

**Draft**

**Feasibility Study of Anaerobic Digestion Options for Perry, NY**

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### **History**

The Town of Perry, located in Wyoming County, has a population of 5,353 (1990 Census). Wyoming County is the largest milk-producing county in New York State and the twentieth largest producer in the country. It is not surprising that there are more cows than there are residents in Wyoming County, thus making dairy farming the number one industry countywide. Therefore it is important for the Town to identify a solution to the waste management problem faced by dairy farmers and residents. Finding a solution to waste management is critical in order to keep agriculture in the Town.

**The goal of this feasibility study is to examine the potential to use anaerobic digesters in a collaborative system to improve manure management in an environmentally and economically efficient method.** Anaerobic digestion provides a way to decrease manure odor, reduce solid contents to improve the potential to apply manure to the fields using irrigation and provide investment recovery from the sale of heat and electricity. This study focused on the feasibility of using one or more digesters, centrally located in close proximity to four larger dairy farms in the Town. All of these farms are subject to CAFO regulations.

Perry, along with four of the large dairy farms in the Town, and several agencies constituted the *Perry Waste Management Committee*, which guided the development of this study. This project demonstrates how a community takes ownership of a problem and seeks to study alternatives in order to find optimal solutions for all parties.

Objectives of the feasibility study included developing information and analysis that will:

- (a) Increase the availability of information about the use of digesters, which describes for farmers the operational costs and environmental benefits of developing a collaborative approach to the problem;
- (b) Outline a plan for implementing feasible collaborative options for using anaerobic digestion to bring long term energy, environmental, and economic benefits to the farmers and residents of Perry, NY.

### **Key objectives for the feasibility study results:**

Minimize odor problems that result from current manure management practices;

Reduce the potential for negative impacts on the environment from existing practices by providing feasible alternatives to farmers;

Increase the use of byproducts resulting from the breakdown of manure; and,

Increase the number of industries in Perry by providing local sources of energy and byproducts generated from manure digestion.

**To accomplish the project goal and objectives, the Town of Perry has completed the following tasks:**

### **Task 1. Project Management**

- A. *Perry Waste Management Committee* was established which included the four farms; Emmerlings, Trues, Butlers and Dueppengiessers; representatives from the county NRCS, SWCD, Cornell Cooperative Extension of Wyoming County, Perry Development Corporation, Wyoming County Bank, Town of Castile, Agricultural Consulting Service, and Western New York Crop Management Association. The committee held monthly meetings to oversee and direct the actions of the program
- B. The Town of Perry hired several different firms and individual to carry out the work of this project including: Optimum Utility Systems, Agricultural Consulting Service, AnAerobics, Microgy, Diane Chamberlain, Cornell Waste Management Institute, and Cornell Cooperative Extension of Wyoming County. The contractor also worked with Peter Wright of Cornell Cooperative Extension to accomplish the technical project management.

## **Task 2. Project Reporting and Information Transfer**

- A. A number of avenues have been used to distribute information developed during the project. First, a presentation was made at the NYSERDA conference held in Syracuse in November of 2000.
- B. Second, a presentation was made at a public meeting held for dairy producers in Jefferson County during the month of January 2001. Third, a public meeting was held in April in the Town of Perry for all interested farms and residents. Fourth, a program describing the project was aired over radio station WCJW in Warsaw on March 26<sup>th</sup>, 2000
- C. The Cornell Cooperative Extension of Wyoming County is producing two articles suitable for the general target audience for the agricultural press such as *Northeast Dairy Business* and *American Agriculturist* on the systems studied.
- D. The Cornell Cooperative Extension of Wyoming County is preparing three fact sheets to cover each of the three best collaborative systems evaluated suitable for dissemination to the general target audience through the Cornell Cooperative Extension, the World Wide Web (WWW) and other outlets. These fact sheets describe the costs, size and location of the digesters, and other benefits of the system.

## **Key Questions of the project proposal:**

What is the size of the digester relative to the size of the farm(s), based on the number of animals confined?

What is the optimum site of the digester, based on proximity to farms, residential areas, industry and environmental areas of concern?

How to transport manure relative to costs and potential environmental hazards (spills) associated with manure transport?

Based on transportation costs, is it best to have one small digester on each farm, or are they capable of sharing one large digester?

How much of each by-product (e.g. digested solids, composted solids, and higher nutrient liquids) will be created and available for sale?

What market exists for the sale of the by-products, or will the by-products be used entirely by farmers?

If no market exists for the sale of the by-products, can a market be created to infuse economic vitality (i.e. through the development of an industrial park adjacent to the site of the digester)?

If farmers will be using the by-products, what is their net investment for the digester based on the cost-savings from the use of the by-products?

This study was also to address the specific provisions listed below and to assess problems that come up during the study and adds other potential opportunities.

1. Identification of proposed facility sites
2. A flow diagram showing the significant facility processes
3. Anticipated material flows through the system by volume and weight, including planned disposition of all products and effluents
4. Identification of significant pieces of facility equipment
5. Identification of transport methods and requirements, including consideration of transport by truck and pipeline
6. Identification of a range of potential businesses that could use the energy and material products of the digestion systems being evaluated
7. Assumptions and design criteria for product/output quantity and quality
  - a. methane content of gas produced
  - b. for any electricity output - kW capacity - kWh production - kWh used on site
  - c. for any hot water produced - the Btu's produced and used on site
  - d. total volatile solids of output vs. input
  - e. nutrient value of liquid and solids outputs vs. input (Total - N, NH<sub>4</sub>-N, P, K) In defining the design criteria for liquid nutrient value, options will be researched and evaluated for concentrating the nutrients or otherwise processing or treating the liquid output to enhance its value.
  - f. total solids or moisture content
  - g. bacteria/pathogen content considering organisms such as fecal coliform counts, e.coli, salmonella, Johnes, cryptosporidium, giardia
8. Explanation of financing, business, and regulatory arrangements for:
  - a. identification of owners and operators of the systems being evaluated including consideration of roles by municipal, for-profit and non-profit organizations
  - b. financing of participants cost shares
  - c. agreements with any other participating farmers for transportation of manure feedstock and distribution of digestion products
  - d. compliance with CAFO and any other regulatory requirements
  - e. agreements with utilities for electricity sales and purchases
  - f. marketing other process outputs
  - g.

### **The four participating farms**

#### **Emerling Farm**

The Emerling Farm is located one-half mile south of Perry Center on Route 246. The heifer facility is in the original farm buildings on the west side of the road and the milking facility and dairy housing is on the east side of route 246. The farm is a family operation and is currently milking 680 cows. The heifer facility houses 415 with 150 under the age of 6 months.

The cows in the free stall barns are bedded with 10 cubic yards of sawdust a day. The manure is scraped to a concrete trench in the center of the barns with a skid steer loader. The manure then flows by gravity

to a collection tank where it is pumped to the lagoon. An expansion of the farm is planned to accommodate approximately 1000 cows and 600 heifers. Sand is being considered as alternative bedding.

The Emerling Farm is planning to expand the dairy to 1000 cows and move the heifers from the west side of the road to the east side to concentrate all the liquid manure to one location. The calves between the ages of 0 to 4 months will remain on the west side in a remodeled barn. After the expansion the waste production on the east side of the road would be 25,000 gallons of waste per day or 4.5 million gallons in six months. Adding 2 million gallons of rainwater the proposed storage (planned to be built in June 2001) will have a capacity for 8 months.

The 10-ft deep manure storage facility, located immediately behind and east of the free stall barns, currently has the capacity for 2.5 million gallons (approximately four months). The Emerlings plan on enlarging the existing storage, increasing the depth to 12 to 14 feet deep and increasing the capacity to 8.5 million gallons. The manure storage is designed to collect the concentrated silage leachate runoff from the bunk silo. The new storage would provide eight months capacity for contaminated runoff, animal waste, milking parlor waste and bedding for 1000 dairy animals and 600 heifers over the age of six months. The eight-month capacity includes 2 million gallons of rainwater.

