☞ 07hr_AC-Ag_Misc_pt07

Details: Informational Hearing (May 17, 2007)

(FORM UPDATED: 07/12/2010)

WISCONSIN STATE LEGISLATURE ...
PUBLIC HEARING - COMMITTEE RECORDS

2007-08

(session year)

Assembly

(Assembly, Senate or Joint)

Committee on ... Agriculture (AC-Ag)

COMMITTEE NOTICES ...

- Committee Reports ... **CR**
- Executive Sessions ... **ES**
- Public Hearings ... **PH**
- Record of Comm. Proceedings ... **RCP**

INFORMATION COLLECTED BY COMMITTEE FOR AND AGAINST PROPOSAL

- Appointments ... **Appt**
- Clearinghouse Rules ... **CRule**
- Hearing Records ... bills and resolutions
  (**ab** = Assembly Bill) (**ar** = Assembly Resolution) (**ajr** = Assembly Joint Resolution)
  (**sb** = Senate Bill) (**sr** = Senate Resolution) (**sjr** = Senate Joint Resolution)
- Miscellaneous ... **Misc**

Anaerobic Digesters and Animal Wastes: Benefits and Limitations

Steve Dvorak, P.E.
GHD, Inc.
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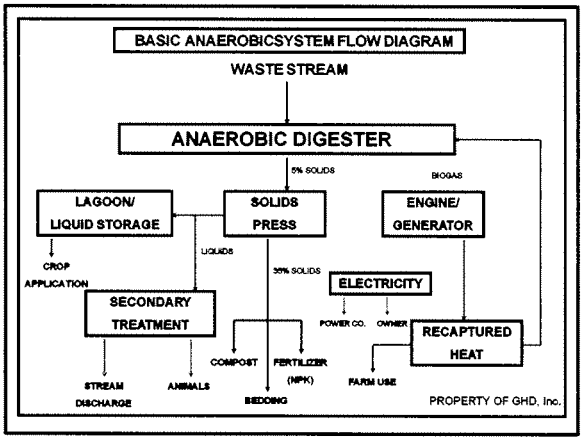
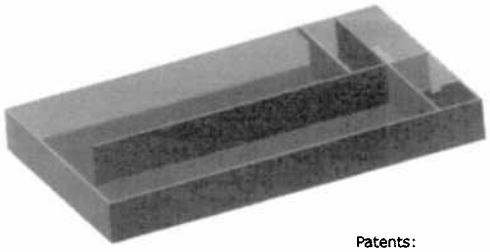
www.ghdinc.net



BIOLOGICAL SYSTEM

- Manure Collection System
- Digester Vessel
  - Plug-flow Digester
  - First In, First Out
  - Acid Chamber
  - Methanogenic Chamber
- Digester Mixing
  - Biogas Recirculation
- Digester Temperature
  - 101°F

PROPERTY OF GHD, Inc.



Patents:
US 6,613,562 B2
US 7,078,229 B2
US 7,179,642 B2
Patents Pending

GHD's WI DIGESTER SITES

Lake Breeze Dairy
Malone, WI
600 kW

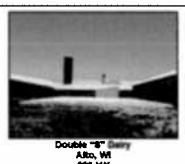
Holsum Irish Dairy
Hilbert, WI
700 kW

Gordondale Farms
Nelsonville, WI
140 kW

Clover Hill Dairy
Campbellsport, WI
225 kW

8 Dairy Wisconsin

GHD's WI DIGESTER SITES



Double "S" Dairy
Alto, WI
200 kW

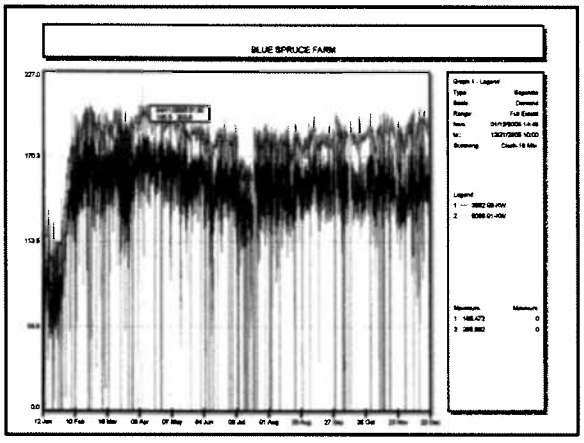
Quantum Dairy
Weyauwega, WI
280 kW

Holsum Elm Dairy
Hilbert, WI
1200 kW

Emerald Dairy II
Emerald, WI
Producing Natural Gas

BIOGAS BENEFITS

- 55 – 60% Methane (CO_2 ~ 45%)
- 110 ft^3/cow/day Biogas
- 65,000 BTUs/cow/day
- 3.5 – 5 cows per kW Generation Capacity
- Gen-Set Provides Renewable Electricity
- Excess Biogas is Flared
- Waste Heat to Digester and Dairy
- Odor Reduction (VFA)
- Outside Substrates
- Greenhouse Gas Reduction



DIGESTER PERFORMANCE

Date 5/8/2007

SITE NAME	LOCATION	GENSET MAX KW	TOTAL kWh	TOTAL RUN HOURS	OVERALL kWh AVERAGE	TODAY'S kWh	TOTAL RUN TIME %
Clover Hill	WI	225	530,932	2,500.00	212.4	228	83.4
Double S	WI	200	1,570,364	19,713.45	79.7	92	87.8
Holeum Irish 1 (Cat)	WI	200	3,465,649	20,114.90	172.3	191	85.4
Holeum Irish 2 (Dustz)*	WI	500	2,552,121	31,482.30	415.3	498	86.3
Holeum Elm 1	WI	600	973,467	2,466.35	391.5	596	83.8
Holeum Elm 2	WI	600	863,285	2,126.50	406.0	0	94.0
Lake Breeze 1	WI	300	2,127,689	9,094.50	234.0	272	97.3
Lake Breeze 2	WI	300	1,709,404	7,641.60	223.7	196	90.2
Quantum	WI	280	3,112,566	16,035.40	194.1	180	97.8
		TOTALS:	**16,906,477** TOTAL kWh	**111,195.00** TOTAL RUN HOURS	**2,328.9** TOTAL kWh AVERAGE	**2,253.0** TOTAL kWh TODAY	**90.4** OVERALL RUN TIME %
			16.9 TOTAL GWHr	12.7 TOTAL RUN YEARS			

* = New switchgear - kWhr reset 7/2006

Totals Do NOT Include:

Emerald Dairy II	WI	-	Boiler System
Gordondale	WI	130	No Dial-in Monitoring (> 47,000 est. hours) (> 4.5 million kWh)

RENEWABLE ENERGY COST COMPARISON

	GHD, Inc. Anaerobic Digester	Solar	Wind
Installed Cost Per Kilowatt	$3,800 to $5,400	$6,000 to $8,000	$3,000 to $5,000
Capacity Factor	92%	15-20%	20-25%
Capital Cost Per Kilowatt Produced (after 1 year)	$0.50 to $0.77 per kWh	$3.42 to $4.56 per kWh	$1.37 to $2.28 per kWh
Capital Cost Per Kilowatt Produced (after 10 years)	$0.05 to $0.08 per kWh	$0.34 to $0.46 per kWh	$0.14 to $0.23 per kWh

Notes: Digester cost per kilowatt produced includes $0.02 per kWh for system maintenance.
Digester costs do not factor in the addition of substrates or other digester savings and benefits.
Solar and wind costs averaged from the awea.org, solarbuzz.com, Motley Fool Financial Advisors, etc.

USDA RENEWABLE ENERGY GRANTS – GHD DIGESTERS

2003 Grants	Amount	Status
Hunter Haven Farms - IL	$ 242,518	Completed
Bill Rowecamp - MN	$ 404,910	
VanderHaak Dairy - WA	$ 272,000	Completed
Schopf's Hilltop Dairy - WI	$ 240,589	
Quantium Dairy - WI	$ 205,991	Completed
Smith, Eugene, and Shaw: Burr Oak Hills Dairy - WI	$ 90,000	
Pagel's Ponderosa - WI	$ 99,950	
	$1,555,958	2003 Grant Total
2004 Grants		
Wright, Whitty, Davis Farms - GA	$ 200,060	Completed
Vreba-Hoff Dairy II - WI	$ 500,000	
Durst Bros. Dairy - MN	$ 249,741	
Wenning Poultry - OH	$ 500,000	Under Construction
Blue Spruce Farm -VT	$ 97,318	Completed
Redtail Ridge Dairy - WI	$ 225,268	
Gordondale Farms - WI	$ 124,649	
Dic-Wisco Farms - WI	$ 254,768	
Emerald Dairy II - WI	$ 500,000	Completed
Weiss Family Farms - WI	$ 253,268	
Lake Breeze Dairy - WI	$ 500,000	Completed
Ducat Farms - WI	$ 247,018	
Sea-Bow Farms - WI	$ 253,268	
Dairyland Farm - WI	$ 260,741	
Four Cubs Farm - WI	$ 184,268	
Trillium Hill Farm - WI	$ 196,766	
	$4,547,155	2004 Grant Total

USDA RENEWABLE ENERGY GRANTS – GHD DIGESTERS

2005 Grants	Amount	Status
Bridgewat er Dairy - OH	$ 500,000	Under Construction
Turner County Dairy - SD	$ 500,000	
DeRuyter & Sons Dairy - WA	$ 499,219	Completed
Beadle Acres Dairy - WI	$ 87,425	
Clover Hill Dairy - WI	$ 280,993	Completed
Holsum Dairies (Elm) - WI	$ 500,000	Completed
Norm E Lase - WI	$ 438,150	
	$2,806,787	2005 Grant Total
2006 Grants		
Amana Farms - IA	$ 500,000	
Hunter Haven Farms - IL	$ 49,875	Under Construction
Berkshire Cow Power - VT	$ 500,000	Completed
Green Mountain Dairy - VT	$ 335,244	Completed
Montagna Farm - VT	$ 365,994	Completed
Newmont Farm - VT	$ 345,744	
	$2,096,857	2006 Grant Total
	$11,006,757	Overall Grant Total
	$ 4,944,134	WI Grant Total (45%)

WI FOCUS ON ENERGY

Customer	Status	Reward
Holsum Dairy - Irish	Completed	$44,869.00
Double "S" Dairy	Completed	$40,328.00
Quantum Dairy, LLC	Completed	$35,000.00
Clover Hill Dairy, LLC	Completed	$45,000.00
HOLSUM DAIRY - Irish	Completed	$45,000.00
Lake Breeze Dairy LLC	Completed	$45,000.00
Lake Breeze Dairy LLC	In Progress	$19,662.00
Emerald Dairy Waste Processing LLC	In Progress	$30,000.00
Quantum Dairy, LLC	Completed	$7,347.00
Redtail Ridge Dairy, LLC	In Progress	$46,086.00
Lisowe Acres, LLC	In Progress	$40,006.00
Holsum Dairy - Elm	In Progress	$19,165.00
		$417,463.00

DIGESTER BENEFITS

- Separation With Screw Press
- Solids Used for Bedding
  - 65 – 70% Moisture
  - Pathogen Reduction
  - Clean Cows
  - Somatic Cell Count/Herd Health
  - NPK with Excess Solids
  - Excess Solids Sold $$

DIGESTER BENEFITS cont.

