BioCycle energy

Geerlings Hillside Farm runs an 8,000-head hog operation. Restrictions on field application of untreated manure forced a change in management methods.

ANATOMY OF A DEAL

FINANCING AN ANAEROBIC DIGESTER

Michigan hog grower, via grants which enabled a loan, puts together a project to design and implement an anaerobic digester to process the farm's manure.

Diane Greer

LENDERS are generally well disposed to projects that diversify revenues while lowering costs and mitigating risks. Add a ready source of equity and you are well on the way toward financing a project that is a win-win proposition for the lender and the project developer. Such is the case with the anaerobic digester project at Geerlings Hillside Farm (GHF).

The Geerlings's 8,000-head hog farm is located in Allegan County in southwestern Michigan. Farmers in the area face restrictions on field-applying untreated manure. Runoff from agricultural operations and other land-based activities have resulted in nutrient overloading and sediment pollution in the local Little Rabbit River watershed.

Because of the restrictions, area livestock operations are forced to haul manure that can't be field-applied locally to farms where manure nutrients are needed. Farmers also face sharp increases in residential development near their facilities, resulting in complaints about manure odors.

To deal with waste and nutrient management issues, the Geerlings teamed with Fennville, Michigan-based Phase 3 Renewables to design and implement an anaerobic digester (AD) to process the farm's hog manure. The innovative system includes equipment to produce pelleted fertilizer and irrigation water through further post treatment of the liquid digester effluent.

The post treatment process coupled with the AD system removes more than 90 percent of the nutrients from the liquid effluent. The resulting liquid contains very low levels of nitrogen and phosphorous that fall within the nutrient management restriction, permitting the water to be used for irrigation.

Three local farms, which are too small to justify on-site AD systems, are partnering with GHF to contribute manure to the system. In total, the digester will process over 8 million gallons of manure from 16,000 hogs and 400 heifers, and produce over 28 million cubic feet of biogas annually.

THE PROCESS

The digester is housed in a 65-foot diameter complete mix-stir tank operating under anaerobic conditions with a capacity of just over 550,000 gallons. Temperatures in the reactor range from 98° to 104°F, with a retention time of 24 to 25 days.

Manure from farms partnering in the project is delivered in closed trailers and pumped into a portal on the digester tank for combination with the on-site manure.

Manure from pits beneath the barns housing the hogs is continuously fed via pumps to the digester. Manure from farms partnering in the project is delivered in closed trailers and pumped into a portal on the digester tank for combination with the on-site manure. The complete-mix digester reduces the impact of varying solids content from the different manure streams, says Norma McDonald, Operating Manager for Phase 3.

Instead of purchasing a turnkey AD system, Phase 3 engineered the digester using all U.S. made components. "It is much less expensive than going with a package out of Europe," explains McDonald. Replacement parts and service are also readily available.

Biogas generated by the digester fuels an I-Power combined heat and power system, which produces sufficient electricity to handle most on-farm power requirements. Waste heat from the system is used to warm the digester tank via a heat exchanger. The heat exchanger is comprised of water loops embedded in the concrete walls and floor of the digester tank, McDonald adds. Additional uses for the heat include reducing the moisture content of the biofibers coming out of the mechanical separation process and polish-drying the finished fertilizer pellets.

Excess power will not be generated for sale to the grid. The interconnection costs are $50,000 to $75,000, making it cost prohibitive for a site of this size, McDonald explains. Instead, excess gas will be used to power a low-BTU biogas boiler that provides additional heat to the digester and to the farm during the winter months.

Digester effluent exiting the system undergoes a conventional liquid separation process employing auger screw press separators. On a dairy farm, the solids or biofibers from the process would normally be used for animal bedding. But hogs don't require bedding. Instead, the biofibers are densified into pellets, which reduce the separat-

ed solids to less than 15 percent of their original volume and create a fertilizer product.

The liquid portion of the effluent is run through a dissolved air flotation (DAF) process to further separate out the bulk of the suspended solids in the liquid. "Those solids are where the majority of the phosphorous is located," says Bernard Sheff at Sheff and Sons Engineering, located in Eaton Rapids, Michigan.

The DAF tank, which operates under anaerobic conditions, is designed to spin on its horizontal axis. Liquid effluent is introduced into the DAF where it is mixed with a polymer that causes the solids to clump. Biogas injected into the bottom of the tank lofts the suspended solids in the effluent to the top of the tank, where they are removed and either pumped back into the digester to create more biogas or added to the biofibers for pelletization.

