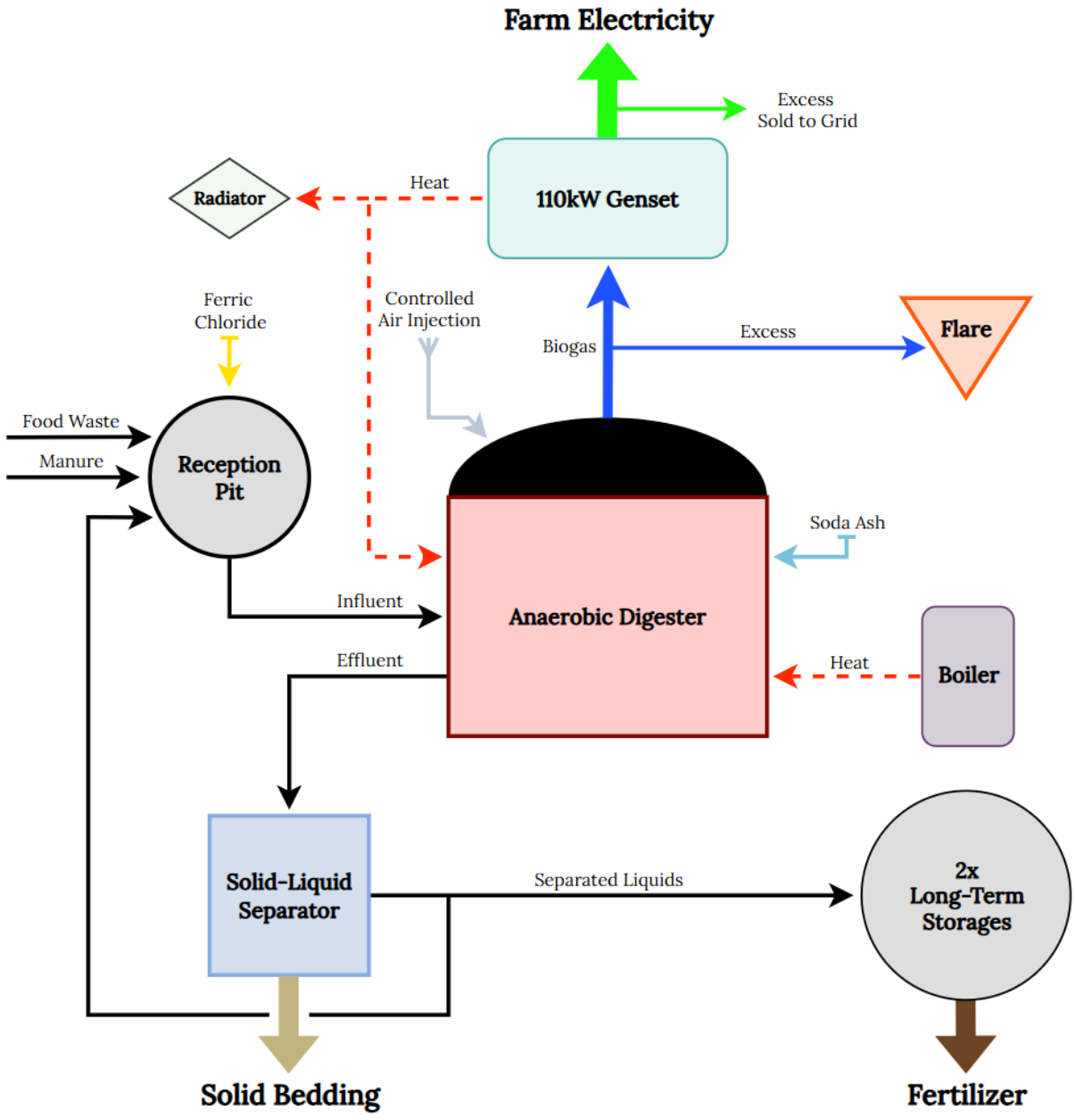

Figure 2. Wagner Farms' original anaerobic digestion system flow diagram.

Changes that led to Refurbishment

Addition of food waste - The original system was designed to process only the dairy's manure, but Wagner Farms started co-digesting manure with off-farm food waste in 2018 to increase their system's economic value from tipping fees, nutrient recycling, and energy generation. The only location available on the farm for receiving food waste was in the same pit as the manure collection scraped from the barns. The added food waste to this reception pit created undesirable influent ratios between food waste and manure, which impacted the digester's operation.