- Liquid for Fertilizer
  - 1.5 – 2.5% Solids
  - Irrigation vs. Trucking
  - Reduction in NPK in Liquid Waste
  - pH Increase
  - Summertime Application onto Growing Crops
  - Crop Yields Increase

AG STAR PROGRAM SAMPLING RESULTS

Gordondale Farms

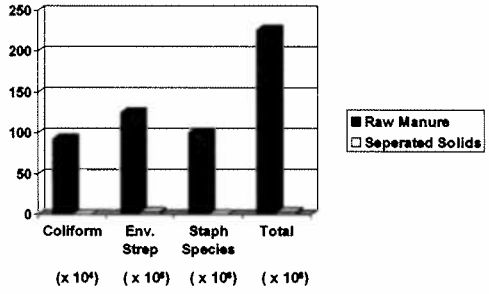
DIGESTER INFLUENT				
PARAMETERS	11/3/2004	11/16/2004	11/30/2004	12/28/2004
Fecal Streptococcus (col/g WWB)	380,000,000	110,000,000	64,000,000	480,000,000
Fecal Coliform (col/g WWB)	350,000,000	170,000,000	130,000,000	160,000,000
Total Phosphorous (mg/Kg WWB)	950	780	910	750
Total Solids (%)	10.9	9.8	9.3	9.3
Volatile Fatty Acids (mg/Kg WWB)	7,520	7,060	6,000	7,140

DIGESTER EFFLUENT				
PARAMETERS	11/3/2004	11/16/2004	11/30/2004	12/28/2004
Fecal Streptococcus (col/g WWB)	8,700,000	6,000,000	1,700,000	34,000,000
Fecal Coliform (col/g WWB)	660,000	570,000	380,000	240,000
Total Phosphorous (mg/Kg WWB)	780	840	860	550
Total Solids (%)	6.4	6.5	6.4	6.1
Volatile Fatty Acids (mg/Kg WWB)	300	282	321	259

% DMB = (mg/Kg DMB) / 10,000
mg/Kg = ppm

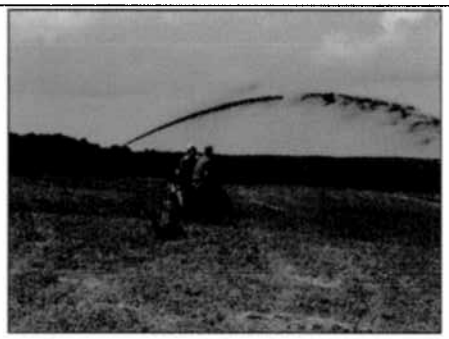
Resource: www.epa.gov/agstar/pdf/gordondale_report_final.pdf

PATHOGEN REDUCTION
Gordondale Farms

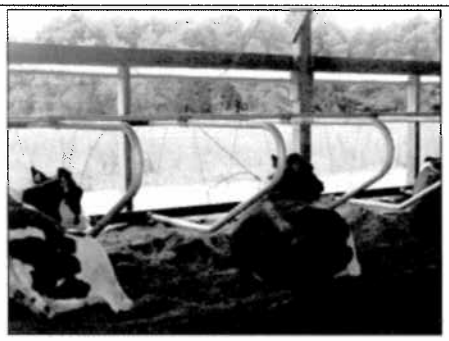


NOTE: SAMPLES COLLECTED 2/7/03

SUMMER CROP APPLICATION



SOLIDS – QUALITY BEDDING

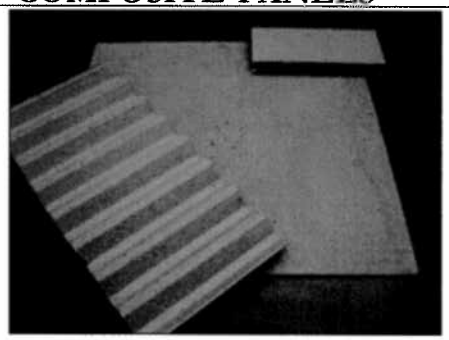


SOLIDS – QUALITY BEDDING

CARBON CREDITS – REAL $$

TESTS: DIGESTED SOLIDS vs. PEAT MOSS

USDA FPL COMPOSITE PANELS



DIGESTER LIMITATIONS

- Total NPK not Changed
- Lagoon Storage Still Required
- Additional Management
- Additional Maintenance
- Low BTU Value per Gallon of Manure
- Low Electricity Prices in Some Areas
- Newer Technology
- Cost $$

QUESTIONS?


FORWARD
E PLURIBUS UNUM

Low-priced electricity hampers digesters

By Jim Massey

Editor

MADISON — Wisconsin farmers would install more anaerobic digesters if they were paid more for the excess electricity the digesters generate, a legislative committee has been told.

Assembly Agriculture and Biofuels and Sustainable Energy committees' members were updated last week about the possibility of turning more animal waste into power. The committees invited Steve Dvorak, president of GHD, Inc., a Chilton anaerobic digester manufacturer, to discuss how digesters work and whether their numbers could increase.

Mr. Dvorak said his company has built eight digesters in Wisconsin and has constructed numerous digesters in other states. Several other projects are planned or being built.

One of the expansion challenges in Wisconsin is the lower cost some utilities pay for digester-generated electricity. Wisconsin farmers receive an average of 7 cents per kilowatt; in Vermont, the going rate is 12 cents per kilowatt.

"Vermont is a good state for digesters right now — the state (government) also (financially) supports the projects," Mr. Dvorak said.

Manure-fueled anaerobic digesters produce methane gas similar in chemical composition to natural gas, Mr.

> **"You can build a digester for one cow, but there are definitely economies of scale for larger operations."**
>
> — Steve Dvorak, president of GHD, Inc., an anaerobic digester manufacturer

engine and generates electricity. Farmers use the digester-generated electricity on their farms and sell the excess to utilities.

Wisconsin utilities pay varying amounts for the electricity, making digesters more feasible for some farmers than others.

"Some people are being penalized if they're in the wrong territory," Mr. Dvorak said. "It can be a huge variable and make a big difference in profitability."

Mr. Dvorak said Wisconsin farmers have lost out on grant opportunities because of lower utility rates and anticipated poorer economic performance as compared to other states. He said Alliant Energy is paying farmers a standardized rate for digester-generated electricity, but "is getting some resistance to that."

Mr. Dvorak said the U.S. Department of Agriculture has determined that anaerobic digesters are more cost-effec-

ators. He said more digesters will be built as electricity rates to farmers increase.

State Rep. Gary Tauchen, R-Bonduel, said he has heard from some dairy farmers that anaerobic digesters require a significant amount of management. Mr. Dvorak said digester maintenance is relatively simple.

"Larger dairies generally have a full-time maintenance person, and we have found that they need to spend on average of about one-half hour per day on the digesters," he said. "Some smaller dairies that don't have a maintenance person hire the local implement dealer to send a mechanic out once per month."

He said digester engines generally need major overhauls every four to five years, and the digesters will last as long as any farm building.

Anaerobic digesters' benefits include odor reduction, clean bedding products, and reductions in nitrogen, phos-

liquid manure. Manure that comes out of digesters can often be irrigated rather than trucked and can be applied to crops during the growing season.

The biogas produced by a digester normally would escape into the atmosphere as a greenhouse gas, Mr. Dvorak said, so farmers are eligible for carbon credits when they convert the manure to methane.

Digester limitations include required lagoon storage, additional management and maintenance time, and the cost of the structures.

Mr. Dvorak said GHD digesters cost about $1,200 per cow for a 600-cow operation, $1,000 per cow for a 1,000-cow operation, and $600 per cow for farms with 3,000 cows.

"You can build a digester for one cow, but there are definitely economies of scale for larger operations," Mr. Dvorak said.

Mr. Dvorak said some people advocate for community digesters, but that it doesn't make economic sense if the manure has to be trucked to the sites.

"The trucks hauling the manure take 140,000 BTUs while manure running through a digester produces 5,000 BTUs," Mr. Dvorak said. "It doesn't take long to figure out that doesn't make much sense."

Community digesters would work for farms close enough together to have the manure pumped to a jointly owned facility, he said.

Jim Massey may be reached at jimmassey@mhtc.net.

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JD 556 Baler - low use, showroom condition

JD 115 Stalk Chopper - flawless

GOOD SELECTION OF TILLAGE EQUIPMENT


FORWARD
E PLURIBUS UNUM

Would like copy of Dvorak presentation

AMBICO

American Biogas Company, Inc.

Sent 5/17/07

Daniel De Buhr

VP – Energy & S.C.A.D.A. Operations

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FORWARD
E PLURIBUS UNUM

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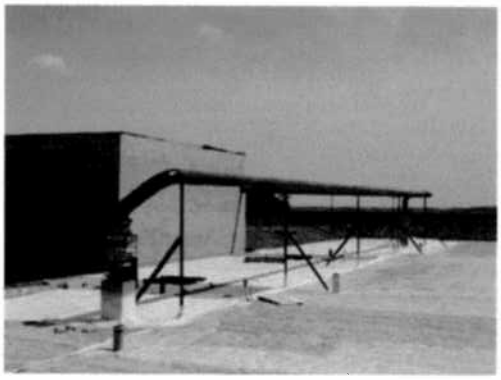
GHD, Inc. ANAEROBIC DIGESTERS

Dairy
Beef
Poultry
Swine

WASTE TO POWER!

Gordondale Farms, Nelsonville, WI



Bos #4 Farm, Fair Oaks, IN

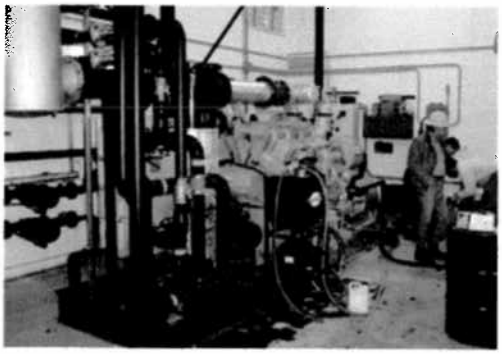
GHD's Services Include:

- Engineering & Design
- Installation
- Permitting
- Utility Contact
- Equipment Specifications
- Complete System Oversight
- System Start-Up
- System Maintenance

Advantages of GHD's Digester:

- Electricity Generation
- Quality Bedding Without Composting
- Excess Heat for Farm Use
- Odor Reduction
- Increased Fertilizer Value
- Pathogen Reduction
- Weed Seed Reduction
- Low Maintenance
- Proven Technology
- Low Operation Costs
- Fly & Vector Control

Vander Haak Dairy, Lynden, WA



Blue Spruce Farms, Bridport, VT

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GHD, Inc. – At a Glance

Successful Background

GHD, Inc. has been a leader in the environmental industry for the past 18 years, specializing in petroleum and farm related environmental engineering. GHD, located in Chilton, Wisconsin, has successfully designed and installed their patented two-stage mixed plug-flow digester system across the nation. Their anaerobic digesters are cost-effective and require low maintenance. By-products from the digester system include: significant odor reduction; a biogas that can be harnessed to create electricity, natural gas or methanol; a bio-solid that is utilized as a high-quality bedding in dairy operations and also as a soil amendment; heat, in the form of hot water, that farmers use to heat various aspects of their operation, such as maintenance shops, parlors, etc.; and a primarily inorganic liquid that can be applied directly to a growing crop, greatly enhancing crop yields and reducing the likelihood of runoff.

GHD, Inc. began research and development on its anaerobic digester system in 1999. In September, 2001, GHD installed its first digester at Gordondale Farms in Nelsonville, Wisconsin. Since then, GHD has installed its system at five additional Wisconsin farms: Double S Dairy near Markesan, Holsum Dairy in Hilbert, Emerald Dairy in Emerald, Quantum Dairy in Weyauwega, and Lake Breeze Dairy in Malone. The company also has operating digesters at: Bos #4, Herrema Dairy, and Bos #1 & 2 in Fair Oaks, Indiana; Vander Haak Dairy in Lynden, Washington; Blue Spruce Farm in Vermont; Scheidairy in Freeport, Illinois; Hunter Haven Farms in Pearl City, Illinois; Willow Point Dairy in Oleans, Michigan; and Wright, Witty, Davis Farm in Waycross, Georgia. Collectively, these operations constitute roughly 44,000 cows. At the end of 2006, GHD brought on-line six additional digesters on dairy farms: Holsum Elm Dairy in Chilton, Wisconsin; Clover Hill Dairy in Campbellsport, Wisconsin; George DeRuyter & Sons Dairy in Outlook, Washington; Hidden View Dairy in Fair Oaks, Indiana; Pleasant Valley Farms in Richford, Vermont; and Green Mountain Dairy in Highgate Center, Vermont. Together, these six farms will process the manure from approximately 12,000 cows through GHD's anaerobic digester. During the spring of 2007, GHD will complete a digester at Montagne Farm in Swanton, Vermont, designed to handle the waste of 1000 dairy cows.

Not only do farmers like GHD's technology, so does the USDA. The USDA Rural Business Development has awarded 37 farmers over $10.5 million in federal renewable energy grants in the last three years based on GHD's technology. This highly competitive grant program does not award money for R&D projects, only proven technologies such as GHD's patented system.

In 2005, GHD was proud to be one of five finalists for the Governor's Small Business Technology Transfer Award, sponsored jointly by the Wisconsin Department of Commerce and the Center for Technology Transfer. The purpose of the award was to recognize and reward Wisconsin small businesses that show outstanding achievement in moving a technological innovation from idea to commercialization.

Qualified Personnel

Steve Dvorak, President of GHD, Inc., is a University of Wisconsin-Madison engineering graduate and a registered professional engineer in the State of Wisconsin. Steve's experience in anaerobic digesters began over 20 years ago with the installation of an anaerobic digester at a food processing company in Green Bay – one of the first ag-related digesters in the state and still in operation today. His success and experience in the biomass field was acknowledged when Steve was asked to serve, and did serve, as a member of Governor Doyle's Biomass Task Force to Japan in 2004.

Melanie Dvorak, Secretary of GHD, is a University of Wisconsin-Madison graduate and received a B.B.A. in accounting. Melanie, a CPA, is responsible for the financial matters of the corporation.

Corey Brickl has worked as Project Engineer for GHD since his graduation from the University of Wisconsin-Madison in 1992, where he earned a B.S. in electrical engineering. Corey provides management experience in the design and implementation of anaerobic digesters, project financial analysis, grant writing, and overall project management.

Melissa Dvorak became GHD's Marketing Manager in 2004 after completing the MBA program at Indiana University, majoring in marketing and strategy. Melissa is also a CPA and received a B.B.A. in accounting from the University of Wisconsin-Madison in 1997.

Gregory Sporer, Project Manager, began working with GHD in 1994. Gregory received a degree in construction administration engineering from the University of Wisconsin-Madison. He is in charge of bidding and overall construction management.

