MONITORING PLAN
FOR
EMERLING AND SUNNY KNOLL BIOGAS SYSTEMS

April 2006

Submitted to:

Emerling & Sunny Knoll Farms
Town of Perry
PO Box 205
Perry, NY 14530-0205

New York State Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Submitted by:

CDH Energy Corp.
PO Box 641
132 Albany Street
Cazenovia, NY 13035
(315) 655-1063

Table of Contents

Introduction

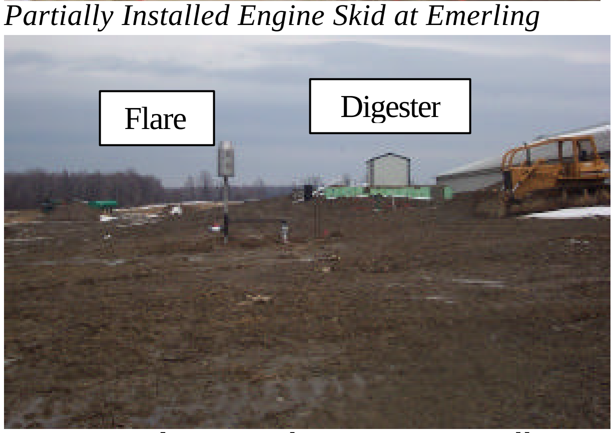
This plan describes our approach to monitoring the performance of two anaerobic digester systems that will produce biogas at Emerling and Sunny Knoll Farms in Perry, NY. At each farm, the biogas will be used to drive an engine-generator to produce power that will be consumed on site and exported back to the local utility. The power exported back to the utility will be credited towards the farms utility bill at retail rates according to NY's "net metering" rules for farm biogas systems. The monitoring system is intended collect the measured data necessary to quantify the economic and technical performance of the biogas system at each farm.

System Description

The digester systems at both farms were designed by RCM Digesters. Both have identical digester and 200 kW engine-generator systems. Each farm is installing the synchronous generator, piping and controls in a new pole barn. All the electrical loads have been consolidated into single a new 3-phase electrical service at each farm to accommodate the generator system. The electrical system includes controls to synch the generator to the grid as well as a protective relay and controls to automatically isolate the farm from the utility grid in the event of a utility power outage.