The manure is spread according to a nutrient management plan on 530 acres of cropland and 450 acres of hay land.

The 680 dairy animals on the east side of the road generate 16,700 gallons of manure per day. This would produce 55,000 cubic of gas per day and 88 kilowatts of power. Power usage was not explored due to the changes in operation that is taking place on the farm.

The Emerlings are concerned with the amount of odors generated by the manure and would like to be able to spread manure on fields that are close to residences. They are very much interested in constructing a digester on their farm.

### **True Farm**

The True Farm is located 0.7 miles south of Perry Center on Route 246. This is a family farm and is currently milking 750 cows and has an additional 300 heifers and 190 calves less than 6 months old.

The cows in the free stall barns are bedded with 10 cubic yards of sawdust a day. The manure is scraped to a concrete trench in the center of the barns with automatic alley scrapers. The manure then flows by gravity to a collection tank where it is mixed with milking parlor waste and pumped to the lagoon. The heifers are bedded with straw and 8000 pounds of paper per week. This manure is currently spread with a box spreader, but could go into a digester.

The manure storage is 1600 feet from the nearest road and holds 5.3 million gallons of rainfall, milking parlor waste and animal waste. Concentrated silage leachate could be directed into the storage after a collection system is implemented. The storage has capacity for 210 days. Manure is spread according to a nutrient management plan on 810 acres of cropland and 310 acres of pasture.

The 750 dairy animals and 300 heifers generate 19,500 gallons of manure per day. This would produce 77,500 cubic feet of gas per day and 124 kilowatts of power.

### **Sunny Knoll Farm**

Sunny Knoll Farm is located 2 miles north of Perry Center on Burk Hill Road. This is a family farm and is currently milking 860 cows and has an additional 725 heifers and 310 calves less than 6 months old.

The cows in the free stall barns are bedded with 15 cubic yards of sawdust a day. The manure is scraped to a concrete trench in the center of the barns with skid steer loader. The manure then flows by gravity to a collection tank where it is mixed with milking parlor waste and piped to the lagoon. The heifers are bedded with 8 cubic yards of sawdust per day. Calf manure is currently spread with a box spreader.

The manure storage is 400 feet from Burke Hill Road and holds 6.5 million gallons of rainfall, milking parlor waste and animal waste. Concentrated silage leachate could be directed into the storage after a collection system is implemented. The storage has capacity for 6 months. Manure is spread according to a nutrient management plan on 670 acres of cropland and 470 acres of hay land.

The 860 dairy animals and 725 heifers generate 28,700 gallons of manure per day. This would produce 110,000 cubic feet of gas per day and 177 kilowatts of power.

Sunny Knoll Farm is considering a digester to reduce odors.

### **Dueppengiesser Dairy**

The Dueppengiesser Dairy is a family farm located on Butler Road 2 miles north of Perry Center. The heifer facility is in the original farm buildings on the north side of the road and the milking facility and dairy housing is on the south side of Butler Road. The farm is a family operation and is currently milking 1000 cows. The heifer facility houses 220 with 460 under the age of 6 months.

The cows in the free stall barns are bedded with 50 cubic yards of sawdust a day. The manure is scraped to a concrete trench in the center of the barns with alley scrapers. The manure then flows by gravity to a collection tank where it is piped to the lagoon.

Two 11 ft deep manure storage facilities are located immediately behind the freestall barns. The storages have capacity for six months of manure, wastewater and concentrated silage leachate. The six-month capacity includes 2 million gallons of rainwater.

The manure is spread according to a nutrient management plan on 550 acres of cropland and 550 acres of hay land.

The 1000 dairy animals on the east side of the road generate 25,500 gallons of manure per day. This would produce 81000 cubic of gas per day and 130 kilowatts of power.

The Dueppengiesser's are concerned with the amount of odors generated by the manure and would like to be able to spread manure on fields that are close to residences.

### **Ideas for collaboration:**

Throughout the study period, the Perry Waste Management Committee suggested many ideas for consideration as possible collaborations between farms associated with manure digestion. These focused around three primary methods of digester siting. These were, one digester shared by all four farms, a digester shared by two nearby farms, specifically one shared by Trues and Emerlings and one shared by Butlers and Duepenguieser, a digester sited on each farm and a digester sited on each farm

but that digester owned and operated by a firm other than that farm. The following out line formats the collaborative ideas for consideration connected with of the above scenarios.

### **Collaborative Opportunities**

- A. One digester shared by all four farms
- B. One digester shared by two nearby farms
- C. One digester on each farm with collaboration in other ways
- D. Collaborate to recruit an independent business development to provide digestion service for farms

### **Farm Energy Use and Needs**

In order to determine the most effective way to collaborate on digester siting, equipment sizing and collaboration the Perry Waste Management Committee determined that how, when and how much energy the farms were using needed to be evaluated. To better understand the energy uses and needs on these farms, complete energy audits were conducted on the Dueppengiesser and True farms. Diane Chamberlain conducted these audits. She was with the Cornell Farm Energy Audit Program for several years during its active time at Cornell University. She is presently on staff with the regional Farm Bureau Office in Batavia. The audit results along with electric billing information from each of the farms was provided to each of the consulting engineers in this project. Darrell Mears with Optimum Utility Systems used the information in his analysis of bio-gas use alternatives and provided an excellent summary of these energy audits plus, based on this audit and energy information, developed a hypothetical farm scenario to represent what would be happening on an average farm of about 1000 cows (See chapter 4 of Biogas Applications for Large Dairy Operations: Alternatives to Conventional Engine-Generators).

### **Example Dairy No. 1 (The Ransom-Rail Farm)**

This dairy is the Dueppengiesser farm (Ransom-Rail Farm, Inc.) near Perry in Wyoming County, NY. The dairy operation increased from 600 to 800 milking cows during year 2000 and had no anaerobic digester.

#### Natural Gas Consumption

The farm is unusual in that heating tasks such as service water heating and building heating are currently performed using natural gas from on-site wells. Unfortunately there is no natural gas metering, so there is no consumption data available. Data is always preferable, however the natural gas consumption can be estimated during an engineering feasibility study.

#### Electricity Consumption

Although the electric rate has time-of-use and demand components, the total annual electric cost of \$34,900 and the total consumption of 321,000 kWh yields an average rate of \$0.109/kWh or 10.9 cents/kWh. This is relatively high and is encouraging in regard to an engine-generator application. For perspective, the average commercial electricity price in the continental U.S. in year 2000 was between 7 and 8 cents/kWh.

Demand charges were typically around \$11.70/kW monthly. This is also relatively high and is also encouraging in regard to an engine-generator application. Demand peaked at 98 kW in late July or early August, and at that time the demand charge alone accounted for over 25 percent of the electric bill.

The electric cost breakdown by application is shown in Figure 4-1. Milk precooling is the single highest cost. Note that milk precooling is a potential thermal energy application (e.g., it can be done with an absorption chiller using hot water or waste heat from an engine-generator). Eliminating electric costs for milk precooling would reduce the annual electric bill to around \$25,000.