Timothy Ott joined GHD in 1996 upon graduation from the University of Wisconsin-Stevens Point where he earned a degree in business and natural resources. As Project Scientist, Timothy's responsibilities include construction bidding, construction management, digester sampling and testing, and research and development.

Bradd Seegers, Project Administrator, obtained a B.A. in geology from Lawrence University in 1988. Bradd joined GHD in 2001 and handles the administrative duties related to grant administration and compliance.

Kim Paterick joined GHD in 2006 as Administrative Manager. Kim obtained a BSBA, with a concentration in accounting, in 2003 and a MBA from High Point University in 2006. Her duties include administration, interoffice support and accounting.

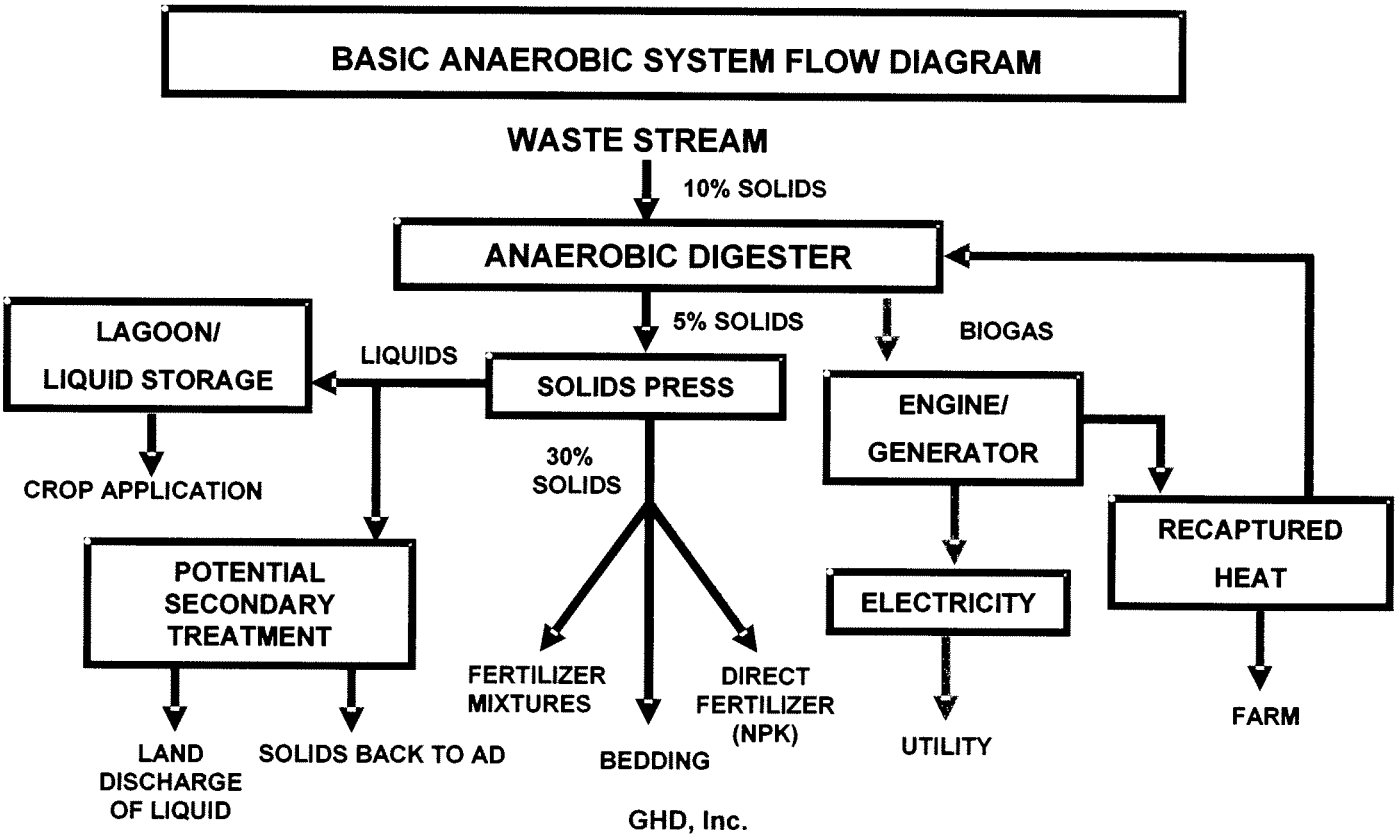
GHD'S ANAEROBIC DIGESTER

Unprocessed cow manure, a renewable resource, is collected in a receiving pit. During the first stage of GHD, Inc.'s anaerobic digester (AD), the raw manure from the dairy is mixed and heated to a temperature of 100° F. In the second stage of the AD vessel, the methanogenic bacteria convert the volatile fatty acids produced in the first stage into a biogas, which consists primarily of methane (CH_4, the same as natural gas) and CO_2.

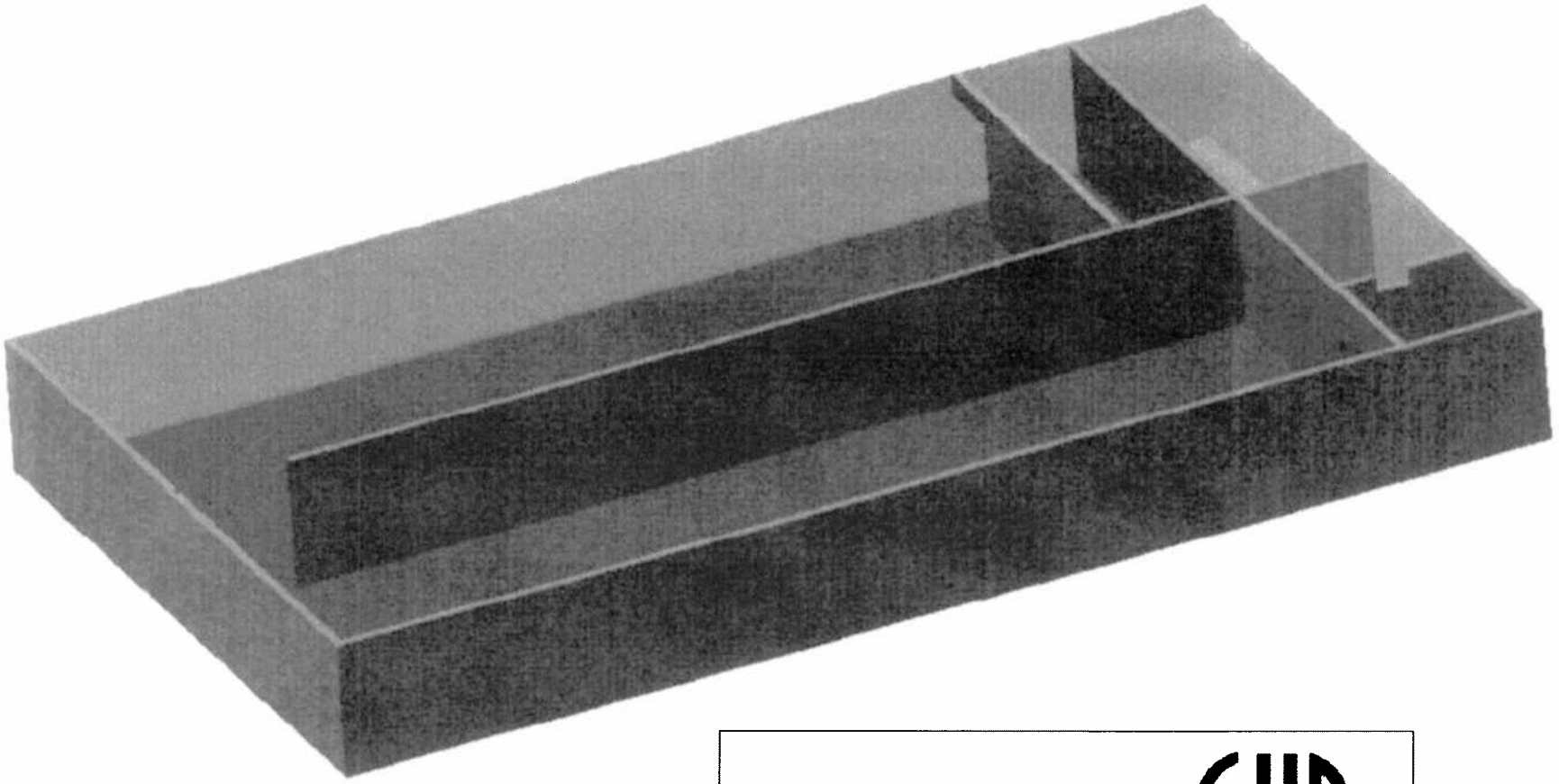
The methane biogas is collected and utilized for fuel in the combined heat and power (CHP) genset. This genset is a commercially available, natural gas-fueled reciprocating engine modified to burn biogas. Electricity produced is sold to the local utility. It is anticipated that five cows will create enough biogas to produce one kW every hour, on a continuous basis of operation. Excess hot water from the system will also be used to heat various dairy locations. No seasonal variations are expected in the system.

The digested manure is pumped from the effluent pit at the end of the AD vessel to a manure solids separator. The mechanical manure separator separates the digested effluent waste stream into solid and liquid fractions. The solids are dewatered to approximately a 30% solid material. The separated solids, having the same odor and pathogen reduction characteristics as the liquid stream, are utilized by the dairy for bedding replacement (an expense reduction). Utilization of the separated solids for bedding typically comprises 50-60% of the generated separated solids from a typical dairy. The residual 40-50% of non-utilized separated solids is sold (system-generated income) to other dairies for bedding purposes, or sold to after-markets, such as nurseries, for soil amendment material.

The liquid from the manure separator, now with the majority of the large solids removed, flows into the dairy's storage lagoon. A large advantage of the effluent from the AD treatment process is that the viscosity of the effluent is such, as opposed to the raw manure influent, that the liquid effluent can be pumped through an irrigation nozzle for field spreading. Another benefit is the reduction of phosphorous, nutrient, and pathogen loading when spreading.



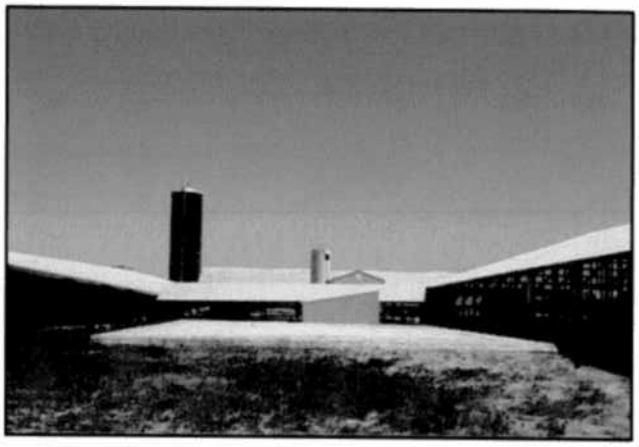
GHD, Inc.
P.O. Box 69 • Chilton, WI 53014
920.849.9797 • Fax 920.849.9160
www.ghdinc.net • corporate@ghdinc.net



PROPERTY OF GHD, Inc.