Stabilizing digester temperature - Wagner Farms struggled to maintain the mesophilic temperature range of the digester in the winter. An auxiliary boiler was needed to supplement the heat recovered from their 110 kW engine-generator combined heat and power (CHP) system.

General maintenance – Digester tank cleanout and numerous repairs were needed to ensure the system would continue to function properly. This included removing substantial accumulated solids in the digester after 10 years of operation, replacing the digester's cover, sealing a crack in a long-term storage tank, and other necessary tasks.

Refurbished Digester System

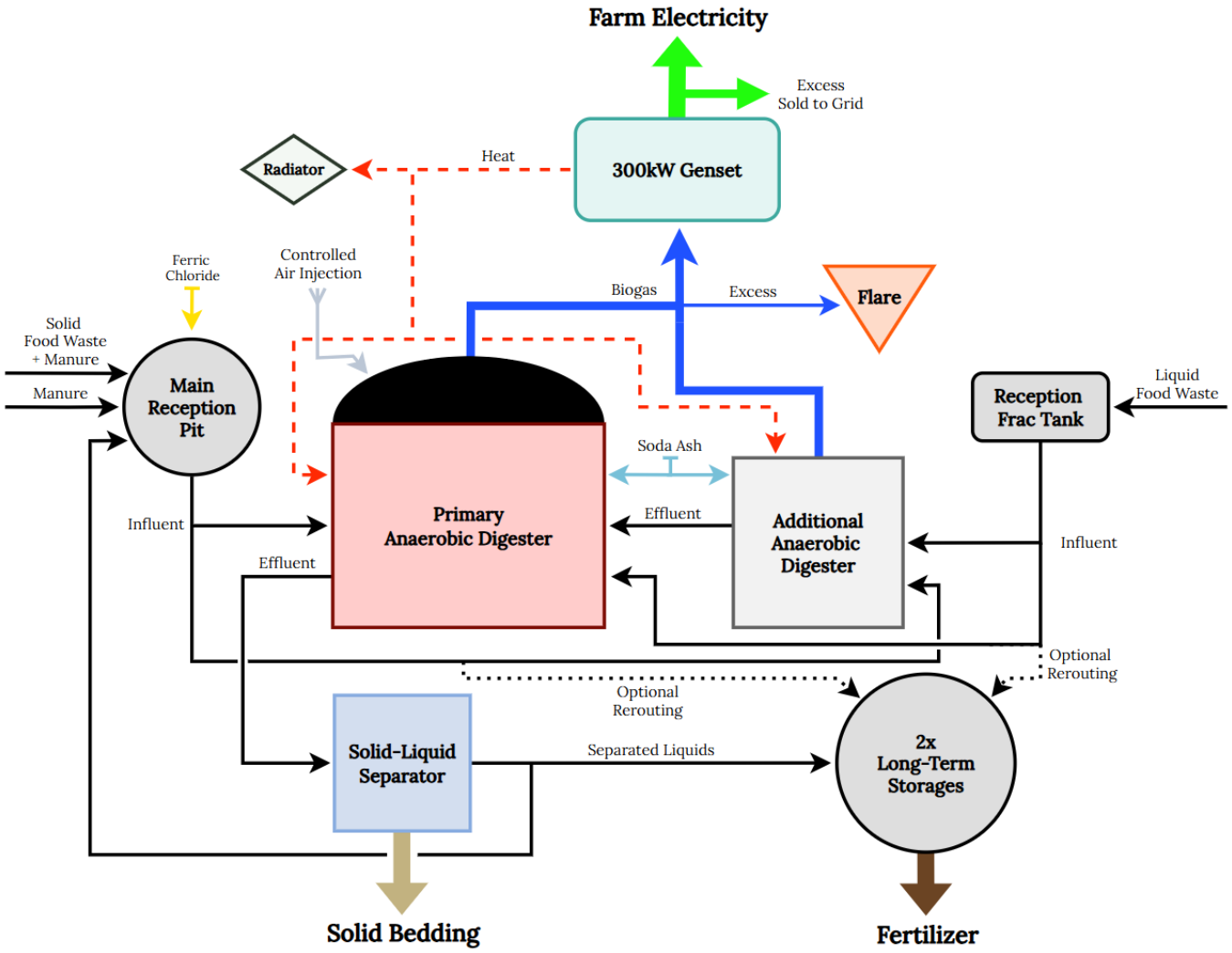

Figure 3. Wagner Farms' refurbished anaerobic digestion system flow diagram.