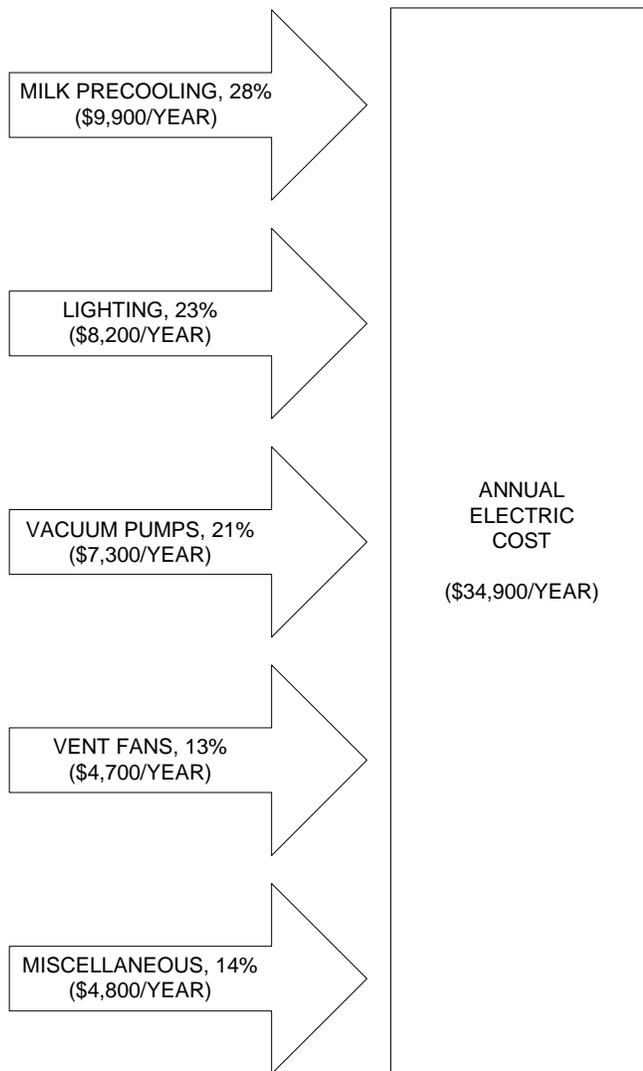


Figure 4-1. Annual electric costs for Example Dairy No. 1.

### Biogas Potential

Using the Lusk estimating assumptions<sup>41</sup> and assuming 700 milking cows, daily biogas production with an anaerobic digester would have averaged approximately 50,000 ft<sup>3</sup>/day and this would have been

sufficient to fuel a 94 kW engine-generator. This is encouraging because it nearly satisfies the peak demand of the dairy: the dairy would be electrically self-sufficient for most of the year and there would almost always be excess electricity for sale to the utility.

Month	Electric On-Peak Demand (kW)
January	47
February	56
March	48
April	72
May	65
June	84
July	98 (annual peak)
August	88
September	83
October	54
November	44
December	39

On this dairy operation, the year 2000 peak for billing demand was 98 kW in July. Examination of the table reveals that the billing demand was substantially lower for most of the year. What the table does not show is that the 98 kW peak may also be an anomaly during the month in which it occurred: it is the highest peak (during the “on-peak” rate periods) for all of the 15-minute intervals during that month. It could be an isolated load spike. For electric self-sufficiency, an on-site generation system would have to satisfy that peak.

### **Example Dairy No. 2 (The True Farm)**

This dairy is the True farm near Perry in Wyoming County, NY. The dairy operation has 750 milking cows and 650 heifers for a manure-collection equivalent of about 900 milking cows. [Manure collection from one heifer is about one fourth that from a milking cow.] There is no anaerobic digester.

#### Natural Gas Consumption

Heating for the barn space heat, residence heat, and all hot water is provided with natural gas. Year 2000 natural gas consumption was 4,452 therms at a cost of \$3,883, yielding an average rate of \$0.85/therm or \$8.50/million Btu. [One therm equals 100,000 Btu.]

The energy audit established that total barn hot water use requires about 1,330 therms per year, or about 30 percent of the natural gas use. This is 133 million Btu/year for an average of about 15,200 Btu/hour for barn water heating.

#### Electricity Consumption

Alas, Example Dairy No. 1 cannot provide good natural gas consumption data and Example Dairy No. 2 cannot provide good electricity consumption data. Less than a half year of year 2000 electric bills were available for the energy auditor. An engineering feasibility study will require obtaining the details of consumption from the utility, New York State Electric & Gas (NYSEG).

A comparison of the Example Dairy No. 1 peak summer bill to the Example Dairy No. 2 bill for approximately the same period is as follows:

	<b>Billing Demand (kW)</b>	<b>Energy (kWh)</b>	<b>Total Cost</b>
<b>Example Dairy No. 1</b>	98	39,200	\$4,357
<b>Example Dairy No. 2</b>	101	49,920	\$5,199

For illustrative purposes, this study will assume the following for Example Dairy No. 2:

- The annual peak demand is approximately 101 kW.
- Annual electrical energy use and cost are 25 percent higher than for Example Dairy No. 1. That yields annual electrical energy use of approximately 400,000 kWh and annual electric cost of approximately \$44,000.

Since these two dairy operations are in the same county (and thus experience the same climate) and are on the same utility and rate structure, this is a reasonable approximation for illustrating a few basic principles.

The electric rate for this dairy is the same as for Example Dairy No. 1 and has time-of-use and demand components. The average rate is probably very close – about 10.9 cents/kWh. This is relatively high and is encouraging in regard to an engine-generator application. For perspective, the average commercial electricity price in the continental U.S. in year 2000 was between 7 and 8 cents/kWh.

Demand charges were typically around \$11.70/kW monthly. This is also relatively high and is also encouraging in regard to an engine-generator application.

### Biogas Potential

Using the Lusk estimating assumptions<sup>41</sup> and assuming manure collection equivalent to 900 milking cows, daily biogas production with an anaerobic digester would have averaged approximately 67,500 ft<sup>3</sup>/day and this would have been sufficient to fuel a 121 kW engine-generator. This is encouraging because it more than satisfies the peak demand of the dairy: the dairy would be electrically self-sufficient and there would always be excess electricity for sale to the utility.

Thermally, at 538 Btu/ft<sup>3</sup> for dairy biogas, this level of biogas production averages 36.3 million Btu/day. That's 1.5 million Btu/hour or 15 therms/hour or 131,400 therms/year. On an annual basis in New York State, roughly 33 percent of the biogas is required for digester temperature maintenance. Thus about 88,000 therms/year are available and that dwarfs the year 2000 natural gas consumption of 4,452 therms. Adding 10 tonR of milk precooling with a hot water boiler and an absorption chiller as in Example Dairy No. 1 would increase thermal energy consumption by an additional (60 therms/day x 365 days/year = ) 21,900 therms/year. At most then, on-site thermal applications could use about 30 percent of the available biogas energy.

This example illustrates that there is almost no escaping installation of an engine-generator for a large dairy operation unless there is a secondary or neighboring business that can use the excess thermal energy or unless the dairy operator is willing to downsize the digester or waste biogas.

A key figure resulting from these energy audits and subsequent analysis is that these Perry farms are paying an average of about 11 cents per kilowatt for electricity. This will be important in the calculations for payback on any digestions and generation system placed in service.

## Projected Digester Systems Costs

Dana Chapman, engineer with Agricultural Consulting Service of Rochester NY was retained to provide the project with projections of digester and co-generation system construction and operation costs and payback potential. It was determined by the Perry Waste Management Committee that, since each of the four farms in the study were of similar size and since all of the farms project future expansion, one digester able to digest manure for approximately 1200 cows should be used in the study. This was preferred to sizing and designing each digester for the immediate exact size of each farm. The Committee also agreed that the figures should be based on proven technologies rather than those that have no track record of success. Therefore new technologies referred to in the Mears report such as micro-turbines, fuel cells, and sterling engines will not be in the analysis here. Yet, a farm in the process of planning should consider these options if supply is available and technical support available.