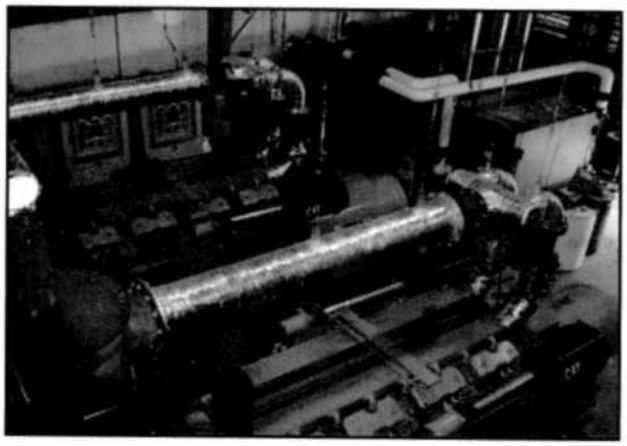
GHD's DIGESTER SITES

Gordondale Farms
Nelsonville, WI
140 kW

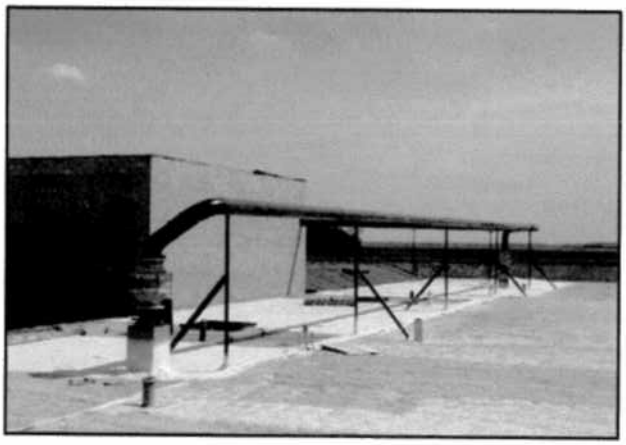


Double "S" Dairy
Alto, WI
200 kW

Holsum Dairy
Hilbert, WI
700 kW



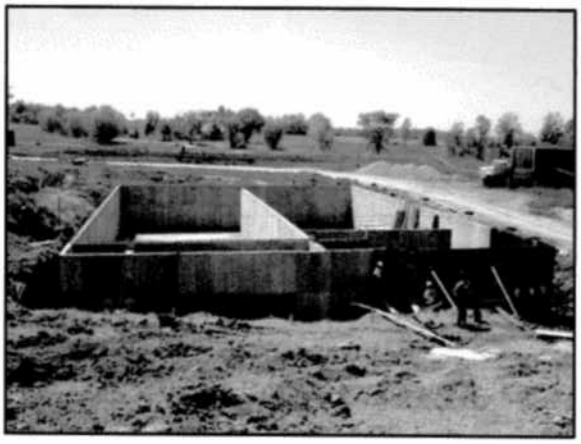
Herrema Dairy
Fair Oaks, IN
800 kW



Bos #4 Farm
Fair Oaks, IN
1050 kW

Vander Haak Dairy
Lynden, WA
300 kW

GHD's DIGESTER SITES

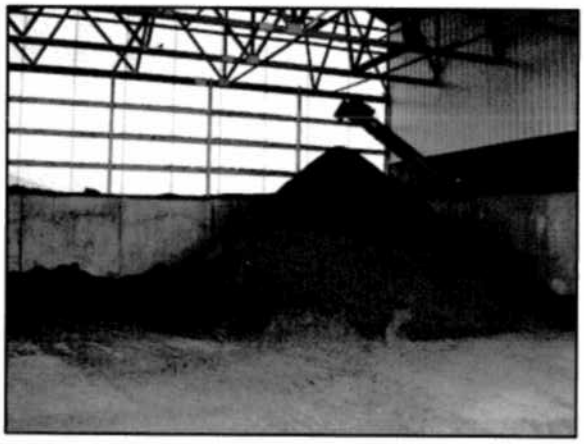


Blue Spruce Farm
Bridport, VT
280 kW

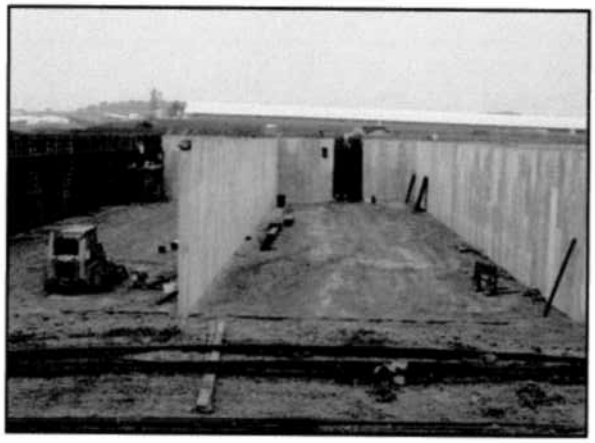
Hunter Haven Farms
Pearl City, IL
140 kWh

Scheidairy Farms
Freeport, IL
140 kW

Quantum Dairy
Weyauwega, WI
280 kW

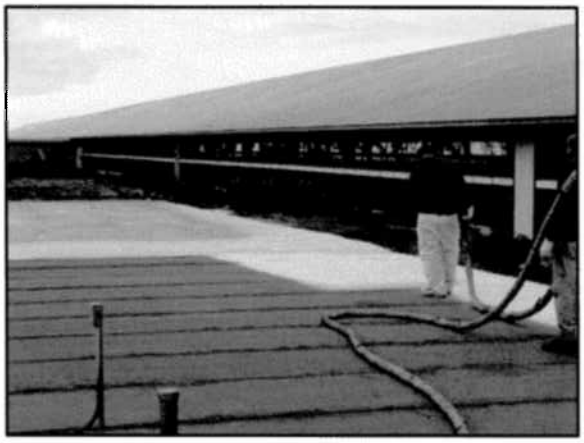


Emerald Dairy II
Emerald, WI
Producing Natural Gas

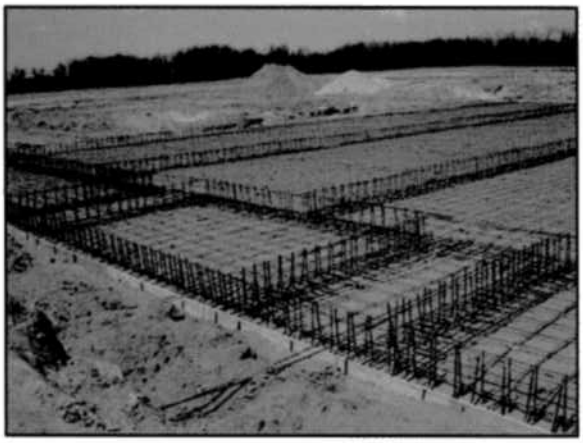


Lake Breeze Dairy
Fond du Lac, WI
600 kW

GHD's DIGESTER SITES



Bos 1 & 2 Farms
Fair Oaks, IN
No Electrical Generation



Willow Point Dairy
Ionia, MI
No Electrical Generation

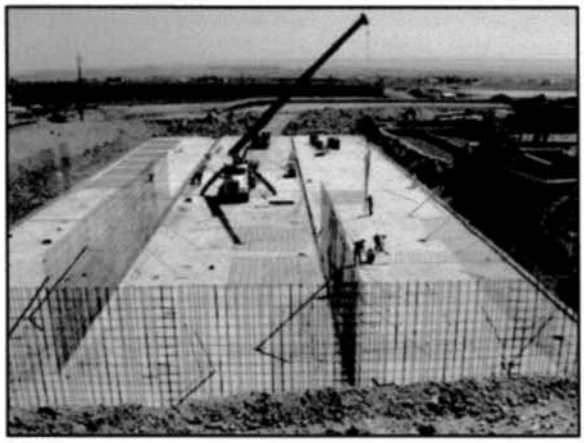
Wright, Witty, Davis Farms
Baxley, GA
200 kW

Hidden View Dairy
Fair Oaks, IN
900 kW

Holsum Elm Dairy
Chilton, WI
1200 kW

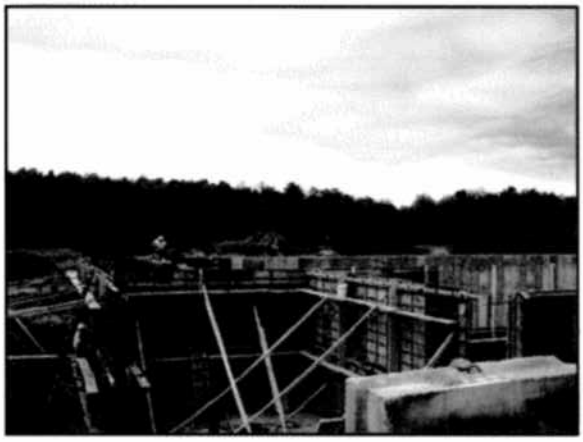
Clover Hill Dairy
Campbellsport, WI
225 kW

GHD's DIGESTER SITES



George DeRuyter & Sons Dairy
Outlook, WA
1200 kW

Pleasant Valley Farms
Richford, VT
600 kW



Green Mountain Dairy
Highgate Center, VT
300 kW

Montagne Farm
Swanton, VT
Under Construction

BioCycle energy

IMPROVING HERD HEALTH

DIGESTER PROVIDES POWER AND COW COMFORT

Anaerobic systems on Illinois dairy farm supplies renewable electricity, crop nutrients and bedding replacement that improves milk quality.

Melissa Dvorak

AT HUNTER HAVEN FARMS in Pearl City, Illinois, an engine fired on May 23, 2005 from an anaerobic digester where biogas powered a generator to create renewable electricity. Also captured and used were a liquid fertilizer with little odor and a solid used as a bedding replacement or as a quality fertilizer for nurseries. Dairy farm owners Doug and Tom Block have been following the progress of digesters for eight years, settling on a GHD unit because it was not "management intensive and liked the comfort that the bedding provided for the cows."

A major benefit of the system is that the bedding leads to improved herd health. An important metric to a dairy farmer is something called "somatic cell count", a measure of the amount of bacteria in the milk. The lower the number, the greater the premium the farmer receives for his milk. So far this summer, even when the temperature was 90 degrees and above, Hunter Haven's somatic cell count was less than 150,000. "When we were on sawdust, our somatic count was 200,000-300,000, with counts over 300,000 at various times during summer. We've seen the lowest somatic counts of any summer." In addition, they have had no instances of *Klebsiella Mastitis*, a serious form of mastitis often resulting in death to the animal. When using sawdust for bedding, the farm would average two to three cases of Klebsiella a month. Reducing the cases of Klebsiella has led to savings in vet bills, as well as saving the significant cost of purchasing a new cow.

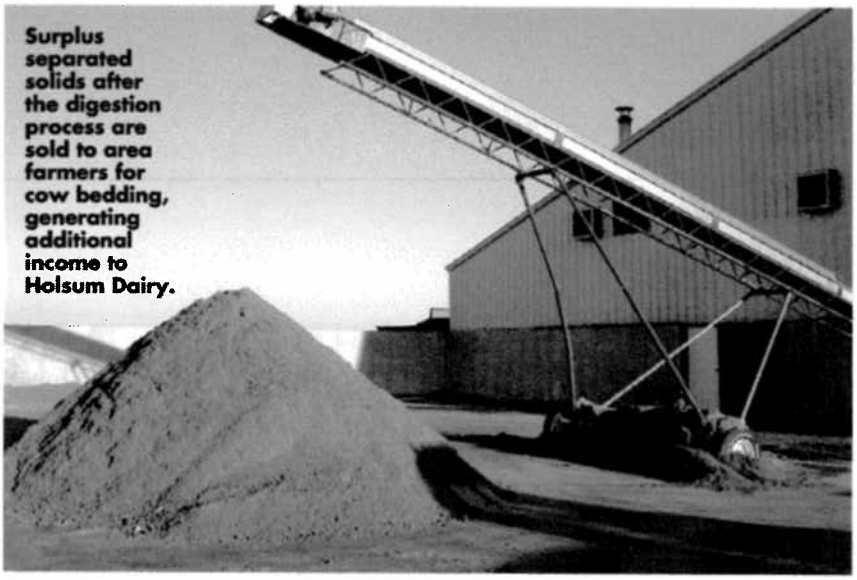
Prior to the digester, Hunter Haven was using sawdust on top of its cow mattresses, spending roughly $100 per year per cow for the sawdust. Now that the farm is using the digested solids for bedding, Block commented that "the cows are now laying down more, are more comfortable than they were on sawdust." Currently they are bedding with the biosolids daily to build depth in the stalls. The farm plans to switch to deep bedding as the mattresses wear out, rather than replace them. In addition to increased cow comfort, Block also has seen a rise in his milk production of four to five pounds, which he attributes to a combination of the biosolids bedding and new feed.

In the months that the digester has been operating, there has been a decrease in odor from the lagoon, and it keeps improving. After the second crop of alfalfa, Hunter Haven spread 6,000 gallons/acre of digested manure from the lagoon on an alfalfa field eliminating the need to purchase potash to fertilize the alfalfa. "It seems to be greening nicely so far," says Block.

Another benefit of the digester was efficient electrical production. "GHD produced more electricity per cow than other systems. Currently the waste from 550 cows is flowing to his digester, with the system consistently producing 97-99 kW per hour. In addition, waste heat from the engine produces a surplus of hot water that will be utilized by the dairy for hot water in their milking parlor. The digester and engine were intentionally oversized, since the Blocks intend to expand their dairy and herd in the future.

According to Block, the most difficult aspect of the project was dealing with the utility. "We had a significant delay getting hooked up with the power company, which added 10 percent to the project. The six month delay meant I was paying interest on loans without receiving any benefits of the system," says Block. ■

USDA-NRCS coordinator Dave Dornbusch (left below) and Doug Block of Hunter Haven observe digester performance at the farm.



Surplus separated solids after the digestion process are sold to area farmers for cow bedding, generating additional income to Holsum Dairy.

PROGRESS IN ANAEROBIC DIGESTERS

NEW MARKETS FOR RECYCLED BEDDING FROM DIGESTERS

THERE is a growing awareness among dairy farmers regarding the increased valuation of the separated biosolids from anaerobic digestion of dairy waste. Financial benefits for dairy farmers include purchased bedding replacement, biosolids sales off-farm, lowered dairy herd somatic cell counts, reduced dairy culling rates, and easier on-farm manure management.

Dr. Kenn Buelow, DVM, is the manager and partner at Holsum Dairy, near Green Bay, Wisconsin. Holsum Dairy, with a dairy herd of 2,900 lactating cows plus dry cows, installed a GHD, Inc. anaerobic digester system approximately two years ago. The total dairy waste, including parlor washdown water, is about 100,000 gallons/day. That waste stream, along with cattle waste from the barn and milking parlor, gravity flows into the anaerobic digester, which is operated at a mesophilic temperature (100°F). The system has 20 days of hydraulic retention time and is a plug flow based design with the addition of a proprietary biogas mixing system. Approximately 420,000 cubic feet/day of biogas are produced and utilized as fuel in both a Deutz and a Caterpillar engine to produce electricity for sale to the local power utility. Power for the dairy is bought back on a separate meter. Electricity sales are estimated at about $300,000/year with the recent addition of a second electrical generator.