Updates made during Refurbishment

Additional digester - Wagner Farms added an additional, in-ground, 60,000 gallon digester tank to their system (Figure 4). In the initial refurbishment plan, this digester was intended to serve as a hydrolysis tank for food waste reception before entering the primary digester. During construction, it was realized that the tank would be best used as an additional digester because the tank's reception hatch was not able to be separated from the tank headspace, so a plume of potentially harmful gases would be released upon each food waste delivery. Material will be pumped into this tank from other reception locations rather than poured into the hatch.

Figure 4. Additional digester tank during construction.

The additional digester tank will increase the total system hydraulic retention time (HRT) as it processes the same influent ratio of food waste to manure as the primary digester and will operate under the same mesophilic, mixed conditions. No controlled air injection will take place in the additional digester tank due to limited headspace; however, Wagner Farms may explore alternative options for additional hydrogen sulfide treatment. A peristaltic pump will move all effluent from the additional digester to the primary digester, as this is the only route to the screw press used to separate solids in the digestate. The additional digester's biogas will be collected, allowing Wagner Farms to recycle more off-farm organic material and produce more energy.

Liquid reception tank – An additional 18,000-gallon reception frac tank will be used to receive various liquid food waste that can be pumped into both digesters. Manure will still be collected via alley scrapers from two nearby lactating cow barns and via trucks from barns down the road into the main reception pit. Solid food waste will be sent to the main reception pit so the chopper pump can grind and mix pit contents before they enter the primary digester. Both pumps can be rerouted directly to the long-term digestate storage during system downtime for maintenance or if any food waste becomes undesirable. This will enable Wagner Farms to receive more food waste, better control their influent ratio based on the food waste type, and subsequently increase biogas production and reduce the risk of digester upset.

Upgraded engine-generator set – The additional biogas that will be produced from the refurbished system has allowed Wagner Farms to upgrade to a 335 kW genset. Currently, the genset is limited to a usable output of 300 kW based on the electric utility grid transformer capacity. With the original 110 kW genset, Wagner Farms was able to supply all their electricity needs and sell some excess to the grid at times. The new genset (Figure 5) will result in substantially more electricity that can be exported to the local utility grid and provide enough recoverable waste heat to stabilize the temperature of both digesters throughout the winter.

Figure 5. New engine-generator combined heat and power container utilizing digester biogas.

Benefits

- More capacity to digest organic material
- More stable digester temperatures
- Increased food waste tipping fees
- Increased electricity sales

Considerations

- Time needed to experiment with system flows
- New form of hydrogen sulfide treatment potentially needed in additional digester
- Interconnection contract renegotiation with utility company
- More recycled nutrients and volume to manage after digestion

Lessons Learned

- Cleanout digester more often to preserve hydraulic retention time (Figure 6)
- Consider private investment with caution
- Ensure initial designs are appropriate

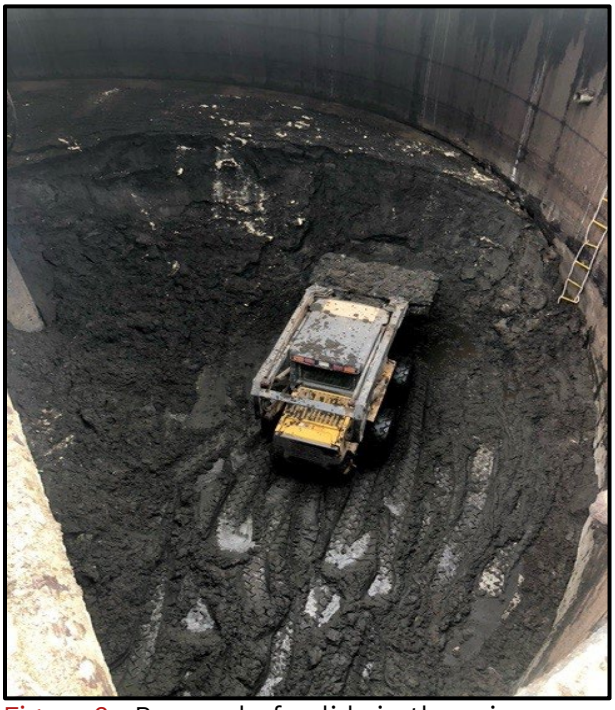

Figure 6. Removal of solids in the primary digester tank after 10 years of operation.

Moving Forward

Wagner Farms completed their refurbishments in the summer of 2024. They will decide on any future plans after evaluating the operation and performance of their updated anaerobic digestion system.

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