Farm	Dairy	Heifers	Daily Manure Production (gallons)	Daily Gas Production (cubic feet)	Daily Power Generation (Kilowatts)	Separated Solids Production (cubic Yards)
Sunny Knoll	860	725	28,700	110,000	177	28
Dueppengiesser	1,000	220	25,500	81,000	130	25
Sub Total	1,860	945	54,200	191,000	307	54
True	750	300	19,500	77,500	124	19
Emerling	680	0	16,700	55,000	88	17
Sub Total	1,430	300	36,200	132,500	212	36
TOTAL	3,290	1,245	90,400	323,500	519	90



	----- -----Single System----- ----- -----				----- Double System-- -----			----- Quadruple System-- -----		
Budget Category	Quantity	Units	Unit Cost	Total Cost	Quantity	Unit Cost	Total Cost	Quantity	Unit Cost	Total Cost
Excavation	3,170	c.y.	2.00	\$6,340	6,341	1.80	\$11,414	12,681	1.70	\$21,558
Stone	166	c.y.	5.00	\$830	331	4.80	\$1,589	663	4.75	\$3,149
Tile	576	l.f.	1.00	\$576	1152	1.00	\$1,152	2304	1.00	\$2,304
2" Floor Insulation	11,796	sq-ft-in	0.35	\$4,129	23,592	0.35	\$8,257	47,184	0.35	\$16,514
3" Wall Insulation	23,461	sq-ft-in	0.35	\$8,211	46,922	0.35	\$16,423	93,844	0.35	\$32,845
4" Top Insulation	21,750	sq-ft-in	0.35	\$7,613	43,500	0.35	\$15,225	87,000	0.35	\$30,450
5" Concrete Floor	114	c.y.	150.00	\$17,100	228	145.00	\$33,060	456	140.00	\$63,840
12" Concrete Walls	300	c.y.	200.00	\$60,000	600	190.00	\$114,000	1200	190.00	\$228,000
12" Precast Top	5,760	s.f.	5.50	\$34,560	11,520	5.25	\$60,480	23,040	5.15	\$118,656
4" Concrete Topping	72	c.y.	150.00	\$10,800	144	145.00	\$20,880	288	140.00	\$40,320
Top Gas Seal	6,739	s.f.	1.50	\$13,478	13,479	1.50	\$20,219	26,957	1.50	\$40,436
Primary Heat Exchanger	1	each	15,070.00	\$15,070	1	25,000.00	\$25,000	2	23,000.00	\$46,000
Hi-Temp Secondary Exchanger	1	each	3,850.00	\$3,850	1	5,100.00	\$5,100	2	5,000.00	\$10,000
32'x32' Cogen Building	1,024	s.f.	20.00	\$20,480	1,024	20.00	\$20,480	1,024	20.00	\$20,480
32'x32 Solids-Separator Bldg.	1,024	s.f.	20.00	\$20,480	1,024	20.00	\$20,480	1,024	20.00	\$20,480
85-kW Cogen Unit with controls	1	each	157,000.00	\$157,000	1	157,000.00	\$157,000	1	157,000.00	\$157,000
KP-10 Solids Separator	1	each	30,000.00	\$30,000	1	30,000.00	\$30,000	2	30,000.00	\$60,000
Solids Separator Pump	1	each	10,000.00	\$10,000	1	10,000.00	\$10,000	2	10,000.00	\$20,000
Boiler					1	10,000.00	\$10,000	2	10,000.00	\$20,000
Electrical Work	1	lump	16,000.00	\$16,000	1	18,000.00	\$18,000	1	25,000.00	\$25,000
Plumbing Work	1	lump	20,000.00	\$20,000	1	30,000.00	\$30,000	1	60,000.00	\$60,000
Design-Build-Startup Services	1	lump	110,000.00	\$110,000	1	130,000.00	\$130,000	1	150,000.00	\$150,000
Total Preliminary Cost Estimate				\$566,517			\$758,758			\$1,187,032

Annual Incremental Benefit	Base Assumptions	Baseline Single Digester with a \$110k Design-Build Cost. One generator.	Four Individual Digesters at \$115k (rather than 4x\$110k for Design-Build. Four generators	Two Double Digesters with a \$130k Design-Build Cost. Two generators.	One Quad. Digester with a \$150k Design-Build Cost. One generator.
Maintenance Sinking Fund	\$0.02/kWh, 65 kW ave. Load, 8400 hr/yr	(\$10,920)	(\$43,680)	(\$21,840)	(\$10,920)
Transport Costs	Ave. Between B&D and T&E for double, more for quadruple			(\$20,000)	(\$120,000)
Electric Cost Savings	65 kW ave load @ 0.085/kWh, 8400 hr/yr	\$46,410	\$185,640	\$92,820	\$46,410
Heating-Fuel Cost Savings	\$8/dT, 0.1 dT/hr load, 8000 hr/yr + 0.4 dT/hr, 3k hr/yr	\$16,000	\$64,000	\$32,000	\$16,000
Other Gas-Use Benefits	Residential or greenhouse heating, soy processing, etc.				
Bedding Cost Savings	Avoided cost of sawdust, sand, newspaper or other material	\$40,000	\$160,000	\$160,000	\$160,000
Bedding Sales Potential	Depends on market development				
Assigned Odor-Reduction Value	Depends on individual neighborhood tolerance				
Assigned W. Poll. Abate. Value	Depends on site conditions and regulatory pressure				
Assigned Fly-Reduction Value	Depends on severity of existing populations and options				
Carbon Credits					
Total Annual Benefits		\$91,490	\$365,960	\$242,980	\$91,490
Number of Systems		1	4	2	1
Cost of Each System		\$566,516	\$494,016	\$758,758	\$1,187,032
Total Capital Cost		\$566,516	\$1,976,064	\$1,517,516	\$1,187,032
Simple Payback in Years		6.2	5.4	6.2	13.0

## **Transportation of Manure**

In discussion with the four producers, it was obvious that there was a reluctance to move manure twice and if it could not be directly spread on the land the manure would have to be moved three times. Moving manure to other farms is further complicated by the recent concern with bio security and commingling the manure from farm to farm.

Costs to truck manure from farm to farm would easily offset the benefits of digesting manure. *Evaluation of Anaerobic Digestion Options for Groups of Dairy Farms in Upstate New York* has an entire chapter devoted to transportation costs of moving manure to a common digester<sup>1</sup>. The computed costs range from \$83.00 per cow to \$134.00. The costs seem high until compared to the commercial rate of \$0.01 per gallon to transport manure to fields for land spreading. Transporting and spreading manure for one cow would cost \$290.00 annually. Transporting manure to supply a digester designed for twelve hundred animals at the rate of \$100 per cow would cost \$120,000 per year.

Pumping manure between Sunny Knoll and Dueppengiesser Dairy and between True and Emerling Dairy is feasible. A pipeline connecting all four farms is not feasible due to the many road crossings, additional pumping stations to keep the fifteen percent solid manure flowing and high operation and maintenance costs.

The capital cost to construct a pipeline connecting the two farms would include; a pump reception and temporary storage to hold a week of manure (\$15,000), a minimum of a six inch line buried below frost depth between the two farms (\$45,000) and a electric manure pump (\$15,000). The total cost of \$75,000 amortized at 7% over six years would equal \$15,700 per year. Adding the annual operation and maintenance cost of \$4000 per year would result in an annual cost of \$20,000 to pump the manure between the farms.

In light of these calculations it would appear that single digesters on each farm or a digester shared between two farms might be feasible economically. The economic success of one digester shared by all four farms is the least feasible and will not be given further considerations in this study other that to see the views of the farmers expressed in the survey. Even prior to the economic results, the issue of trucking manure to a remote site then having to transport digested manure back to the farm then to the field meet with resistance from the farmers in the study. They felt that this would greatly increase their exposure to the liability of having manure trucks on the road and neighborhood resistance and condemnation.

## **Ownership and Transportation of Manure Survey**

As part of the study the Perry Waste Management Committee determined that the four farmers in the study as well as other farmers in the Perry area should be surveyed about their opinions about digester ownership, collaboration, and manure transportation. Sixteen surveys were returned with the following results.

