Anaerobic Digester at EL-VI Farms: Case Study

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Who Should Consider a System Like This?

- Farms in need of odor control.
- Farms where manure can be collected easily.
- Farms with capital available for initial start up costs.
- Farms with technical interest and skills for the system operation and maintenance.
- Farm with adequate cropland for the nutrients.

Farm Information

EL-VI Farms Partnership, located close to the Village of Newark in Wayne County, is an 800-cow dairy managed by a partnership of Ted Peck, Allan Ruffalo, George Andrew, and Josh Peck. The farm also has a stock of 700 heifers and 2,200 acres of crops. Ted is in the process of installing an anaerobic digester to control odors and supply heat to the milking center.

Why the Digester?

Increasing the herd size and the accompanying concerns with odors from applying stored manure motivated the farm to look for a low-cost anaerobic digestion system. Odor control with the flexibility to expand as the herd increases in the future led to a design that could be expanded or reengineered. Manure was traditionally daily spread on crop fields. Phosphorous index requirements from a concentrated animal feeding operation (CAFO) plan, and the desire to limit spreading on saturated soils for environmental and compaction reasons led the farm to install a six million gallon manure storage pond to add to a previously existing one million gallon manure storage pond. Ted knew that this additional long-term storage could create greater odor issues in the community.

Determined to control the odors without incurring the large capital costs of a digester with an engine generator, Ted decided to design and build a digester with limited hydraulic retention time (HRT). The HRT would be long enough to control the odors (projected to be 10 days), but not as long as traditional digesters (20-25 days). If the digester does not provide enough odor control, or when the herd expands, or when more methane is desired to run an engine generator, the digester can be expanded. Initially the methane generated will only be used to heat the digester and supply hot water to the milking system. The project was originally budgeted for $113,500. Obtaining a cost-sharing contract from New York State Energy Research and Development Authority (NYSERDA) helped move the project forward. The project goals are to

install a system that can demonstrate cost-effectiveness and the following benefits:

- Odor reduction
- Heating savings
- Flexibility for future expansion

Construction on the digester started in summer 2003, and it is hoped that the system will be operating by spring of 2004. The farm is acting as its own construction crew to keep costs down.

Digester System

System and Process Description

The digester system on El-VI farms is composed of several subsystems (see Figure 1):

- Manure collection
- Separation of the liquids and solids prior to digestion
- Preheating in a converted bulk tank
- Mixed digestion followed by plug-flow digestion
- Liquid storage.

With 700 milkers, 100 dry cows, 700 heifers and milking center wash-water, the manure production is estimated to be 30,000 gal/day. The digester, a rectangular concrete tank with a volume of 20,000 cubic feet, is partially buried in the ground and insulated with 2 inches of styrofoam. The digester is a hybrid design with mixed and plug-flow portions. A portion of the separated liquids flows into the first part of the digester that acts as a mixed digester. This part of the digester has a Houle 7.5 hp agitator, which while mixing, will inoculate the liquids and treat the manure for about 5 days. The manure leaving this portion of the digester will flow in a non-agitated manner much like a plug-flow digester to the outlet. Digested manure will be combined with the rest of the separated liquids, about 44% of the separated liquids that will not be digested and pumped to an earthen storage (see Figure 1). There should be potential for additional settling and nutrient partitioning in the storage system following digestion.

The combined digested effluent and undigested separated liquid manure will likely react in the earthen storage to reduce the volatile solids content before the manure is applied to cropland, thus controlling odors. Both scraped manure from the main barn together with milking center wash water is pumped to a 75,000-gallon concrete tank and mixed with the scraped manure from two heifer barns. Manure from this collection pit is estimated to have 8% dry matter (DM) content. This mixture will then be pumped to a Vincent KP 10 screw press separator. The solids will be loaded on a truck, composted, and used as a soil amendment in the cropping program, used as bedding or sold. The liquids will flow to the 35,000-gallon concrete storage by gravity. The digester feed will be heated in a converted bulk tank with additional heat coils added, then flow to the digester. The digester itself will have 1,800 square feet of walls internally heated to maintain the temperature.

Heat Generation

It is estimated that the biogas production will be 17,900 ft^3 per day at 40 ft3 per cow per day. The methane (CH_4) content is estimated to be about 60%. There likely will be other byproducts such as carbon dioxide (CO_2), and trace gases like hydrogen sulfide (H_2S). Biogas is collected from the digesters and fed with a regenerative blower to pressurize the burner. The burner is

rated at 1,000 ft3/hr and is co-fired with natural gas. It is specifically designed to also handle low pressure, low energy "dirty" gas.

Hot water from the 600,000 Btu /hr. cast iron boiler is used to heat the influent to the digester, maintain the digester temperature, and for hot water needs in the milking center. Excess heat will be released through a radiator.

