BIOCYCLE
ADVANCING COMPOSTING, ORGANICS RECYCLING & RENEWABLE ENERGY

Home
Current Issue
Contents by Issue
Article Database
About BioCycle

Equipment/Systems
Resources & Links
BioCycle Advertisers
BioCycle Data Update

Compost Science
In Business

findacomposter.com

COOL2012

Site Access - READ ME

Biomethane Fuels Dairy Fleet

BioCycle June 2009, Vol. 50, No. 6, p. 36

With digesters producing excess gas, California dairy takes advantage of a public-private partnership that provided a grant to design and install a biogas upgrading and compression system.

Diane Greer

ROB Hilarides, owner of Hilarides Dairy in Lindsay, California, opted for an innovative solution to handle the excess biogas produced by his digesters. He converted the biogas into a vehicle fuel called compressed bio-methane (CBM), which replaces diesel to run his trucks and farm equipment.

"Now we can utilize the dairy's potential to power our trucks, in addition to generating electricity for our operations," Hilarides says. "This will significantly reduce our energy costs and give us some protection from volatile energy prices." At full capacity the CBM system will process about one-third of the biogas generated from the dairy's digesters, replacing 750 to 800 gallons of diesel fuel per day.

To date, Hilarides has converted two heavy-duty trucks delivering milk to Hilmar, California, and six pickup trucks to run on CBM, as well as four large propane boilers consuming about 20 percent of the dairy's biogas. Utilization of CBM will increase as additional over-the-road trucks and farm equipment are converted to use the fuel.

The project was made possible by a public-private partnership to encourage the use of biomethane produced from waste generated by food processing operations and dairies. The California Air Resources Board (CARB), one of the project partners, provided a $600,000 grant from its Alternative Fuel Incentive program to help fund the project. Other partners include San Francisco-based Sustainable Conservation (SUSCON), Western United Resource Development (a nonprofit organization formed by Western United Dairymen) and the U.S. Environmental Protection Agency.

"California has very serious air pollution problems and is trying to reduce our greenhouse gas emissions down to 1990 levels," says Demetri Stanich, CARB spokesperson. Converting cow manure into vehicle fuel decreases greenhouse gas emissions, lessens the nation's dependence on imported fossil fuels and reduces air pollution from diesel emissions in California's Central Valley.

"Diesel fuel emissions are pretty dirty," explains Allen Dusault, Director of Sustainable Agriculture at SUSCON. Particulate matter, nitrogen oxide (NOx) emissions and volatile organic compounds (VOCs) are reduced or eliminated when CBM is used instead of diesel. "That's very significant in terms of public health for the San Joaquin Valley," he says.

BIOGAS PRODUCTION

Hilarides started producing biogas in covered lagoon digesters in fall 2005. The system flushes or scrapes manure from the dairy's 10,000 cows into settling ponds, where solids are separated from the liquids. Liquids are pumped to the covered lagoons and digested to produce biogas. Vacuum pumps draw the biogas from beneath the lagoon covers. Blowers then push the biogas through underground pipes to the electrical generators.

The initial generator installation consisted of four, 125kW Caterpillar G342 reciprocating engines producing a total of 500 kW of electricity. Excess biogas not used in electricity production was flared. In August 2008, Hilarides covered another lagoon and installed two more 125 kW Caterpillar
engines, increasing the dairy's electricity generation capacity to 750 kW. Biogas production from the lagoons varies with temperature, ranging from 300 to 500 cubic feet per minute. Despite the increase in electricity production, the digesters still produced more biogas than required to meet the electrical demands of the dairy. Installing additional generators to utilize the excess biogas to produce electricity for sale back to the grid was not practical or economic. Newly imposed California regulations limiting NOx emissions make it "next to impossible" to obtain the necessary permits to add new generators, Hilarides explains.

Even if the regulatory hurdles could be overcome, Hilarides does not want to sell the excess power back to the local utility at wholesale rates, as required under the dairy's net metering agreement. "I just do not think there is enough incentive to do that," he says. "I would rather offset my retail costs."

The dairy also can't take advantage of California's recently legislated feed-in tariffs, which

Subscribe
Renew
Address Change
Contact Us

Advertise

Books & Reports

BioCycle Merchandise

BioCycle Conferences
Renewable Energy 2009
Organic Waste Diversion In The Rockies International 2009

Events Calendar

require utilities to pay premium rates to producers selling renewable power to the grid. Under the program rules, the dairy is not eligible for the new tariffs since it took self-generation incentive funding to finance the purchase of its initial Caterpillar engines, Dusault explains.