"The process does a wonderful job on suspended solids," Sheff says. Effluent exiting the process is not clean enough for discharge into a creek, but the process produces irrigation water low enough in nutrient composition to meet state watershed protection and remediation regulations. Irrigation water from the process is stored in a tank with a capacity of 2.2 million gallons and pumped to the fields as needed, replacing water previously pumped from the Little Rabbit watershed.

BENEFITS OF THE PROCESS

Adding the system to pelletize the biofibers reduces operation costs on the farm. "This area of Michigan is saturated with livestock operations," McDonald points out. "It is not phosphorous limited, so you need an economical way to transport nutrients out of the immediate area."

Prior to the installation of the digester, the Geerlings were hauling about 3.7 million gallons of manure. Hauling manure within a 20-mile radius, using farm-owned equipment and labor, costs about $0.015 per gallon given current fuel costs, McDonald says. "A contract manure hauler may charge $0.02 to $0.03 per gallon."

Densification of the biofibers into pellets allows for the efficient storage and transport of nutrients. Pellets created by the process can be either spread on the Geerlings fields in a single-pass operation or sold as fertilizer, creating another revenue source for the farm. Since pellets are only applied once a year, compared to four times a year for manure, they also reduce soil compaction and vehicle emissions.

Phase 3 is negotiating marketing agreements for sale of the pellets into the commercial or residential fertilizer markets. Investigations are also underway to determine how the commercial value of the pellets can be enhanced. One option is to add composted poultry manure, which is high in nitrogen, McDonald says. "The interesting part is the extent to which you can combine processes to shove as much nutrient value as possible into the pellet."

Beyond the fertilizer market, the pellets also have value as a fuel. "We believe there is an excellent market in industrial power," McDonald notes. "But to do that, you really need to add horsepower to the pellet mill to pack as much solid matter as possible into every pellet."

Replacing conventional fossil fuels with clean, renewable biogas for electricity production and heat generation also lowers costs and reduces greenhouse gas emission. Reductions in greenhouse gas emissions are estimated at 6,700 metric tons of CO_2 equivalents a year. The carbon credits generated by the project will be aggregated and sold on either the Chicago Climate Exchange or another exchange, producing yet another revenue source for the farm.

Digester effluent exiting the system goes through an auger screw press separator (top). The solids, or biofibers, are densified into pellets. The liquid portion of the effluent is run through a dissolved air flotation process (bottom) to separate out suspended solids.

GRANTS PAVE WAY FOR FINANCING

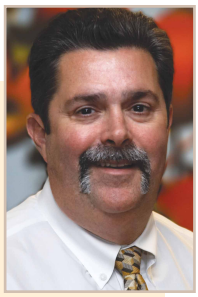
Estimated costs for the project are around $1 million, which includes the main digestion tank ($350,000), the liquid storage tank ($70,000), construction costs ($75,000), electrical generation equipment ($150,000), the separation equipment ($55,000), the DAF ($100,000) and the pellet mill ($50,000).

Two grants — a $250,000 Michigan Department of Agricultural Innovation Fund (MDAIF) award and a portion of a $500,000 United States Department of Agriculture (USDA) Section 9006 grant — facilitated financing of the project. The USDA grant will be split with a project on another Geerlings facility. Negotiations are still underway as to how the money is to be split.

The USDA grant is the result of the Farm and Security Rural Investment Act of 2002 that established the Renewable Energy Systems and Energy Efficient Improvements Program. Under the program, grants and loan guarantees are awarded to agricultural producers and small rural businesses for the purchase of renewable energy systems and energy efficiency improvements.

MDAIF is funded with money Michigan received as part of the U.S. settlement with tobacco companies. "The State sold part of the tobacco settlement money and bonded it, creating an economic development initiative," explains Michael DiBernardo, Economic Development Specialist with the Michigan Department of Agriculture (MDA). "Our department received $10 million of that $400 million initiative."

The first grants under the program were awarded in 2006 to 40 projects totaling $4.7 million. A major criterion for awarding grants was the size of the project's innovation as it related to the economic development of the local community. The Geerlings's proposal provided an opportunity to demonstrate anaerobic digestion using hog manure and aggregating the manure from multiple sites, DiBernardo says. "Going forward, what will make all these projects work is how they create busi-



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Michael DiBernardo, Economic Development Specialist, MDA

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DiBernardo sees these grants as a means of helping agricultural operations obtain funding from lenders. "The finance community has been very reluctant on these systems," he says. "The grant document gives [the project developer] the ability to go to the financial institution and say agriculture supports the technology and the process." The grants also help project developers negotiate more favorable loan terms. In essence, the grants act as a risk reduction vehicle.