1. If there were no difference in the cost to our farm to have access to a digester I would prefer to:
  - a. Own and manage our own digester here at the farm
  - b. Share ownership and management with another farm
  - c. Have someone else own and manage a digester where I would take manure

*Choices A and C were the most picked with choice B being very unpopular.*

2. If we were to be part of a collaborative digester project I would prefer to:
  - a. Have one farm own and management and the rest pay for manure processing
  - b. Own and manage the digester as a partnership

- c. Have the digester set up as its own corporation held equally by the involved farm's own management
- d. Have a corporation totally independent of and not owned by the farms own and manage the digester

*Choices C and D were about equal in response while choice B received only two votes and choice A received none*

3. How much would your farm be willing to invest in a collaborative digester project if it was strictly a break even situation?
- a. Nothing, this seems too risky
  - b. \$50,000 to \$100,000
  - c. \$100,00 to \$200,000
  - d. more than \$200,000

*The responses to this question show that the respondents would either invest nothing or little if the project was break-even*

4. How much would your farm be willing to invest in a collaborative digester project if it cost the farm \$10,000 to \$20,000 in additional expenses each year?
- e. Nothing, this seems too risky
  - f. \$50,000 to \$100,000
  - g. \$100,00 to \$200,000
  - h. more than \$200,000

*The overwhelming response would be that no one would invest anything in such a project if it caused additional expenses that were not covered by income related to the system*

5. How much would your farm be willing to invest in a collaborative digester project if it generated \$10,000 to \$20,000 per year?
- i. Nothing, this seems too risky
  - j. \$50,000 to \$100,000
  - k. \$100,00 to \$200,000
  - l. more than \$200,000

*When the variable of profit is added to the question , most of the respondents would have been willing to invest \$50,000 to \$100,000 in the project, a few willing to invest more.*

6. If you were part of a collaboratively owned digester, which included substantial investment, the electricity generated should be.
- a. divided equally between owner, investors
  - b. divided based on the amount of manure provided to the digester
  - c. sold to the highest bidder to pay for the project expenses

*Most of the respondents picked choice B, as the electricity would have the greatest value by replacing current farm electricity. The same people who were willing to invest more than \$100,000 in Question 5 also responded to this question with choice C.*

7. Place in order of importance the reasons why you would consider investing in a digester project.

- \_\_\_ Get rid of odor problems caused by our present handling system
- \_\_\_ To obtain a more reasonable source of electric and heat

- \_\_\_ So we could irrigate the manure to reduce hauling and spreading costs, and reduce soil compaction when spreading
- \_\_\_ To meet CAFO regulations
- \_\_\_ It could serve as a tax shelter for present profits
- \_\_\_ We hope it will add a line of revenue to the farm

*The choice that ranked the highest overall was “Get rid of odor problems caused by our present handling system”, followed by “to obtain a more reasonable source of electric and heat”*

8. If you moved forward on any digester project whether it be a private system for your farm only or a collaborative project where you would share ownership and maintenance responsibilities, how much time per week would you be able to spend on digester maintenance?

*Most farms responded with about 7 hours per week though the answers ranged from 0 to 20 hours*

9. If you were a partner in a digester project, and if costs were about the same, which would you prefer?
- a. I would take care of trucking the manure to the digester
  - b. Have one group transport the manure from the farms to the digester. This group could be employees of one of the farms, or employees of the partnership.

*Those who responded showed a perfect split between the two choices.*

### **Collaborative Opportunities: Looking further**

- A. One digester shared by all four farms
- B. One digester shared by two nearby farms
- C. One digester on each farm with collaboration in other ways
- D. Collaborate to recruit an independent business development to provide digestion service for farms

As we have determined to no longer consider the option of one digester shared by all four farms lets take a closer look at what opportunities seem feasible and which are impractical where two farms would share a common digester. Based on the economic analysis provided by Dana Chapman PE this system would pay back in the same number of years as a digester on each farm. The analysis also show that with this system capital outlay at construction would be less but that cost of operation would be higher, yet ending up with the same payback period. The distance between farms may make a significant difference with this system. For instance the Dueppengiesser farm and Butler farms are about one and one-half miles apart while Trues and Emerlings are only one tenth of a mile apart. As the cost estimates averaged these two situations it is obvious that cost of moving manure between Trues and Emerlings would be less, however Trues and Emerlings are separated by a State Highway 246 but the other two would only have the complications of crossing a Town Highway. The Perry Waste Management Committee generated a list of possibilities for collaboration with this system. They are as follows:

1. All electric and heat sold
2. Sale of all energy by product(no co-generation), gas, or hot water or chilled water
3. Electric sent back to the farms
4. Gas piped back to the farms
5. All manure by products returned to the farms
6. Post digestion solids separated and returned to the farm for bedding

7. Post digestion solids separated and marketed
8. Post digestion solids separated composted and marketed
9. Recruit partner or outside business to build new, near by company to use excess energy or by-products

We will take each of these separately and look at the pros, cons and feasibility of each.

**1. All electric and heat sold**

The advantage here is that wiring and plumbing to get the energy back to the farms could be expensive to construct and maintenance outside the usual farm experience. Another advantage is that two farms would only need to purchase one set of equipment to up-link power into the grid instead of two. This system would generate cash income that could help cover the capital cost of the project. The disadvantage here is that these farms are paying about 11 cents per kilowatt for power and the common rate being paid to small electric generators is only about 2.5 cents per kilowatt. Again distance becomes an important consideration if the heat is to be sold anywhere but back to the nearest farms. Though it may be feasible to sell excess electric. This option of selling all the electric would only be feasible if the electric could be sold at a premium such as green power or some other very special market were in place.

**2. Sale of all energy by product(no co-generation), gas, or hot water or chilled water**

The advantage here is the potential capital savings of not needing to install a generator and associated controls and equipment for getting electric into the grid. A disadvantage is that the digester would need equipment to provide heat to the digester rather than using waste heat from the generation system. If the energy were to be sold as gas, hot water or chilled water the issue of distance again becomes key. The cost of insulated pipe to carry hot or chilled water is estimated to be about \$30 per linear foot installed, gas line at \$7 to \$10 per foot depending on line size and equipment used.

Gas Transport Equipment	Estimated Price per Farm
If 2" pipe is used:	
Boiler	\$7-\$8 /linear foot installed Capital cost of \$1,000 per Btu/hr output
Bladder Storage Tank	\$1.00/gal
Rotary vane compressor	±\$5,000
Gas Meter	Cost is nominal
If 4" pipe is used:	
Boiler	\$9-\$10/linear foot installed Capital cost of \$1,000 per Btu/hr output
Gas Meter	Cost is nominal

The figures in the chart above include the cost of a boiler to heat the digester where the waste heat is not available. Where chilled water would be sold for summer air conditioning a chiller would also need to be included. Daryl Mears in his report includes information on chiller types and costs. As it would appear that the cost of piping is likely to be the major factor consider the following calculation.

A digester sited between the True and Emerling Farms sits between two potential market sites for gas, hot water or chilled water. Such a site would be about 2000 feet from several Ag related businesses at the north end of Perry, including W.Glenn Sedams, Perry Veterinary Clinic, Crop Management Association Offices, and The Bank of Castile Management Center. It would be about 1300 feet from Kelly's Garage and 2400 feet from the Perry Center Fire Hall, both in Perry Center. The cost to send gas line to the businesses at the north end of Perry at 2000 feet would be only \$18,000 at \$9 per foot. It would cost \$21,600 to deliver to Kelly's and the Fire Hall in the opposite direction. This price seems reasonable and feasible when you look at the alternative of spending \$157,000 on the generator and controls as reported by Dana Chapman. A survey of the businesses at the north end of Perry indicated that several of these businesses would be interested in purchasing farm-generated energy. The sale of energy to these businesses would also require that investment be made in their systems to install

alternative burners or other equipment for the system to work. The farm would also need to invest in the necessary equipment to clean up the biogas and pressurize it for being transported. This system seems to offer a reasonable economic feasibility. Hot and chilled water or biogas could also be sent back to the two farms to reduce electrical energy use and peak demands by cooling milk and heating space. In the case where the pipe to the businesses was for the chilled or hot water the costs would be \$60,000 to pipe to the north end of Perry and \$72,000 to Perry Center. These numbers would reflect much more capital cost, yet still in reasonable range when compared to the generation system. An analysis needs to be done of the return per unit of bio-gas if producing electric for sale or being sold directly to a business as gas, hot water or chilled water. A major concern is the need for right of ways and highway crossings with the piping, some business sites present greater challenges here than others. There appears to be no potential for this type of marketing of energy at the Butlers and Dueppengisers.