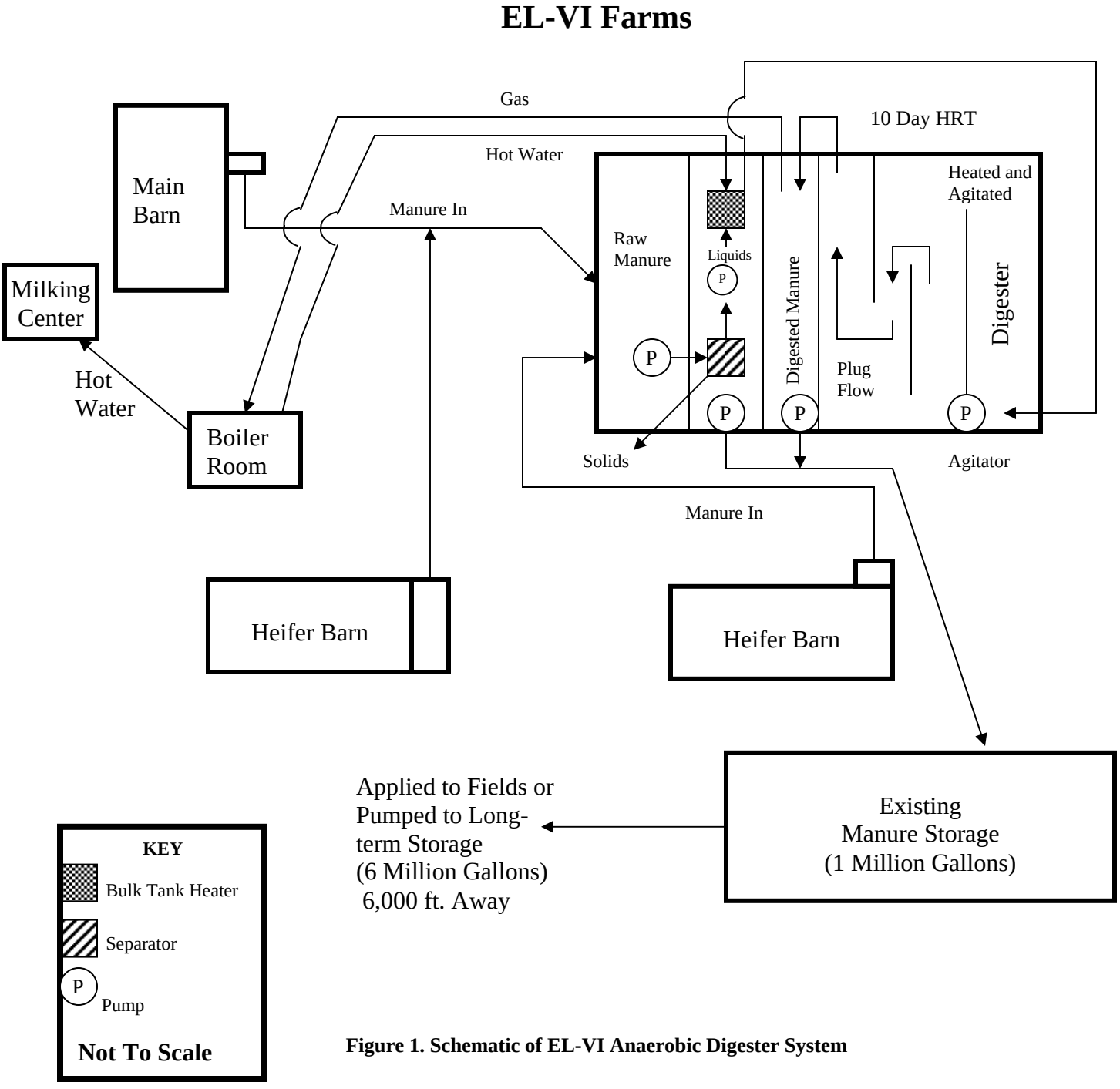

Figure 1. Schematic of EL-VI Anaerobic Digester System

Economic Information

	Items	Cost/Benefit *
Capital Costs	Digester - Digester Construction and Materials - Building for separator and heat exchange, pumps, plumbing and electric. Subtotal	 $37,000 $114,000 $151,000
	Boiler - Burner, boiler and plumbing - Building Subtotal	 $16,000 $10,000 $26,000
	Manure Storages and piping	$52,000
	Solids and Liquids Separation - Separator	$30,000
	Total Capital Cost	$233,000
	Total Capital Cost per cow	$291
	Total Annual Capital Cost	$21,525
Annual Operating Costs	Maintenance, Repairs, Labor, Fuel, Insurance, etc.	$21,715
	Manure Spreading Cost (estimated)	$26,280
Annual Benefits	Nutrient Savings	-$6,000
	Heating Fuel Savings (projected)	-$6,000
	Bedding	-$30,000
	Odor Control (@$10/cow/year)	-$8,000
	Total Annual Benefits	-$50,000
Annual Net Cost Per Cow ($/cow/year)		$24 **

Note: * - The costs (capital, maintenance, and repairs) and revenues are projected numbers as of January 1, 2004. An updated analysis will be provided with real data once the system is operated for one year.
** - Manure management without digester and solids separator would cost $44/cow/year.

Advantages and Disadvantages

Advantages	Disadvantages
- Odor Control - Heating Fuel Savings - Nutrient Management Ease - Pathogen Reduction? - Lower capital costs - Bedding produced	- Adding Complexity to Farming - Dedication to Digester System Management (i.e. labor and maintenance)

Lessons Learned

Constructing the digester and ancillary structures using the farms own labor, equipment, and management resources keep the costs low. This is particularly appropriate when the system does not include an engine generator.

Building the digester so the inlet end can be expanded outward if and when additional capacity is needed adds flexibility to the system. The system can be expanded without major refitting of the digester system.

Who to Contact

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