Solids utilization becomes significant income stream as dairy farmers discover range of benefits.

Steve Dvorak

SOLIDS SEPARATION

The biodigested waste is sent to a FAN solids separator, where solids at approximately 30 percent dry weight are automatically separated from the liquid waste stream. The biosolids are stored on a concrete pad and the liquid fraction gravity flows to a storage lagoon. Holsum Dairy utilizes the separated solids in its free stall dairy barn for cow bedding, resulting in an estimated bedding replacement savings of $9,000/month. Surplus solids, sold to five to eight area farmers per week, generate an additional $4,000/month in revenue to the dairy — opening options for the dairy's manure management plan. Holsum Dairy currently has a backlog of farmers wishing to acquire biosolids for bedding, and is considering additional methods to increase solids production.

Buelow is also pleased that the somatic cell count of his milking herd has decreased from 350,000, when the dairy utilized wheat straw and rice hulls for bedding, to the current 145,000 count with the recycled biosolids. What makes this more remarkable is that Holsum Dairy never has tested or culled individual animals based on somatic cell counts (instead using culling based on criteria such as milk volume production, cow health). This naturally leads to a lower somatic cell count overall in the dairy herd when culling can be done based on individual somatic cell count per cow. Area farmers who are purchasing his biosolids also report similar herd improvements.

Holsum Dairy also has found that the digested liquid effluent, with the coarse solids removed, has led to improvements in its manure management and disposal. The dairy currently hauls about one-third of its liquid via semitankers to its most distant fields. Another third is used to irrigate fallow ground, and the remaining third is irrigated directly on crops during the summer growing season. Besides the lower costs of manure disposal via irrigation, alfalfa fields that Buelow directly applied liquid manure to achieved about 6 to 7 tons of alfalfa production per acre, without the application of commercial fertilizers. ■

Steve Dvorak is president of GHD, Inc. based in Chilton, Wisconsin. The company has installed its patented two-stage mixed plug-flow digester system across the Midwest (www.ghdinc.net).

Renewables Producer Profile

GHD's Steve Dvorak: Farming Biopower from Manure

Steve Dvorak heads GHD, Inc., Chilton, Wisconsin, which provides an array of engineering services with a workforce of eight to 10 employees, depending on the season. Design and installation of anaerobic digesters for treating animal wastes accounts for about half of the firm's work. GHD received a boost in 2002 with a $15,000 feasibility study grant from Focus on Energy to evaluate the operation of three anaerobic digesters located in Wisconsin

Dvorak grew up as a "farm boy" near Manitowoc and earned an industrial engineering degree from UW -Madison, as well as the professional engineer title. His first job was with Packerland Packing in Green Bay, and he eventually assumed responsibilities that included waste management. In 1978 he became a farm implement dealer and in 1989 started GHD (Geo-Hydro Designs), focusing largely on petroleum clean-up projects.

GHD has installed five digesters in Wisconsin, including two farms with two digesters apiece. Dvorak also has projects pending in Ohio, Minnesota, Washington, Illinois, Indiana, and California.

The U.S. Department of Agriculture in 2003 awarded $1,211,580 to nine Wisconsin farms to install GHD-designed digesters. Wisconsin's Focus on Energy program funded an initial business plan for six of these projects.

Q. *Farmers, especially dairy farmers, seem to be looking favorably on biodigesters. What's motivating their interest?*

Manure management issues. Anaerobic digesters help solve a farmer's manure management problem. They give farmers another option for handling animal wastes. The wastes contain nitrogen and phosphorus, key ingredients in fertilizers, so the wastes have to be managed properly. A certain number of pounds of nitrogen and phosphorus can be spread on a farmer's fields, but it has to be carefully controlled so that it doesn't leach into the groundwater, doesn't run off, and doesn't carry over from year to year. Also, many farms don't have sufficient acreage to use all of the nutrients they produce. By separating the solids, which account for 8 percent of the waste, from the fluids which make up the other 92 percent, the farmer can dispose of the solids off the farm. They can sell the solids as soil supplements to a cash-grain farmer who doesn't have animals,. The solids also make good bedding for animals.

Of course, manure also means odor. As suburbs creep away from cities, closer and closer to farms, people can smell the odor. So a digester will solve another farm problem — odor. We burn the smell when we burn the biogas in the engine that runs the generator. Actually, the methane doesn't smell; it's odorless. Other "contaminants" mixed with the methane produce the odor. When the methane burns, the smell burns with it.

Q. *Then farmers should be beating a path to door, shouldn't they?*

You might think so, but biodigesters still aren't a certainty. A digester is a capital outlay, and they don't have a long track record yet; that is, we haven't had many in operation long enough to know with certainty how much revenue they'll generate, what costs a farmer could avoid, and how much revenue they'll bring to a farm operation.

Q. *What do you mean by avoided costs?*

I mentioned bedding. A farmer with a digester can use the solids for bedding on his own farm, saving the cost of buying bedding material -- as much as $40,000 a year for some farmers. Heat comes off the engine that burns the methane, and that heat can be captured to heat the barn and milking parlor. That saves on energy costs. Spreading the nutrients saves on the cost of buying fertilizer.

Q. *What kind of revenue are you talking about?*

We installed the anaerobic digester at Deere Ridge Dairy near Nelsonville in Portage County. Kyle Gordon, whose family owns the dairy, figures to come out ahead financially with the combination of avoided costs and the electrical sales revenue. But we only built that digester in 2001. So we go back to the issue of certainty. We just don't have enough data yet, and whatever data we get will be very specific to each particular farm.

Q. *If some farmers might not need a digester and some might be hesitant because of the uncertainties, then, who's buying digesters?*

The farmers who want to be among the leaders. The Type A personalities. Farming is going to keep changing and some farmers want to be proactive; they want to stay ahead of possible government regulations and avoid neighborhood issues regarding manure disposal.

Q. *Are these the same people who would want to put up wind turbines for their farms?*

Not necessarily. When you talk to farmers about wind turbines, they generally want to rent land to the big wind farms. [Editor's note: Farmers might receive as much as $4,000 in rent annually for every utility-sized turbine on their land.]

A farmer has a totally different mindset about a wind turbine. They're not doing it to solve a farm problem. They're doing it because they're environmentalists or for some other reason.

Continued on page 7

GHD: Farming Biopower

Continued from page 6

Q. *How do farmers find GHD? Do you advertise?*

They learn about us through word of mouth. GHD advertises in agriculture magazines and publications dealing with manure handling. GHD exhibits at various trade shows, and I speak when I'm invited.

Q. *We've covered some of the motivation and financial considerations, let's talk about the technology. Would you say it's mature, adolescent, or still in its infancy?*

I'd put it about medium. The technology itself is old. It's been around for a long, long time. We've just designed it to meet the needs of farmers, and they're more accepting than they used to be.

We've learned a lot in the last 20 years, especially about the "gen-set" -- the engine and generator. We've learned that the engine cannot contain metals that contain copper. The methane corrodes the copper. We've learned to run the engines hotter than they'd otherwise run, because the gas has moisture in it when it comes into the engine. If we keep the engine oil just under the boiling point for water, most of the water evaporates and doesn't dilute the engine oil, which is good because diluted engine oil leads to excess wear on engine parts.

We've learned to keep it simple, too. A successful system should require as little labor as possible for operation and maintenance. GHD holds patents on the heating and mixing processes, so we know we've got the process right from the start of any installation. And we can duplicate the installation at a new location and bring the farmer and his employees to the existing digesters for training. In other words, duplication of the systems adds simplicity.

We've put the total system together, and it will also adapt to new technologies. For example, we could burn the methane gas in a fuel cell to make electricity.

Q. *Okay, the farmers are interested, the technology is good. Can the government or utilities do anything to spur installation of more digesters?*

Every utility is different, of course, but by and large they're receptive. It would be a big help for utilities and state governments (or the federal government) to develop consistent rules and regulations, like some sort of national code, so that what we do in Indiana, for example, would be acceptable in Illinois and vice versa.

Also, the U.S. doesn't have an energy policy. Other than pursuing crude oil, we need some direction on where we're going to go. Germany, by comparison, greatly subsidizes anaerobic digesters for environmental reasons and for electrical production. Europe also has more people, living closer together, than the US does, so the urban encroachment on traditional agricultural land is even a bigger issue in Europe than in the US.

The Wisconsin Focus on Energy program has been very supportive on our anaerobic digester technology usage. Focus is currently working with the U.S. Environmental Protection Agency to do a detailed study of the Deere Ridge Dairy's anaerobic digester system and the total energy production from the usage of biogas generated by this system. Focus also provides statewide technology forums for public education concerning anaerobic digestion and provides financial assistance to farmers for renewable energy production and energy replacement projects.

Q. *One final "tough" question. Don't the digesters enable the development of larger and larger factory farms that wipe out family farms?*

I don't think so. The digester lets a farmer become an energy provider. It turns a waste into a viable product. Deere Ridge Dairy is a family farm and has a successful digester.

You're going to see more digesters on big and small farms because they solve a farm problem in a constructive way for all of us. ☼

Yes! I want to help RENEW promote the use of clean, renewable energy resources to diversify Wisconsin's energy resource mix.

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- Additional donation of $ _____

Your contribution is tax deductible.

Manure Produces Power

By Ed Blume

Dairy cows produce a lot of manure and a lot of milk. The milk is no problem; dairy products are always in demand. Neither is the manure for Kyle Gordon. He turns it into bedding and fertilizer, as well as electricity and heat.

On his Deer Ridge Dairy near Nelsonville in Portage County, Gordon's nearly 900 cows produce 100 tons of manure a month. Instead of going into a manure pit, the waste is routed into a heated and oxygenless structure that looks nothing like the typical holding lagoon; it's an enclosed, underground structure, with baffles, insulation, temperature sensors, and other controls. Bacteria "digest" the manure and produce methane gas, captured under an airtight cover. The methane gas runs an internal combustion engine that turns an electric generator. Like any motor, the engine gives off heat, and Gordon circulates it to maintain the digesting manure at 100 degrees, warm his milking facility, provide hot water, and heat the floors of the freestall barn.

Additionally, Gordon uses separated manure fiber as bedding and has enough left to sell to other dairies. After he cleans the bedding from the barns, he uses it for weed control in his fields. He cut his fertilizer costs because the bedding and effluents add nutrients when spread on his fields.

There are even more benefits:

- Odor and fly control. Bacteria in the digester reduce odor-causing compounds. There's a real value to avoiding a lawsuit over odor as suburbs creep farther into the countryside. The heat created by decomposition also kills fly eggs, reducing the disease-carrying pests.
- Pathogen control. Pathogens like E. coli, Salmonella, Streptococcus and Cryptosporidium can't survive the heat either. According to a recent evaluation by the US EPA, over 99 percent of these organisms were reduced.
- Avoiding global warming. Where farmers store animal manure in pits or lagoons, methane goes directly into the atmosphere. By capturing the methane, the digester system reduces its damaging effects, which are more than 20 times greater than carbon dioxide, a leading cause of global warming. According to the same EPA study, the system reduced the equivalent of over three tons of carbon dioxide per cow per year.

What Is Anaerobic Digestion?

Anaerobic digestion is the bacterial decomposition of organic matter that occurs in the absence of oxygen. Anaerobic bacteria exist naturally at the bottom of ponds, swamps and other moist and airless places, and even in the digestive tracts of termites and large animals. These bacteria are among the oldest life-forms on earth. Thousands of years ago, anaerobic decomposition of organic matter formed the earth's coal and oil deposits and created the natural gas we currently use for cooking and heating. The same process can be duplicated today with a mechanical digester that re-creates the ideal natural conditions for decomposition.

Anaerobic digestion differs from composting, which is an aerobic, or oxygen-utilizing, process. Composting organisms produce the high temperatures the process requires by consuming oxygen. Their efficiency is maintained by providing the proper mix of air and types of organic matter. Creating a thriving anaerobic climate, however, requires maintaining a consistent temperature and quality of organic matter within a sealed and airless container. The anaerobic digestion process is more chemically complex and technically demanding than the composting process is, but it requires less space. In addition, its products make more efficient use of the organic resource.

- Nutrients. Most of the organic nitrogen in the manure converts to ammonia, and the liquid effluent from the digester can be spread on fields. If the composted solids aren't used as bedding or spread, they can be sold as a soil amendment.

Digesters become cost effective on operations with at least 500 high-milk-production dairy cows, or other operations with a large number of animals, such as pigs. They're most successful where operators commit to training and spend 20 to 30 minutes a day on monitoring and maintaining the system. The Gordondale operation expects to pay for their equipment over a six year period and then make about $100 per cow per year as profit.

Still the interest is "about medium" among Wisconsin farmers, according to Steve Dvorak, who heads GHD, Inc., an engineering firm in Chilton, Wisconsin.

"Digesters aren't yet a certainty," Dvorak explains. "A digester is a capital outlay, and they don't have a long track record yet; that is, we haven't had many in operation long enough to know with certainty how much revenue they'll generate, what costs a farmer could avoid, and how much revenue they'll bring to a farm operation."