### **3. Electric sent back to the farms**

In this situation the primary advantage would be that shipping the electric back to the farms would create the greatest savings to the farms as they presently spend more for electric than they are likely to be paid by any potential purchaser. A disadvantage would be that due to the distance between any of the farms involved the electric would either need to be uplinked to the grid for moving or a transfer wire system and voltage upgrade equipment installed to move the electric back to the farms. Once again distance would be key if the farms needed to construct their own power line system and maintain that system. This idea again offers serious potential at the Emerlings and Trues but would be much more expensive for the Butlers and Dueppengisers. Discussions with various engineers and organizations indicated that crossing a state highway with private lines would not be possible without a lot of political intervention.

### **4. Gas piped back to the farms**

Piping the gas back to the farms from a commonly held digester follows much of the information discussed under point two above. It is apparent from that discussion that the cost of cleaning, pressurizing and piping the gas back to the farms from a common digester would not in itself be prohibitive. However, one of the primary savings from having two farms share a digester is that only one generation plant, and equipment for uplinking to the grid would be need to be purchased. According to the figures provided by Dana Chapman PE this alone would add back at least \$157,000 to the capital investment. This then would seem less practical than each farm having it's own digester on site to reduce the costs of moving manure, reduce the bio-security issues of mixing manure from different farms, installing and maintaining significant distances of gas line. Finally, we are once again removing the use of waste heat from electric generation to keep the digester warm and using up our energy products directly to provide the digester heat.

### **5. Post digestion solids separated and returned to the farm for bedding**

A second way that the common digester serving two farms gains its economic efficiencies is that the manure can be separated into solids and liquids with one set of equipment. Separated solids can be further dried and used on the farms as bedding. The New York State Dairy Farms Summary for farms over 300 cows would indicate that the average farm spends about \$40 per cow per year on bedding. This is a key way that cash is freed up on the farm to pay for constructing and operating a digester. The concern here is one of bio-security. By mixing the manure from two or more farms then using that manure for bedding do we significantly increase the potential for spreading diseases? Our cooperation in the project with the Cornell Waste Management Institute was intended to see if digestion alone reduced the risk of spreading cattle diseases. With the costs presented in the Chapman report it would appear that this collaboration of separating solids and returning them to the farms for bedding is very feasible. In addition to the advantages of use of the solids from the digested manure there are advantages in handling the liquid portion of the digested manure as well. With the solids removed the liquid portion can now be pumped and spread through irrigation equipment with much greater ease. It would be a significant savings to the farms in time and labor if manure could be irrigated onto fields just prior to and during the cropping season. It would make sense that several farms could invest in the irrigation equipment together to further the benefits of collaboration. The primary concern with irrigation would be the certainty that the

digested manure did not yield significant odor and the need for excellent calibration and management to insure that over application did not occur.

#### **6. Post digestion solids separated and marketed**

As indicated earlier in this text most of the farms would produce more solids than would be used in bedding on that farm. Excess solids could be sold to other farms for bedding, if bio-security issues are fully addressed. In this situation with two farms cooperating having significant solids to market would be an advantage. The potential to use these solids as a peat moss substitute in the retail trade or in greenhouse or nursery soilless mixes could provide a significant market. Through testing in cooperation with the Cornell Waste Management Institute (see the appendix of manure test results) we see what problems we are likely to see with these separated solids for these uses. We also expect to determine what further treatment or processing may be necessary to make the separated solids work in these potential markets.

#### **7. Post digestion solids separated composted and marketed**

Composting the separated, digested solids may be one way to insure that no diseases or pests are passed to other animals from their use as bedding. Composting may also make the separated solids a better peat substitute for marketing retail or as part of a commercial greenhouse or nursery soil mix. Again collaboration between the two farms would provide the greater volume needed to cover the costs of a composting site and equipment. It would also not be unreasonable to consider composting the solids from several collaborative or single site digesters at a single site. To be acceptable in some markets that require a completely weed free product the composting may need to be done indoors. Also, sharing the costs of turning and loading equipment and marketing costs would greatly enhance the economic feasibility of composting these solids. Tests were run on the manure from each of the four farms as well as manure, separated manure and composted separated manure samples taken from Bob Amen and Paterson Farms. Several very positive results were seen in these tests. None of the samples showed severe levels of any metals, though copper did very greatly with samples and should be watched closely if the products were to be used as a peat substitute. All samples, even those that had been composted showed the presence of fecal Coliform. It was interesting that in germination tests with cucumber plants, where composted, digested, separated solids were mixed with vermiculite and compared with a commercial greenhouse mix that the manure product was superior. Weed tests were run on all the digested separated and or composted samples. All of these samples were rated as weed free or very low infestation. If the farms were to collaborate and develop a weed free, disease free product that could be added in place of some or all of the peat in a greenhouse or nursery grower mix, it would be of much greater value than it used for bedding. The pH of these samples usually was greater than 7. This trait would make it ideal to add with peat in a mix as the low pH of peat can be a problem in these mixes.(see the appendix of manure and compost tests results)

#### **8. Recruit partner or outside business to build new, near by company to use excess energy or by-products**

As we have looked at the expense of moving gas, hot water, or chilled water or even electric to businesses located away from the farm, we find that each of these add costs to the project. These costs increase the start up capital costs and maintenance costs and in turn the time required to make the project pay. It is clear that the best way to make the project successful is to have the farms displace costs for energy and bedding. The main reason for this is the fact that the energy doesn't need to be transported. If other appropriate business could be recruited to set up shop on or right next to the digester and generation system that would purchase the excess energy for the digestion system without the need for significant energy transfer costs, this could be a very successful collaboration for both the farm and that business. Key issues would be to make sure that the two businesses were sufficiently compatible in energy needs and site acceptance. A concern is the present zoning and planning regulations may not be compatible with this type of Ag and commercial mixing. Where two farms are digesting in a common digester, the size of business that could be recruited to use the excess energy could be larger or at least have greater energy needs. This thinking could lead to a new type of business development in the Town of Perry.

**Collaborative Opportunities: Looking further**

- A. One digester shared by all four farms
- B. One digester shared by two nearby farms
- C. One digester on each farm with collaboration in other ways**
- D. Collaborate to recruit an independent business development to provide digestion service for farms

In our initial thinking on collaboration we thought that having a digester on each farm was likely to enter into significant consideration. However, as we toured an operating digester and cogeneration system at the Bob Amen farm in Candor NY, and looked at the issues around the transportation of manure, we have moved it to the top of our priority for consideration. The primary question being, in what effective ways can farms collaborate on the digestion yet still have a digester on each farm. Below is the list of opportunities that the Perry Waste Management Committee put together to be analyzed for feasibility:

- 1. Joint marketing of the electric
- 2. Joint marketing of biogas, hot water or chilled water
- 3. Gas piped to a common co-generation site
- 4. Joint composting and marketing of separated solids
- 5. Joint digester construction, management and maintenance
- 6. Recruit partner or outside business to build new, near by company to use excess energy or by-products

We will take a look at each of these in order.

**1. Joint marketing of the electric**

It would seem reasonable that joint marketing of electric produced on four farms our have greater opportunity to negotiate price than each farm acting alone. If each farm is the primary user of the electric produced then the actual available electric to sell many be too small to be significant in the market place. Exactly how the farms should be organized to best take advantage of marketing together is very unclear and needs additional study. The engineers from Microgy did an analysis of some of these organizational possibilities (see the Microgy Feasibility Study in the appendix). It would also be reasonable to assume that the cooperating farms could joint an existing electric marketing company or cooperative, particularly one specializing in green power or renewable energy.

**2. Joint marketing of biogas, hot water or chilled water**

In this case of a digester on each farm the choice would be to generate electric for the farm and sell the excess energy as gas, hot water or chilled water or sell all the energy as one of these three. In order for this to work as a collaboration, farms would need to work together to market a supply other businesses with this energy. We will first take a look at the farms deciding to not generate electric at all but to sell all of the energy. The advantage here is the potential capital savings of not needing to install a generator and associated controls and equipment for getting electric into the grid. A disadvantage is that the digester would need equipment to provide heat to the digester rather than using waste heat from the generation system. If the energy were to be sold as gas, hot water, or chilled water the issue of distance again becomes key. The cost of insulated pipe to carry hot or chilled water is estimated to be about \$30 per linear foot installed, gas line at \$7 to \$10 per foot depending on line size and equipment used.