Financing for the portion of the Geerlings's project not covered by grants was provided by East Lansing, Michigan-based Greenstone Farm Credit Services. Financing AD systems is relatively new for Greenstone. In the past three years, the company has lent money to a few installations in Wisconsin. The Geerlings's is the first AD system financed by the company in Michigan.

"We view these renewable energy projects as a new opportunity for us, and we fully support them," says Larry Urban, Vice President for Commercial Lending at Greenstone. "They reduce costs and enhance revenues. In any business, diversification is a risk mitigator for the lender." Financing was provided through a 10-year real estate mortgage with fixed rates using a standard long-term mortgage financing arrangement, Urban adds. "Payback on the investment was estimated in the 4.5 to 5 year range."

To date, all the AD projects financed by Greenstone received grants. "The grants are very important because it provides equity to the deal, and when you are looking at something that is not yet proven technology, I think it is especially important," Urban explains. Normally, Greenstone looks for a minimum of 30 to 35 percent equity in a deal.

Urban sees the technology as the biggest risk in this type of a deal. Despite the fact that AD systems have been in use for a long time in Europe, the technology is still relatively new in the U.S., he says. "It is not necessarily unproven technology, but we are not convinced that it is 100 percent proven technology yet either."

MITIGATING INVESTOR UNCERTAINTY

Part of the uncertainty with AD systems result from past failures, attributable to problems with the design and operation, says Michelle Crook, Engineering Specialist with MDA. "Operations are a big issue for the facilities we have seen in the past where there have been a lack of qualified operators." MDA is currently trying to develop and expand operator-training programs.

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"Engineers and consultants are also now taking a different approach to system design, tailoring each system based on site requirements as opposed to a cookie cutter approach where one design fits all," Crook adds.

The involvement of qualified and experienced engineers designing and building an AD system helps reduce technology risks. "With technology that is relatively unproven, it would almost be a requirement that a customer work with some sort of consultant or have a turnkey system," Urban says. "Having someone try to do this themselves would be significantly riskier."

Operational risks are also a consideration, but Urban believes this type of risk is manageable. Most large farms are already dealing with operational risk and the systems fit reasonably well into the existing operations. One advantage for both producers and the lender is the mitigation of environmental risks provided by the installation of an AD system. "On any loans we write now, we require farms to be in compliance with all environmental regulations, and these digesters go a long way in mitigating that risk," Urban adds.

On the revenue side of the equation, lining up markets for AD by-products, such as pel-

IMPROVING RETURNS WITH OFF-FARM FEEDSTOCKS

THE HILLSIDE FARM project, operated by the Geerlings, could further improve returns on its anaerobic digestion system by adding off-farm feedstocks in the digester. Alternative feedstocks, such as food processing and other organic wastes, provide the potential for increasing biogas production and the nutrient value of the fertilizer pellets. For example, one of the Geerlings's other projects, Scenic View Dairy, recently added syrup silage, a by-product of ethanol production, to its digester. (See "Adding Value To On-Farm Digesters," September 2007.) Even a small amount, 2.5 percent of the waste stream, added to the digester increased biogas production by 40 percent, says Michelle Crook, Engineering Specialist with Michigan Department of Agriculture (MDA).

The farm had to stop adding the syrup due to unresolved regulatory issues. Mixing feedstocks raises concerns about potential volatile organic chemicals (VOCs) and metals in the digester effluent. MDA is currently working with Scenic View Dairy, the Michigan Department of Environmental Quality and a team at Michigan State University under a grant from the U. S. Department of Energy to perform analytical testing on mixed feedstocks. "Over the next year or so, hopefully we will resolve some of these issues," Crook says.

PROJECT AT A GLANCE

Developer: Geerlings Hillside Farm and Phase 3 Renewables

Location: Allegan County, Michigan

Size: 550,000 gallon anaerobic digester; 8 million gallons/year of hog and heifer manure

Project Cost: $1 million (rounded)

Financing Package: $250,000 Michigan Dept. of Agriculture grant, plus a portion of USDA grant estimated at $325,000; Remainder of project costs financed with a 10-year real estate mortgage with fixed rates by Greenstone Farm Credit Services

Technology: Digester engineered, constructed with specified components

Estimated Start Date: Digester construction started in May 2007. The reactor was filled by September 25, 2007 and the downstream unit operations went into full operation December 1, 2007.

lets, is viewed as a secondary consideration. Most projects can show payback on AD systems with the savings on electricity purchases and, where applicable, sale of electricity to the grid, Urban explains. "Sale of secondary products is not required for payback." Urban sees the most successful projects as those with teams that include experts in the field who have done their homework and come prepared to the financing discussion with a lot of information regarding costs and cash flows. Producers who involve consultants or someone that understands these projects will be a lot more successful in obtaining financing, he says. ■

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