The technology isn't the issue, Dvorak added. "It's been around for a long, long time," though he and his engineers have learned a lot about digesters in the last 20 years, especially about the "gen-set"–the engine and generator.

"We've learned that the engine cannot contain metals that contain copper. The methane corrodes the copper. We've learned to run the engines hotter than they'd otherwise run, because the gas has moisture in it when it comes into the engine. If we keep the engine oil just under the boiling point for water, most of the water evaporates and doesn't dilute the engine oil, which is good because diluted engine oil leads to excess wear on engine parts."

His company also learned to keep it simple. "A successful system should require as little labor as possible for operation and maintenance."

GHD, Inc. holds patents on the heating and mixing processes, so "we know we've got the process right from the start of any installation. And we can duplicate the installation at a new location and bring the farmer and his employees to the existing digesters for training. In other words, duplication of the systems adds simplicity."

Digesters will also adapt to new technologies. For example, Dvorak believes they could burn the methane gas in a fuel cell to make electricity.

For both farmers and engineers who want to know more about digesters, help is available from Focus on Energy–Wisconsin's energy efficiency and renewable energy initiative. Those interested in learning more about Focus on Energy can visit its Web Site at www.focusonenergy.com, or call 800.762.7077. Focus on Energy staff can give you a free telephone consultation, provide brochures, fact sheets, case studies or help in applying for grants. The Focus on Energy Program may also be able to cost share on a feasibility study and offer installation grants up to 30 percent of the project cost to a limit of $80,000. You can also visit the Wisconsin Biogas Development Group Web site at www.mrec.org/anaerobic_digestion_text.html for a list of current resources on the topic of anaerobic digestion.

About the Focus on Energy Renewable Energy Program

Focus on Energy is a public-private partnership that provides energy efficiency and renewable energy information and services to the state's energy utility customers. Focus on Energy's Renewable Energy program seeks to raise awareness, provide training and financing, enhance marketing, promote technical assistance and support the installation of renewable energy technologies across Wisconsin. Focus on Energy provides applications, with full program details, at 800-762-7077 or at focusonenergy.com

Types of Digesters

For Wisconsin's climate, three types of digesters are generally suitable. The first type, a ***plug flow digester***, is a tank or long, covered trough that is filled daily with manure. Biogas collects under an expandable gas-tight cover and can be drawn off and fed to a generator. It is not advisable to use this type for swine manure, which requires mixing to keep the solids in suspension.

The second type, the ***complete-mix digester***, uses a cylindrical tank that heats and mixes the manure for more efficient biogas conversion. Dairy manure also works well in a complete-mix digester.

A third type, ***the temperature-phased digester***, combines two types of digestion technologies (mesophillic and thermophillic) into a two-stage reactor, increasing methane yields. Although it shows great potential, there is currently less field experience with this technology. System components can be made from a variety of materials including steel, plastic or concrete, and can be built either above or below ground. A typical installation will have a container or area for premixing the organic material, a digesting tank, and systems for storing or using the collected biogas and the liquid and solid effluent that are the products of digestion. If the system is designed to produce electricity, additional components will usually include a combustion engine, generator, control system, power conditioning equipment and waste heat recovery system.

Ed Blume works for Renew Wisconsin.

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BIOCYCLE energy

ANAEROBIC SYSTEMS IN WASHINGTON STATE

DIGESTERS BRING POWER AND INCOME TO WEST COAST DAIRY FARMS

IF DAIRY FARMING on the West Coast is to survive, we need to move ahead with projects like this," says Darryl Vander Haak about the new digester on his farm in Lynden, Washington just south of the U.S.-Canadian border. The state's first commercial dairy anaerobic digester which will use manure from up to 1,500 cows to produce electricity began operating this month. Two neighboring dairies will also supply the digester with manure.

Seventy percent of the $1.2 million project cost will be paid by Vander Haak, with the rest of the money coming from grants and other resources. Payback is expected within five to seven years, possibly sooner. The project won a cost-share grant from USDA's Rural Development Renewable Energy Systems Improvements Program, as well as assistance from Washington State University's Climate Friendly Farming Project. (See article in this section.) In addition, Puget Sound Energy will purchase the digester's electric output as part of the utility's "green power" program.

Looking at the economics, Craig MacConnell — Whatcom County, Washington Extension chairman — pointed out that the digester provides another income stream so a dairy farmer is not solely reliant on milk checks. Marlin Statema, president of Andgar Corporation — which is building and managing the project — explains that when drought pushed power rates up three years ago, his company started looking at methane digesters.

Payback for biogas system will be within five to seven years, while generating a revenue stream that's not solely reliant on milk checks.

HOW THE SYSTEM WORKS

According to the technical report prepared for the USDA grant application, major problems currently confronting large-scale farming operations include: government regulations on manure disposal, contaminant leaching to underground aquifers, run-off to surface waters, methane generation by livestock to atmosphere, and odor complaints.

The Vander Haak Dairy retained Andgar Corp. of Ferndale, Washington to install the proprietary digester system developed by GHD, Inc. of Chilton, Wisconsin. GHD describes the system performance as follows:

Unprocessed cow manure from the dairy will be collected in a receiving pit. The manure from the dairy barn and parlor holding area, along with the milking parlor wastewater, will be collected throughout the day in the receiving pit and pumped directly into the anaerobic digester (AD) vessel. The unprocessed manure input to the AD system is therefore uniform and has had little time for aerobic degradation. Minimization of aerobic degradation of the raw manure results in more biogas production within the AD system and less manure smell in the barn.

During the first stage in the AD concrete vessel, raw manure from the dairy will be mixed and heated to a temperature of 100°F. Reclaimed waste heat from the electrical cogeneration system will be utilized to raise the temperature of the manure to the optimum growth temperature of the methanogenic bacteria. The first stage of the AD system is designed to facilitate the growth of acid forming bacteria which break down the raw manure input stream into simpler volatile fatty acids and acetic acid. Residuals from the first stage in the AD vessel will gravity flow into the second stage in the AD vessel.

The second stage will be the largest stage, due to the slower growth rate of the methanogenic bacteria that convert the volatile fatty acids into a biogas, which consists primarily of methane and CO_2. Reclaimed waste heat from the electrical cogeneration system will also be utilized in the second stage vessel to maintain a 100°F fluid temperature to offset thermal conduction losses through the vessel structure. After the second stage of the AD system, with a designed 20-day hydraulic retention time, the treated residuals will gravity flow into an effluent collection pit where they will be further processed.

The methane biogas will be collected from the first two stages of the AD vessel and will be utilized for fuel in the combined heat and power (CHP) gensets. These gensets are commercially available, natural gas-fueled reciprocating engines modified to burn biogas. No purchased fuel will be utilized in the AD system gensets to produce electricity. Electricity produced will be sold to the electric utility and/or utilized on the farm as a substitute for currently purchased power. Power produced will be 480v, 3 phase.

Waste heat from the electrical generator will be retained and stored at as high an effluent temperature as possible. The waste heat, in the form of hot water, will be collected from both the engine jacket liquid cooling system and from the engine exhaust (air) system. Approximately 30 to 60 percent of this waste heat will be utilized in the AD system. The remaining waste heat can be utilized by the dairy as a replacement for hot water production (reducing the need for natural gas or propane purchases) and for in-floor heating of the dairy and holding areas. Using that heat is not part of this project at the Vander Haak Dairy, but can be used sometime in the future. Additionally, there is sufficient heat to conduct secondary drying of the fiber if a value added market can be established in the future.

The new digester at Vander Haak Dairy in Lynden, Washington will process manure and wastewater — facilitating growth of acid forming bacteria in the first stage and converting volatile fatty acids into biogas during the second stage for use as heat and power.

About 20 percent of the AD biosolids, rich in methanogenic bacteria, will be recycled from the end of the third digestion zone and reused at the beginning of the second digestion zone of the AD vessel as "seed" stock for the methanogenic bacteria process. The remaining 80 percent of the biosolids will be pumped from the effluent pit at the end of the AD vessel to a manure solids separator. The mechanical manure separator will separate the influent digested waste stream into solid and liquid fractions. The solids will be dewatered to approximately a 35 percent solid material. The separated solids, having the same odor and pathogen reduction characteristics as the liquid stream, will be utilized by the dairy for bedding replacement (an expense reduction). Utilization of the separated solids for bedding typically comprises about 40 to 60 percent of the generated separated solids from a typical dairy. The residual 40 to 60 percent of nonutilized separated solids will be sold (system-generated income) to other dairies for bedding purposes or eventually sold to after-markets, such as nurseries and composters, for soil amendment material once that market is developed.

Liquid from the manure separator, now with the majority of the large solids removed, will gravity flow into the dairy's storage lagoon. A large advantage of the effluent from the AD treatment process is that the viscosity of the effluent is such, as opposed to the raw manure influent, that the liquid effluent can be pumped much more easily through an irrigation nozzle for field spreading. Of even greater benefit is the fact that the absolute volume of effluent to spread is at least 15 percent less in total volume due to the digestion process and fiber separation that has occurred to this point. Spreading less volume is an expense reduction. A second large advantage of the AD treatment process is that the organic nitrogen and carbon are substantially converted to inorganic nitrogen and carbon-based material in the effluent liquid.

A report on how utility companies such as Puget Sound Energy are using biomass power in their green energy programs appears in the accompanying sidebar. — J.G. ■

GREEN POWER FROM NORTHWEST UTILITIES

AFTER the Washington state legislature passed a bill three years ago, Puget Sound Energy (PSE) and 15 other regional utilities were required to offer customers a program to invest in renewable energy. The PSE green power plan is a voluntary program that costs an additional $4/month on a subscriber's electricity bill. Under this arrangement, PSE buys energy from renewable sources such as the anaerobic digester on the Vander Haak farm described in the accompanying article.

The Bonneville Environmental Foundation (BEE) administers the PSE green power portfolio which is generated from resources such as wind, solar, geothermal, landfill gas as well as biomass energy from agricultural residues, forests and dedicated energy crops "that do not include wood pieces that have been treated with chemical preservatives." Last month, BEF announced that Puget Sound Energy had committed to an increase in its purchase of Green Tags generated from solar power projects.

"PSE's green power program is one of the region's leading environmental energy programs, providing a great way for people to personally support the benefits of renewable energy," says Rob Harmon, BEF vice president for renewable programs. Adds Mike Richardson, PSE manager: "Participation in our green power program is up more than 50 percent over last year, and customers continue to sign up at a pace of several hundred per week." The utility's green power program has more than 13,000 customers helping to generate approximately 4 million kilowatt hours every month of renewable energy for the Northwest grid. PSE is Washington state's largest energy utility.

A dairy goes on the grid

■ Blue Spruce Farm is close to making profitable electricity from manure

By Susan Harlow

Earl Audet, co-owner of Blue Spruce Farm, worked with GHD Inc., in Wisconsin, to build a digester that fits into the dairy's manure system.

Manure digesters have yet to put much money in farmers' pockets. That's about to change for one dairy.

Blue Spruce Farm in Bridport, Vt., owned by Earl, Ernie and Eugene Audet, began generating power from a new anaerobic manure digester last January. It's the first dairy to participate in Central Vermont Public Service Corporation's (CVPS) CowPower program (See sidebar).

When the Audets were asked to participate in the Vermont Methane Demonstration Project four years ago, money wasn't their first thought. "Our concern was odor," says Earl Audet. "We had a neighbor who complained, and that made us realize that it was only going to get worse and worse. We also looked at it as another source of income from our cows."

GHD Inc., a Wisconsin firm, designed the two-stage, modified mix-plug flow digester for Blue Spruce. It's designed to generate 285 kilowatt hours (kWh) of electricity per hour, or 1.5 million kWh annually.

Total cost of the digester was $1.2 million, a large chunk of money for any dairy. "The cost of the project is prohibitive, so for us, it was the help from grants and CVPS' CowPower program that made it feasible," says Marie Audet, Eugene Audet's wife. Grants from the Vermont Methane Demonstration Project, Otter Creek Natural Resources Alternative Manure Fund, Vermont Best Management Practices program, Environmental Quality Incentive Program (EQIP) and the USDA Renewable Energy Project paid about $474,000 of the cost. The Audets are covering the rest; they expect the digester to pay that back in about seven years.

The Audets sell all the electricity wholesale to CVPS, although they haven't been paid yet. There's a lag time of about six months while the New England Power Pool, which operates the region's power system, records the farm's electricity generation and then trades the green credits on the energy market.

Blue Spruce has about 1,000 mature cows and 500 heifers. The manure from the freestall barns is piped into an underground reception pit and from there into the 72- by-100-foot digester, a solid concrete tank set 14 feet into the ground and covered with concrete and foam insulation. As manure moves horizontally through the digester, heat coils warm the manure to 100 degrees F. and agitators mix the manure vertically. Four probes monitor temperatures. The manure flows through the digester for a 21-day heat retention time (HRT), after which the digested manure is pumped into an effluent pit.

From the digester, the biogas fuels a gas motor, which runs the generator to produce electricity. That power then goes onto the regional electrical grid through a three-phase power line.