Finally, adding electrical generators is now more costly due to new regulations limiting NOx emissions. To meet the regulations, Hilarides must install catalytic converters on all his generators. "This is very expensive, the controls have not been proven commercially and operation and maintenance costs are very high," Dusault says.

Upgrading the biogas for injection into a natural gas pipeline is equally problematic. The closest natural gas pipeline is one-half mile away, Hilarides says. Connecting to the distant pipeline would be costly. He was also concerned about meeting the utility's stringent biogas upgrade specifications. "I am busy enough and just did not want to have that headache," Hilarides says. "I would rather produce the gas to my specification."

The answer to Hilarides's dilemma came when he won a grant under CARB's Alternative Fuel Incentive program. Utilizing the excess biogas for vehicle fuel made sense since the dairy owns a fleet of trucks and hauls its own products, Hilarides explains. "I am trying to offset some of my diesel costs and decided to put in an upgrading plant to do that."

As part of his due diligence process, Hilarides traveled to the Scenic View Diary in Michigan to see the only commercially operating biogas upgrading system on a dairy at the time. His investigation led him to select the system's designer, Phase 3 Renewables, Cincinnati, Ohio, to design and install the biogas upgrading and compression system for his project.

UPGRADING BIOGAS TO CBM

Upgrading biogas for vehicle fuel is similar to upgrading the gas for injection into natural gas pipelines. Both hydrogen sulfide and CO2 need to be removed, but there is more latitude in the BTU value and oxygen content, explains Norma McDonald, operating manager at Phase 3.

Pipelines have strict specifications regarding the BTU content of the gas. "For instance, a pipeline might require a 970 BTU minimum," McDonald says. "The vehicle manufacturer, in this case, only requires a 900 BTU minimum, so you have different possible process targets."

But lower BTU content, or lower fuel density, needs to be balanced against mileage. Ten percent of the volume of every cubic foot of gas compressed at 900 BTU is composed of CO2, which has no energy value, McDonald explains. Purer gas costs more to produce. "It is a cost-benefit analysis," she says. "You have to look at your costs and how many miles of vehicle range you want from your tanks."

Currently, Hilarides's upgrading system is producing CBM at 970 BTU/cubic-foot. At this BTU content, the CBM tanks in the dairy's heavy-duty trucks hold the diesel fuel equivalent of 112 to 115 gallons. If CBM is instead supplied at 900 BTU/cubic-foot, the diesel fuel equivalent would drop to around 100 gallons, McDonald says.

Pipeline injection also requires the removal of oxygen from the gas. Pipelines want to keep oxygen out of the line to prevent microbial growth, she explains. But in an engine, the gas is not stored long enough to create a similar problem and microbial growth does not occur under high pressures.

The skid mounted gas upgrading and compression system installed by Phase 3 is comprised of three integrated processes. The biogas upgrading system skid includes QuestAir Technologies M-3200 pressure swing adsorption (PSA) units and Vilter compressors. Individual pieces of the system were delivered to the company's subcontractor, Newkirk Electric-Theka Engineering of Muskegon, Michigan, where the components were assembled and integrated on a skid. The skid was then shipped to Hilarides Dairy on flatbed trucks.

By preassembling the system in Michigan, Phase 3 achieved better control over the cost, timing and quality of the system, McDonald explains. Preassembly removes the unpredictability that comes with assembling components in the field. "For example, the distance between different pieces of equipment can make a difference in the pressure and condensation," she says. Preassembly also allows Phase 3 to give projects a firm price quote. Otherwise the project would be done under a cost plus approach or based on an estimate that is dependent on field installation issues.

The biogas upgrade system (BUS) arrived at the dairy and was set into a new building during December 2008. To integrate the BUS into the existing biogas distribution system, Phase 3 installed a "T" connection in the piping system conveying the biogas to the generators, diverting a portion of the gas to the BUS. Work on the system was completed and production started in January 2009.

The upgrading system initially compresses the gas to 175 psig (lbs/sq. inch gauge) using a single screw compressor with variable speed drive. The biogas is then purified in QuestAir's PSA system, which consists of nine vessels or beds containing layers of adsorbent materials. As pressurized biogas flows through the beds impurities such as CO2 and water stick to the surfaces of the adsorbent particles.