Gas Transport Equipment	Estimated Price per Farm
If 2" pipe is used:	\$7-\$8 /linear foot installed
Boiler	Capital cost of \$1,000 per Btu/hr output
Bladder Storage Tank	\$1.00/gal
Rotory vane compressor	±\$5,000
Gas Meter	Cost is nominal
If 4" pipe is used:	\$9-\$10/linear foot installed

The figures in the chart above include the cost of a boiler to heat the digester where the waste heat is not available. Where chilled water would be sold for summer air conditioning, a chiller would also need to be included. Daryl Mears in his report includes information on chiller types and costs. As it would appear that the cost of piping is likely to be the major factor consider the following calculation.

The True and Emerling Farms sit between two potential market sites for gas, hot water or chilled water. The farms are about 2000 feet from several Ag related businesses at the north end of Perry, including W.Glenn Sedams, Perry Veterinary Clinic, Crop Management Association Offices, and The Bank of Castile Management Center. The distance is about 1300 feet to Kelly's Garage and 2400 feet to the Perry Center Fire Hall, both in Perry Center. The cost to send a gas line to the businesses at the north end of Perry at 2000 feet would be only \$18,000 at \$9 per foot. It would cost \$21,600 to deliver to Kelly's and the Fire Hall in the opposite direction. This price seems reasonable and feasible when you look at the alternative of spending \$157,000 on the generators and controls for each farm as reported by Dana Chapman. A survey of the businesses at the north end of Perry indicated that several of these businesses would be interested in purchasing farm-generated energy. The sale of energy to these businesses would also require that investment be made in their systems to install alternative burners or other equipment for the system to work. The farm would also need to invest in the necessary equipment to clean up the biogas and pressurize it for being transported. This system seems to offer a reasonable economic feasibility. Hot and chilled water or biogas could also be sent back to the two farms to reduce electrical energy use and peak demands by cooling milk and heating space. In the case where the pipe to the businesses was for the chilled or hot water the costs would be \$60,000 to pipe to the north end of Perry and \$72,000 to Perry Center. These numbers would reflect much more capital cost, yet still in reasonable range when compared to the generation system. An analysis needs to be done of the return per unit of bio-gas if producing electric for sale or being sold directly to a business as gas, hot water or chilled water. A major concern is the need for right of ways and highway crossings with the piping, some business sites present greater challenges here than others. By working and marketing together it would seem a more consistent and marketable supply could be sold to these types of customers. The distance involved in having all four farms participate in this is unreasonable. There are several smaller businesses such as Deiners Furniture and a small trucking company near the Butlers and Dueppengiessers where selling excess energy is feasible but not enough to need their total energy production from digestion.

### **3. Gas piped to a common co-generation site**

If each farm has its own digester, what is the potential that each farm would then pipe the gas to a common co-generation site to produce electric? The Anaerobics company was recruited to provide data to analyze this situation, see their report in the appendix. Distance here again becomes the critical issue. It would take in excess of five miles of pipe to connect the four farms at a cost of at least \$230,000 just for the pipe. The digesters would have to use biogas directly to heat the digesters because the waste heat would not be available. Electric or waste energy from the generators would not be available to the farms without additional investments to move them. The savings would primarily be in the reduced costs of the generators at each farm but a much

larger on at the generation site. The expected difficulties with placing this gas line system in place from highways, right-of-ways and other obstacles makes this option look very weak as a viable option.

#### **4. Joint composting and marketing of separated solids**

If the solids were to be separated at each of the farms and marketed for bedding or other use, a collaborative marketing and supply agreement between the four farms could be helpful and useful. This could be formal or informal in nature as long as there was cooperation. Manure, post-digestion separated manure and composted post-digestion manure were tested for market quality in this study. These tests were done in cooperation with the Cornell University Waste Management Institute. The intent was to determine risk to the purchaser of these different products from the potential of spreading animal disease in bedding. Also to consider what further treatment many be necessary to make these products acceptable into the bedding market. Wyoming County alone has over 50,000 milk cows and over 86,000 cattle total. According to the 1999 Cornell Dairy Farm Business Summary, on the average a farm spent \$41 per cow. This would represent a potential market opportunity of over \$2,000,000 just for the milkers in Wyoming County for bedding. We also looked at marketable quality as a substitute for peat moss to be sold to home consumers or incorporated into commercial greenhouse and nursery grower mixes. These potential markets are very large in Western New York if market standards can be met. Of concern in this field are microorganisms that can be a problem to humans such as some strains of E-coli, weeds, or toxic levels of items like salt or copper. Tests were run on the manure from each of the four farms as well as manure, separated manure and composted separated manure samples taken from Bob Amen and Paterson Farms. Several very positive results were seen in these tests. None of the samples showed severe levels of any metals, though copper did very greatly with samples and should be watched closely if the products were to be used as a peat substitute. All samples, even those that had been composted, showed the presence of fecal Coliform. It was interesting that in germination tests with cucumber plants, where composted, digested, separated solids were mixed with vermiculite and compared with a commercial greenhouse mix that the manure product was superior. Weed tests were run on all the digested, separated and or composted samples. All of these samples were rated as weed free or very low infestation. If the farms were to collaborate and develop a weed free, disease free product that could be added in place of some or all of the peat in a greenhouse or nursery grower mix, it would be of much greater value than it used for bedding. The pH of these samples usually was greater than 7. This trait would make it ideal to add with peat in a mix as the low pH of peat can be a problem in these mixes.(see the appendix of manure and compost tests results) Actual commercial growing tests should be run. Collaboration could be achieved by having all of the farms bring excess separated solids to a common site for composting, processing or packaging and marketing. The volume here would be totally dependent on whether the farms first used their own bedding out of the separated solids or chose to compost the whole amount. Dana Chapman in his analysis looked at solids production and bedding needs in the appendix.

#### **5. Joint digester construction, management and maintenance**

The Chapman report showed that substantial saving could be obtained during the construction of a digester if all four farms could agree on a common design, plan and equipment. This could save engineering costs and allow for better purchasing power with suppliers of construction materials, specialized controls and equipment. The report showed that the payback for all four farms to use identical systems could reduce the pay back period from 6.2 years to 5.4 years, nearly a year less. Actual cash savings were estimated at about \$70,000 per farm. This agreement could also greatly improve the service available for the equipment as well as the training and experience necessary to maintain the digesters. It would also be reasonable to assume that the four farms could employ one technician who could over see the daily management and maintenance of digesters on all four farms. This type of collaboration could be very key to the success of the digesters as one person would be more likely to become knowledgeable and proficient in digester operation than several employees who had the digester added to a list of other responsibilities. A schedule of maintenance could be set up that would be pretty much identical for all of the farms. The draw back here would be that a truly workable plan for the digesters

must be agreed on by all of the farms. Management agreements would also have to be worked out and an excellent person hired to manage and maintain the digesters.

#### **6. Recruit partner or outside business to build new, near by company to use excess energy or by-products**

As we have looked at the expense of moving gas or hot water or chilled water or even electric to businesses located away from the farm, we find that each of these add costs to the project. These costs increase the start up capital costs and maintenance costs and in turn the time required to make the project pay. It is clear that the best way to make the project successful is to have the farms displace costs for energy and bedding. The main reason for this is the fact that the energy doesn't need to be transported. If other appropriate business could be recruited to set up shop on or right next to the farm, that would purchase the excess energy for the digestion system without the need for significant energy transfer costs, this could be a very successful collaboration for both the farm and that business. Key issues would be to make sure that the two businesses were sufficiently compatible in energy needs and site acceptance. A concern is the present zoning and planning regulations may not be compatible with this type of Ag and commercial mixing. Individual farms would need to be careful to match the excess energy production with the energy needs of such a business. It is also not out of the question that the farm itself could develop an additional business that would benefit from the available energy. Where farms are close to each other such as the Trues and Emerlings, it may be feasible for one larger business to locate nearby and use the available energy from both farms allowing for a larger business to be recruited or developed. This thinking could lead to a new type of business development in the Town of Perry. No businesses were surveyed or contacted as part of this study to assess potential interest in this kind of relocation or development.