Maintenance takes about five or 10 minutes three times a day, and the digester has operated with little problem. "So far we've been lucky," Earl says. "We had a 96% run time for the month of March, at 182 kWh."

Once digested, the manure is put through a screw-press separator in another room, then augured into a contiguous shed. Some of the separated manure solids are used for bedding. The system produces two to three times the amount of bedding the dairy needs, so for now the rest is sold to a neighbor for composting. Liquid effluent from the digester is pumped to a reten-

FYI

■ Contact Blue Spruce Farm at bsf@gmavt.net or call (802) 758-2179.

■ Contact GHD, Inc. at (920) 849-9160 or go to www.ghdinc.net.

■ For more information on CowPower, go to http://www.cvps.com/cowpowerfaqs.html Or call David Dunn at (802) 747-5681 or e-mail ddunn@cvps.com.

■ For information on funding digesters, go to www.manuremanagement.cornell or www.epa.gov/agstar

■ For information on the Vermont Methane Demonstration Project, contact Dan Scruton, project coordinator, Vermont Agency of Agriculture at (802) 828-3836 or e-mail dan@agr.state.vt.us

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tion pond.

The digester can take any type of biomass, but Blue Spruce is limited by how many nutrients it can apply to its fields under its concentrated animal feeding operation (CAFO) permit. The farm crops about 2,500 acres, where it spreads the liquid effluent.

"The digester hasn't changed the nutrient values at all," Earl Audet says. "We still have as many nutrients to get rid of. But it's a more plant-friendly product, too, after the digester, and we could irrigate directly on crops without burning them."

Solids for bedding

Blue Spruce used kiln-dried sawdust for bedding and although it was getting hard to find and more expensive, Eugene Audet was skeptical of manure solids. He was convinced otherwise by a trip to Wisconsin to see other GHD-designed systems.

Now about half the herd, including fresh and prefresh cows, is bedded on manure solids. Because solids are cheaper than sawdust, the Audets can bed them more heavily.

Part of the herd is in a year-long study by John Barlow of the University of Vermont Animal Science Department, who's comparing changes in somatic cell counts and bacterial counts in bedding between two groups of milking cows.

The Audets will know by this summer if they've solved the odor problem, but they think they have the answer. The only odor is when the digested manure goes into the effluent pit. Manure produces odor and biogases, including the potent methane, as microorganisms break it down. Forcing it take place within the digester during just 21 days speeds up this degradation process and keeps the odor pretty well confined to the digester.

"We hope our neighbors are happier," says Marie Audet. "We don't like the odor either, so this is a win-win for everyone "

CowPower plugs in dairies

Central Vermont Service Corporation's (CVPS) CowPower program is unique in the country because it creates a direct link between farmers who generate "green" electricity and customers who want to purchase it, says David Dunn of CVPS. The program's purpose is to promote development of renewable energy by creating a market for electricity generated from cow manure.

In 1998, Vermont passed a net metering law that helps customers who generate their own power from small-scale renewable energy systems such as solar, wind or farm-produced methane to reduce their electric bills. A meter measures both the electricity generated and electricity used. If customers generate more power than needed, they can sell the excess to the public utility at the wholesale price plus four cents per kilowatt hour (kWh). A recent update of the law allows farmers to apply their self-generated power to any meter on their farm.

The CowPower program allows Blue Spruce and, in the future, other dairies, to sell electricity commercially. CVPS customers who choose CowPower pay an extra four cents per kWh for their electricity. That adds about $20 to the monthly electric bill for a residential customer using 500 kWh per month, Dunn says. For every kWh requested by customers, CVPS pays the farmer the market price for energy plus the four-cent premium.

By mid-April, 1,465 CVPS customers had signed up for the program.

Blue Spruce is the only farm generating power for the program and since CVPS customers are buying more than twice the energy the dairy can generate, the utility is working with two other farms to help them transition into construction of methane digestors. "Our goal is to have 10 farms in the program over the next five years," Dunn says.

Meanwhile, to make up the shortfall, CVPS must purchase Renewable Energy Certificates (REC) issued by the New England Power Pool, the regional system operator, to help other generators of renewable energy in the region. If CVPS can't do that at the right volume or price, it puts the money into CVPS' renewable development fund.

Is a manure digester in your future?

If you're thinking about a digester for your manure system, you'll first need to sit down with someone who knows digesters. You, your consultant or the designer should be able to answer the following questions. The answers are critical to the type of digester you select, or if you decide to build a digester at all:

❒ What are your goals for a digester: odor reduction, energy production, bedding? Or all of the above?

❒ What kind of manure system do you have now? Do you flush or scrape? Will you separate or grind manure before it goes into the digester, or after?

❒ What type of bedding do you use? Sand does not work well in a digester, unless it is first separated from the manure. Chopped hay or straw bedding may cause crusting in a digester.

❒ How will a digester work in your climate? Frozen manure can be a problem.

❒ Where will you site the digester? How will you get utilities to it, and can manure be easily transported to the site?

❒ How much solid and liquid manure, by weight, will the digester process?

❒ How much biogas will it produce?

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How much electricity?

❒ How will you pay for it? Electricity production alone won't yield an attractive return on investment, according to Stan Weeks, an agricultural engineering consultant in Middle Grove, N.Y. Recently, net metering laws have speeded up payback time for some digesters, "but break-even time is still not attractive when compared to most business decisions regarding investments," Weeks said.

❒ What is your management style? How much time can you commit to operating and maintaining a digester? Who on the farm is going to keep it running?

❒ How much dry matter will your dairy provide for the digester?

❒ How will what you feed your cows affect its operation? For instance, adding Rumensin to rations knocked some digesters off-line at first.

❒ How much will the system reduce manure pathogens such as Johne's?

❒ How will the system ensure safety? For example, the digester system should include a flare to burn off unused biogas. But you'll have to make sure the flare works properly – if it doesn't burn off well or goes out, the excess biogas can rise, condense and guarantee odor complaints.

❒ How will it be cleaned out? Grit, indigestible material and lime can accumulate in the digester. You'll need a convenient way to clean it. Hydrogen sulfide, one of the gases produced, is fatal. Whoever is cleaning the digester and/or manure reception pit should wear a hydrogen sulfide badge to alert them to its presence, and a blower should be installed, Weeks said.

❒ Do you plan to bring in off-farm manure or other waste? If so, is your digester big enough?

"If it's just for your own manure, you can put it through a plug-flow digester and separate the solids after," says Anne Wilkie of the University of Florida's Department of Soil and Water Science. "That's the simplest and cheapest. If you want to bring in other wastewater or other wastes, then you'll have to size your reactor properly ahead of time, and you would want a complete mix digester. That gives you the option of doing other things in the future."

Adding an off-farm source of waste means more energy production, and you may be able to charge a good tipping fee for taking them, especially materials that are getting harder to handle, says Don Hilborn, by-products management specialist with the Ontario Ministry of Agriculture and Food. Livestock manure can be a stable base for those materials.

On the other hand, you'll probably have to follow more rules and do more work. You will need more land for waste application because you're adding more nutrients to the effluent. And you'll have to be prepared for impure materials.

Your goal will determine economics

The economics of a digester will depend on your objectives. Constructing a digester isn't cheap – its almost equivalent to building a new freestall, on a per-cow basis, says Curt Gooch of Cornell University's PRO-DAIRY program.

Gooch and David Ludington of DLtech Inc., Ithaca, N.Y., compared the costs and benefits of four anaerobic digester options with the following goals.

1. Reduce odor.

2. Reduce odor and generate electricity.

3. Reduce odor, generate electricity, reclaim solids for bedding and remove nutrients from the farm.

4. Reduce odor, generate electricity, reclaim solids for bedding, remove nutrients from the farm and compost manure solids.

The economic analysis of the four options was based on a 1,300-head herd, including youngstock, in New York. (See Table 1.) The limited number of anaerobic digesters in existence means that the projections are not absolute, but a good way to compare different objectives.

To make anaerobic digestion work economically, separated manure solids must be either used as bedding, thereby saving purchased bedding costs, or sold off the farm for a profitable price, Gooch says. He found the third option the most economical, as long as using raw separated solids for bedding doesn't compromise udder health and milk quality. "If it can't, then it's more of a cost than a benefit," he says. ■

Table 1. The economics of anaerobic digester systems with different objectives

	Option I	Option II	Option III	Option IV
Total capital costs	$215,100	$482,000	$615,850	$782,700
Total annual costs	30,400	68,800	94,800	129,400
Total annual revenues	0	66,000	130,000	143,600
Total annual cost or benefit	-30,400	-2,800	35,200	14,200

Source: Curt Gooch, Cornell University. Based on a feasibility study by DLtech, Inc., Ithaca, N.Y.

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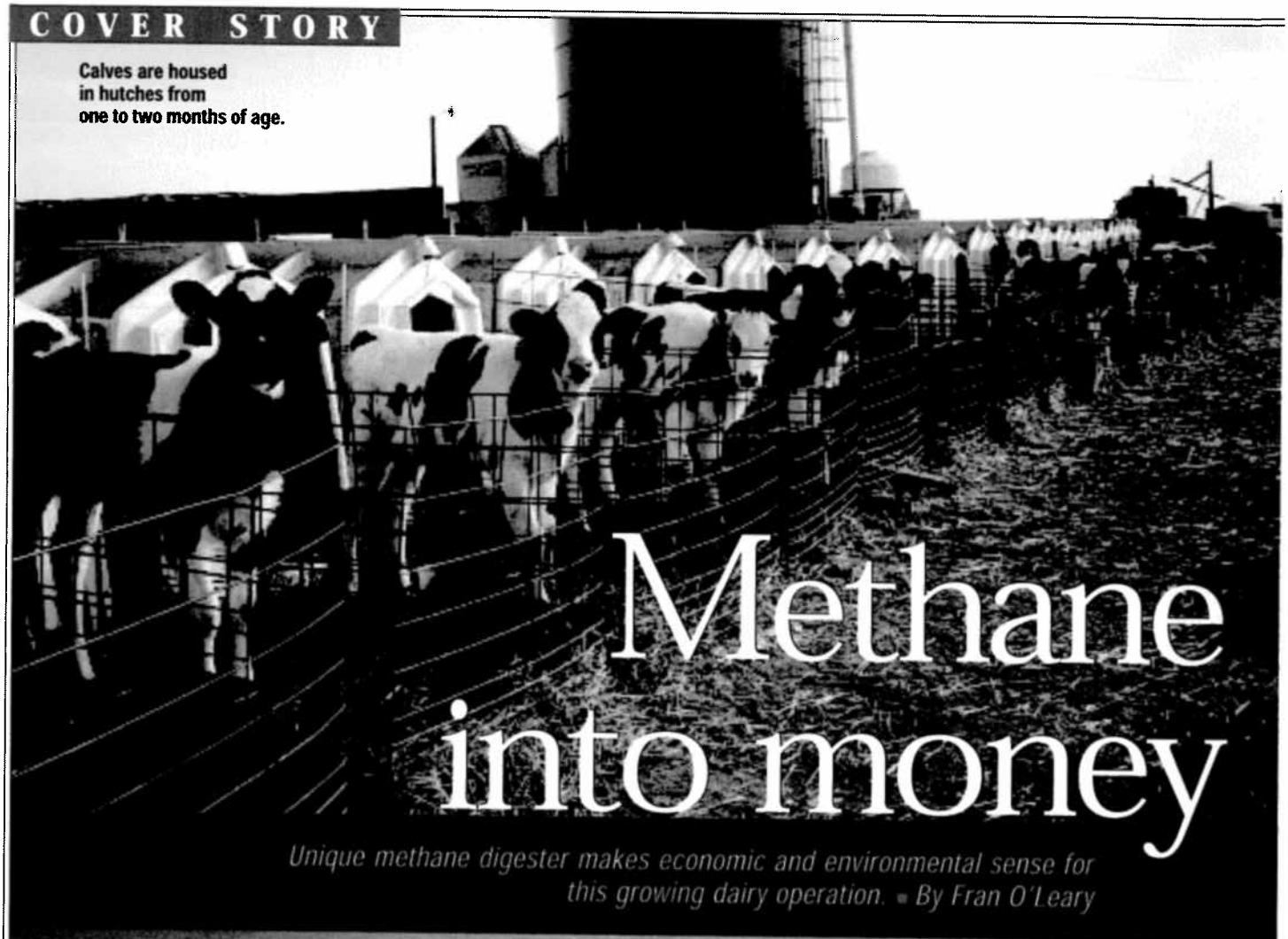
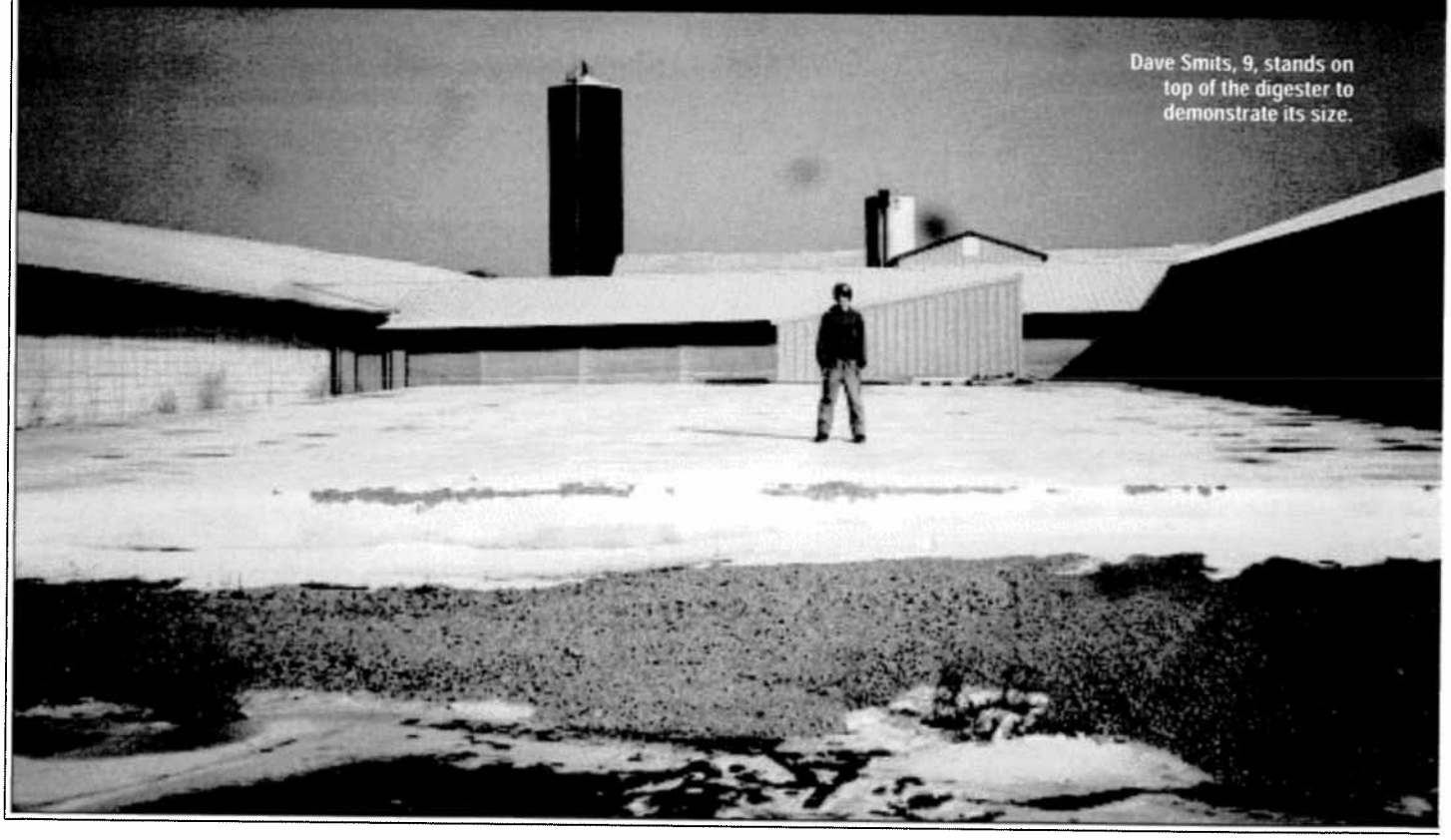
COVER STORY