"Basically pure methane exits the top of the bed," says Andrew Hall, President and CEO of QuestAir, Burnaby, British Columbia. "It is almost like the gas equivalent of a water filter."

Once the adsorbent material gets loaded with impurities the system switches to the second stage of the cycle. In this stage the pressure is lowered, flushing the impurities from the system as an exhaust gas. "As you drop the pressure the CO2 is desorbed or released," Hall explains. "You are alternating between low and high pressure in each of the beds in the unit. At any given time at least one of the beds is producing product gas."

Gas separation within the PSA unit is not perfect. When the pressure is lowered, a small amount of methane remains in the vessel and is expelled in the exhaust gas. Phase 3 designed the Hilarides system not to waste the methane in the exhaust stream. The exhaust, which contains about 200 BTU/cubic-foot, is remixed with biogas from the lagoons and used to generate electricity.

After upgrading, the gas is pressurized to 3,600 psig in a second stage compressor and sent to storage cylinders. Underground lines convey the CBM from the storage cylinders to a dispensing pump, similar to pumps used to dispense compressed natural gas (CNG). The high-side compression skid and gas storage/dispensing system were provided by another

subcontractor, Air & Gas Technologies of New Jersey.

ENGINE CONVERSION
Hilarides retrofitted two of the dairy's Peterbilt 389 semitrucks with Cummins-Westport ISL G-320 natural gas engines. Six lightweight fiber-composite tanks installed in the truck's sleeper compartment hold the CBM.
The new engines differ considerably from standard diesel engines. "With diesel you have a compression ignited engines," Hilarides explains. "But purified biomethane requires a spark ignited engine. It is like the difference between diesel and gasoline." Mileage on the converted trucks is equivalent to diesel at about six mpg.
In addition to retrofitting truck engines, Hilarides also converted four propane hot water heaters at Three Sisters Farmstead Cheese to run on biomethane. The gourmet cheese operation is located on-site and run by one of Hilarides' daughters.
Currently, the BUS system is running eight hours a day to meet the CBM needs of the converted trucks and equipment. "My goal is to have enough equipment converted so that I can run it 24 hours a day," Hilarides says.

PAYBACK
Hilarides estimates the payback on the system is under five years, but cautions that making projections regarding payback is highly speculative. "It is a huge function of what the price of diesel is going to do," he says. "When we started planning the system diesel was $4.50/gallon, now it is $1.50. That takes a lot of the fun out of it."
Another big question mark is the cost of converting existing vehicles or purchasing new vehicles that run on CBM. While the conversion was done using off-the-shelf technology, it was still very expensive, Hilarides says.
Warranted and certified conversion kits are available for each of the various engine manufacturers, but the market is still very specialized and prices vary considerably around the country, McDonald explains. Phase 3 is currently collaborating with a couple of engine manufactures and the Natural Gas Vehicle Association to start putting a focus on CNG-fueled farm vehicles.
The alternative to retrofitting — purchasing a new CNG truck — will become a possibility later this year when Freight Liner comes out with the first heavy-duty CNG vehicle, Dusault says.
LESSONS LEARNED
From a technology aspect the project was not difficult, since the dairy already had the infrastructure in place to gather the gas, Hilarides says. But obtaining the necessary permits for the project from the air district and the county was a huge task. "What's a shame in my mind is something that is so obviously environmentally friendly has become so difficult to permit," he says. "We have one agency wanting us to do it and providing grant funding and a half dozen other agencies making it difficult."
Dusault, while enthusiastic about the technology, cautions that more work is required to figure out the models that are viable. Currently the cost of upgrading biogas is only viable for larger dairies. Smaller dairies may need to share centralized upgrading systems to make project economics work. "Hopefully, the cost of upgrading will come down," he says.

Diane Greer is a Contributing Editor to BioCycle.

Previous Article: « Optimizing Biogas Yields With Substrate Selection (Europe) | Next Article: Getting To The Bottom Of An Odor Challenge »

SEARCH ARTICLE ARCHIVES | BIOCYCLE | IN BUSINESS | COMPOST SCIENCE | CONFERENCES | BOOKS | SUBSCRIBE | ADVERTISE | LINKS | CONTACT US | ABOUT US | HOME
findacomposter.com

www.jgpress.com
Copyright & Trademark Notice