#### **Collaborative Opportunities: Looking further**

- A. One digester shared by all four farms
- B. One digester shared by two nearby farms
- C. One digester on each farm with collaboration in other ways
- D. Collaborate to recruit an independent business development to provide digestion service for farms**

One of the ideas raised by the Perry Waste Management Committee and positively identified by the survey of farms in the Perry area was the possibility of an outside company owning and managing a digester. The idea being that this digester business could utilize the manure from a farm to generate energy or electric for sale. Then the digested manure could be returned to the farm with odor substantially reduced for application to the land. The farm or the digester business could also further process the manure by separation and or composting. The Microgy Company was recruited to study the feasibility of having an independent company like their own operate digesters for this purpose in New York State and particularly in the Town of Perry. The Microgy study is titled "Feasibility Study to Develop a Green Bio-Power and Environmental Improvement Program For Selected Dairy Farms in Wyoming County and the Town of Perry, New York" and is available in the appendix. The goals and objectives of the Microgy study are as follows.

#### Goals

- To develop a economic development program that could create sustainable commercial business opportunities with dairy farms in Wyoming County for a private renewable energy developer like Microgy;
- To improve the overall environmental quality of dairy farms by addressing air and water emissions,
- To enhance the economic viability and sustainability of the dairy industry in Wyoming County.

## Objectives

- To survey four dairy farms near the Town of Perry and collect and analyze data;
- To determine technical feasibility of building and operating individual bioenergy plants at each dairy;
- To research utility issues related to the sale of “green power”, interconnection with the power grid and power quality;
- To assess the economic feasibility of privately financing, owning, operating and maintaining bioenergy plants at no capital cost to the dairy farms;
- To identify areas that the dairy farms, Microgy and Wyoming County can collaborate;
- To conduct an educational workshops with community stake holders and report of the findings and recommendations of Microgy’s Feasibility study.

As a result of completing this study, Microgy has concluded that is economically, technically and environmentally feasibility to privately finance, develop and own/operate bioenergy plants at each of the four dairy farms. The feasibility of developing such facilities are based on the following findings:

- Each dairy farm has a large enough herd generating sufficient volumes of manure waste to justify building a bioenergy plant;
- Most of the available cow manure is being collected in an effective manner mainly through use of scraping systems;
- Land is available at each farm to site and operate a bioenergy plant;
- All of the farms have adequate crop land surrounding the dairy to maintain nutrient balance, however, build up of organic nitrogen and phosphorus in the soils could be contributing to ground water quality concerns;
- Current land applications of organic nitrogen are being regulated, but phosphorus may come under new restrictions in the near future;
- Odors emanating from dairy farms are public issues, especially when manure is pumped from the storage lagoons and applied on crop land;
- The dairy farms experience high electrical energy costs due to on-peak demand charges. The average cost of power is over \$0.11/kWh with peak energy charges at over \$0.19/kWh and ratchet fees for setting peak billing kW demand;
- All four farms are well designed with modern free stall dairy barns and milking parlors;
- All four farms have manure lagoon storage systems, but one dairy is limited in storage capacity;
- Two of the four dairy farms (Duppengiesser and Butler) may have limited electric line capacities which may require upgrading to accommodate the increased power supplied to the utility grid;
- The market may be limited for the sale of green power to the utility grid due to the fact that neither New York State Gas and Electric (NYSEG) and Niagara Mohawk (NIMO) have active green energy marketing programs. Both NYSEG and NIMO serve the majority of dairy farms within Wyoming County and surrounding region between Buffalo and Rochester;

- The New York State Energy Research Development Authority (NYSERDA) has financial incentives available to encourage the development of renewable energy sources through funding provided by System Benefit Charges mandated by the New York Public Service Commission (PSC).
- Under Retail Access regulations under the PSC, Wyoming County or the Town of Perry or the dairy farm associations could form their own special Energy Services Company (ESCO) or cooperative ESCO to buy and sell power to any customer within their service territory. Note that both Monroe and Erie counties have formed their own ESCO's to provide energy to their public facilities.

Microgy goes on in the study to propose a system of implementation that they feel would be feasible with the cooperation of the farms in the study. Other companies have also expressed an interest in similar programs for farms in Wyoming County.

### **Summary and Conclusions**

The Town of Perry, the dairy farmers of Wyoming County as well as many other interested parties are very interested in solving manure odor issues. Digestion of manure is proposed as a technology which can greatly reduce manure odor while at the same time provide energy as electric or heat to help offset the high costs associated with digestion. Digestion and co-generation involves a large capital investment for the farm. It is the purpose of this feasibility study to look a ways that by collaboration, by working together farms can either reduce costs or enhance revenue to make digestion more economically feasible. Four farms cooperated in the study. Six different professional firms were hired to accomplish different portions of the study.

Our first impression was that by constructing one large central digester we would gain the greatest efficiency. However, when the issues and costs associated with moving manure and digestion end products between the farms and the digester were considered, this system is not economically feasible under these circumstances.

Second, we considered having one digester shared by the pairs of farms that were closest to each other. Here the pay back was feasible with distance between the two farms being the key issue. The following nine ideas for possible collaboration were also considered:

1. All electric and heat sold
2. Sale of all energy by product(no co-generation), gas, or hot water or chilled water
3. Electric sent back to the farms
4. Gas piped back to the farms
5. All manure by products returned to the farms
6. Post digestion solids separated and returned to the farm for bedding
7. Post digestion solids separated and marketed
8. Post digestion solids separated composted and marketed
9. Recruit partner or outside business to build new, near by company to use excess energy or by-products

Each of these nine had pros and cons and may work for different farms depending on distance between farms and distance to other businesses or markets for excess energy.

Third, we considered the option of having one digester constructed on each farm. We then considered other ways that the farms could collaborate to gain important efficiency. The following six ideas for collaboration were viewed in detail.

1. Joint marketing of the electric
2. Joint marketing of biogas, hot water or chilled water
3. Gas piped to a common co-generation site

4. Joint composting and marketing of separated solids
5. Joint digester construction, management and maintenance
6. Recruit partner or outside business to build new, near by company to use excess energy or by-products

The option of a digester at each farm was the most feasible option when considering all the farms involved. The option with the greatest immediate savings and least payback period resulted from having all the farms agree to install identical systems. Again distance to potential energy markets was a key consideration. Alternatives for equipment to best utilize biogas on the farm was studied and very useful information collected in a study by Optimum Utility Systems. Any farm installing a digester should study and research the equipment available and make selections on cost efficiency and energy efficiency. Simply using all the biogas produced to generate electric is not the most efficient unless a high premium is paid for that electricity. The option of selling excess energy as gas, hot water or chilled water may be the most profitable if the distance to a market is not excessive.

The final option for consideration raised by the Perry Waste Management Committee and positively identified by a survey of farms in the Perry area was the possibility of an outside company owning and managing a digester. The idea being that this digester business could utilize the manure from a farm to generate energy or electric for sale. Then the digested manure could be returned to the farm with odor substantially reduced for application to the land. The farm or the digester business could also further process the manure by separation and or composting. The Microgy Company was recruited to study the feasibility of having an independent company like their own operate digesters for this purpose in New York State and particularly in the Town of Perry. The Microgy study is titled "Feasibility Study to Develop a Green Bio-Power and Environmental Improvement Program For Selected Dairy Farms in Wyoming County and the Town of Perry, New York" and is available in the appendix. Microgy determined that it is feasible for a digester to be owned and operated by an outside business and operate successfully.