Calves are housed in hutches from one to two months of age.

Methane into money

Unique methane digester makes economic and environmental sense for this growing dairy operation. ■ *By Fran O'Leary*



Dave Smits, 9, stands on top of the digester to demonstrate its size.

Markesan dairy farmers Dan and Steve Smits have learned to crawl before they walk and to walk before they run in the dairy business.

Dan started dairying in 1983 with 50 cows. By the time Steve joined his older brother in 1993 to form Double S Dairy, the brothers were off and running. That year, they built a 260-cow freestall barn and double-12 parallel milking parlor.

In 1996, they expanded their herd size and the freestall barn to handle 600 cows.

Two years ago, the Smits were looking for a way to add a transition barn.

"Our cows were calving outside on a bedding pack and we wanted them inside. We needed a hospital area," Steve explains. "Then we wondered, if we're adding more cows, should we build a parlor, too?"

In January 2002, their quest for a transition barn led them to build a new double-20 parallel milking parlor, to add a 300-cow freestall barn and a manure handling system that can be found on only a handful of Wisconsin dairy farms.

With the addition of 300 more cows, the Smits knew they needed to do something different to handle the extra manure.

CAPTURE THE POWER

After checking out their options, they decided to install a methane digester. The digester takes the power from cow manure and transforms it into electricity. Double S Dairy is one of only six dairy farms in Wisconsin with a digester.

"Selling the electricity is an environmentally sound way to capture the methane gas," explains 40-year-old Dan.

The Smits own the digester in partnership with Alliant Energy. The brothers paid for the plumbing, electrical work and construction of the digester; Alliant paid for the motor and generator.

Double S Dairy generates enough kilowatts to provide electricity for 133 homes, according to GHD, the Chilton engineering and design firm that built the Smits' digester.

Alliant pays the Smits 1.5 cents per kilowatt. "If we want to buy the generator and motor, then Alliant would pay us 6 cents a kilowatt," says Steve, 35.

One of the main reasons the Smits installed the digester was to control odors. Another was to utilize the separated solids for bedding.

"I don't think anyone will argue that sand is the best bedding for cows, but the more cows you have, the more sand you have to deal with in the manure pit," Steve says.

Dan Smits holds a handful of separated solids. The Smits use half of the product for bedding on their own farm and sell the rest to area dairy farms.

HOW IT WORKS

The digester is 14 feet in the ground and measures 106 feet long and 65 feet wide. The manure-to-methane process begins in the digester tank that acts like a mechanical stomach. It's filled with a slurry of manure and water. Bacteria in the manure turn the waste into methane while thriving in the 100-degree temperature of the tank. Since it's lighter than air, the methane rises to the top and fuels the engine that turns the generator that creates electricity.

Manure coming from the digester is separated into liquids and solids. The solids are then recycled as bedding. The Smits use 50% of the separated solids for bedding in their freestall barn. The remainder is sold to area dairy operators with freestalls.

The Smits sell and deliver the pathogenic-reduced product to area farmers for considerably less than either sand or shavings. The brothers say it's easier to handle than sand, but acknowledge there are drawbacks to using separated solids.

"When we used sand, our (somatic) cell count was in the low 100 thousands," Steve says. "Now it's in the upper 100 thousands. That's not as low as we'd like, but it's acceptable."

CONSERVING RESOURCES

The digester also allows them to reuse and recycle water.

Continued on page 14

Dan Smits, co-owner of Double S Dairy, Markesan, shows the side view of the methane digester and generator.

Continued from page 13

"Because we recycle our water, we don't use any more water than a farm that doesn't flush their alleys," Dan points out.

Hot water from cooling the digester generator engine is used to heat the floors in the parlor and holding pen. Water running through the plate cooler used to cool the milk is also recycled.

Two large tanks are located outside the parlor. One tank collects water used to cool the milk. This water is used to flush the areas where the cows enter and leave the parlor. The water is then collected from the flushing into a second tank and is used to flush the freestall barn alleys before heading into the separator.

The separator removes liquids from the manure, which are then pumped into two lagoons. Liquids from the lagoons are pumped twice a year to fertilize the fields.

"By using the digester and separator, our phosphorus levels in the lagoons have been significantly reduced," Steve says.

COW MANAGEMENT

Cows are milked three times a day. Each milking takes six hours. Herdsmen Butch Guenther and Dennis Burk handle herd health. Cows produce an average of 85 pounds of milk per cow per day.

Dry cows eat outside on the Double S Dairy in Markesan.

Milk is cooled and then pumped directly into a semi-tanker. The Smits haul their own milk to Alto Dairy Cooperative, located just three miles east of the farm.

Heifer calves are started in the old stanchion barn before being moved into hutches. At two months of age, the animals are moved off the farm and custom-raised. They return to the farm 45 days before freshening.

The Smits farm 1,400 owned and 700 rented acres, growing nearly all of the feed for their dairy herd.

Their crop program includes 1,000 acres of corn, of which 370 acres are used for silage, 600 acres of alfalfa, and 500 acres of peas, sweet corn and green beans. After the canning crops are harvested, fields are direct-seeded to alfalfa. Corn is planted in 15-inch rows. The Smits own a self-propelled chopper in partnership with Keven and Cheryl Schultz of Fox View Dairy.

All of the protein for the dairy herd is purchased.

TEAM EFFORT

The Smits have 11 full-time employees. Several family members are also involved in the farm operation. Dan's wife, Nancy, handles the bookkeeping and substitute teaches. They have four children, Danielle, 10; David, 9; Beth, 7; and Rachel, 6. Steve's wife, Heidi, takes care of the payroll. They have four daughters, Becca, 9; Breanna, 7; Lynnae, 4; and Kaytlyn, 2.

Dan and Steve's father, John, is an integral part of the farm operation. He mixes feed at the farm seven days a week. Heidi's father, Cal Flegner, retired last year and spends a good deal of time helping at the farm, too.

The Smits say they are in the dairy business for the long haul and plan to continue expanding their operation as it becomes necessary.

"We'll build the other half of the second freestall barn someday, which is another 300 cattle," Steve says. "And who knows after that." ◆

—O'Leary lives on a dairy farm near Brandon.

Separated solids from the methane digester are used as bedding at Double S Dairy and are sold to area dairies. Employee Jose Martinez dumps separated solids in free stalls.

AGRI-VIEW

April 03, 2003

Manure Digester Generates Income, Savings

By Ron Johnson - Dairy Editor

A manure digester has generated some $300,000 in extra income and cost savings for Deere Ridge Dairy.

Kyle Gordon, Nelsonville, who with his father, Gale, owns the Portage County farm, gave that analysis during last week's Wisconsin Manure Biogas Symposium at Fond du Lac.

The Gordons have 725 cows and began digesting manure to create methane and generating electricity 14 months ago.

The obvious income source is the sale of electricity. Alliant Energy owns the methane-powered generator and switching equipment and pays the Gordons approximately $1,500 per month for the power produced.

Savings: mattresses, sand

After the herd's manure has been digested, the Gordons separate the solids and use them for bedding. Thanks to this bedding source, Gordon estimated that the farm no longer has to buy cow mattresses, for about $100 each.

Plus, the farm no longer spends $60,000 per year on sand for bedding. What's more, the Gordons have been selling 50 tons of digested, dried manure each month.

Less propane, herbicide used

Another cost saving shows up on the propane bill. Since waste heat from the generator goes into the dairy facility, it's "rare" to spend more than $400 a month on propane, Gordon said.

Since anaerobic digestion kills weed seeds, the Gordons spent less money on herbicides

last year. And they're buying less lime and fertilizer.

Good fly, odor control

Gordon also pointed out that he did not sign a contract with a pest control company last year, due to fly eggs in the manure being killed during the digestion process.

Then there's the matter of odor. Anaerobic digestion leaves the resulting liquid and solid portions of manure virtually odor free. Gordon admitted that it's tough to pin a firm value on odor control, but he said he penciled in $6,000.

He noted that the farm also has a 300-sow barn that's been operating a number of years. The barn, he quipped, "has given us extensive experience with odor and odor production."

Digester appraised as 'pit'

Gordon touched on some of the frustrations associated with new and emerging technologies. He explained that the manure digestion system cost the farm $650,000. He would like to get a loan to buy the generator from the power company. That way he could sell the electricity for 6 cents per kilowatt, more than the farm receives under the present arrangement.

Trouble is, the manure digester has been appraised as a "manure pit" and is valued at just $200,000 instead of its $650,000 cost. His lender, Gordon said, will let him borrow only 65 percent of the digester's appraised value. That works out to $130,000, versus $422,500 of the system was appraised at its actual cost.

Figure $650 per cow

Construction costs have climbed since Deere Ridge Dairy built its digestion system, Gordon warned. But he told the audience to figure on spending "at least" $650 per cow.

It's been taking the manure from 5.25 to 5.5 cows to generate one kilowatt of electricity, he estimated. That can change, depending on the ration. When the farm changed the ration so it was let "hot" and less expensive, the methane gas produced less electricity.

"Don't expect to pay for the project just with electricity sales," Gordon advised other farmers who might be considering manure digestion and methane production. He suggested they think about all the angles associated with such a project. For example, Gordon is pondering the possibilities of eventually producing hydrogen.

Expect some problems

And don't expect things to go perfectly smoothly. He noted that they started their digester in January of 2002 - a tough time of year to start heating a large amount of

manure and liquid to the requisite 101 degrees Fahrenheit.

"You've got to have someone who is a really good plumber," he added. These kinds of systems are laced with pipes, valves and gauges.

He revealed his attitude toward solving the problems linked to manure digestion when he said, "There are three problems - those you've had, those you're having, and those you'll have."

Gordon pleased with system

Overall, though, he said, "We've been really happy with it."

What's more, Gordon asserted that manure digestion will one day play a large role in the future of agriculture. "I believe it to be the critical link," he stated, "between production agriculture and sustainable agriculture."