Partially Installed Engine Skid at Emerling

Biogas Conditioning Skid at Emerling



Digester and Biogas Flare at Sunny Knoll

Figure 1. Photos of System Components at Emerling and Sunny Knoll

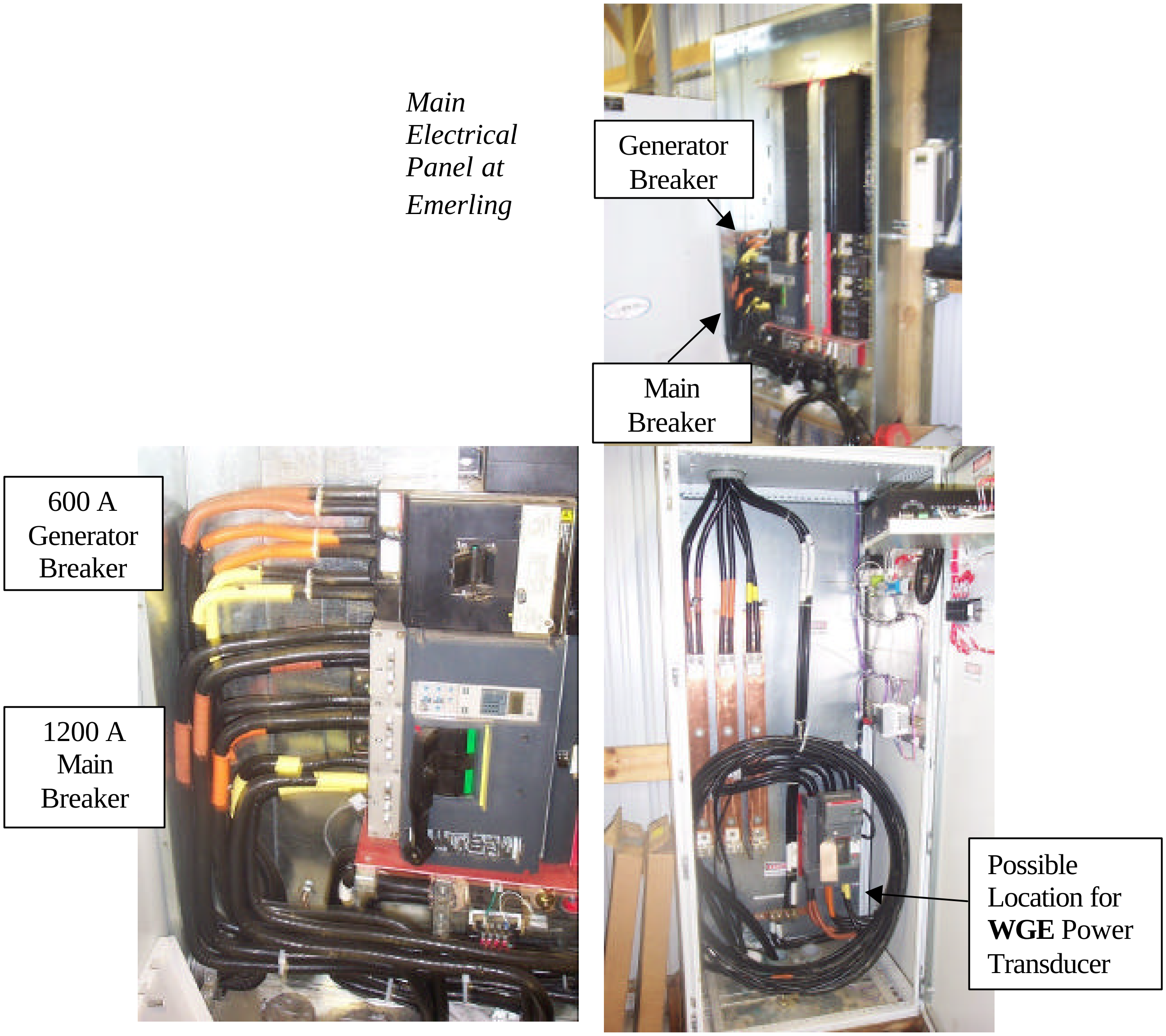


Figure 2. Photos of Electrical System at Emerling

Table 1. Biogas Systems at Emerling and Sunny Knoll Farms

	Emerling	**Sunny Knoll**
Contact and Address	Mike Emerling Emerling Dairy 2904 Rte. 246 Perry NY 14530 585-237-2548	Eric Butler Sunny Knoll Farm 7429 Burke Hill Road Perry, NY 14530 585-703-8012
Digester	Plug Flow, Soft Cover	Plug Flow, Soft Cover
Engine-Generator	Caterpillar G379 200 kW output on biogas 480 VAC, 3 phase	Caterpillar G379 200 kW output on biogas 480 VAC, 3 phase
Backup Fuel	Propane	Natural Gas
Additional Heat Recovery	"Milk house" water preheating	none

Figure 3 schematically shows the biogas systems. Biogas from the digester is used in the engine or flared (the biogas flare operates using a mechanically-actuated valve that vents biogas to maintain the digester at 1.5 inches of static pressure). Biogas for the engine is de-watered and pressurized to 7 inches for use in the engine. The biogas blower uses a VSD to maintain the pressure setpoint.

The hot water leaving the engine jacket runs through an exhaust heat exchanger where it is further heated. The heated jacket water is sent through a plate frame heat exchanger to provide heat to the digester loop or the to meet other thermal loads on the farm. It the jacket water leaving the exhaust HX is too warm, a mechanical, temperature-actuated valve diverts jacket water to the radiator. The radiator fan speed is controlled by a VSD based on temperature (is fan operation initiated by a flow switch?). The jacket water loop also includes low temperature mechanical control valve that bypasses the plate frame HX and returns water to the engine block if the water temperature is too low.

The plate frame HX is split to provide heat to two separate water loops on the load side. The digester heating loop has about 1/3 of the load-side HX surface area. The digester heating loop includes a pump and 3-way valve that bypasses flow around the HX. The modulating bypass valve is controlled by the PLC to maintain the digester temperature (or the heating loop temperature?). The remaining 2/3 of the load-side HX surface area can provide heat to thermal loads at the farm. At Sunny Knoll there are currently no plans to use the engine heat to meet thermal loads on the farm. At Emerling, the future plans are to install about 400 feet of underground piping to the milking parlor building to meet water preheating loads.

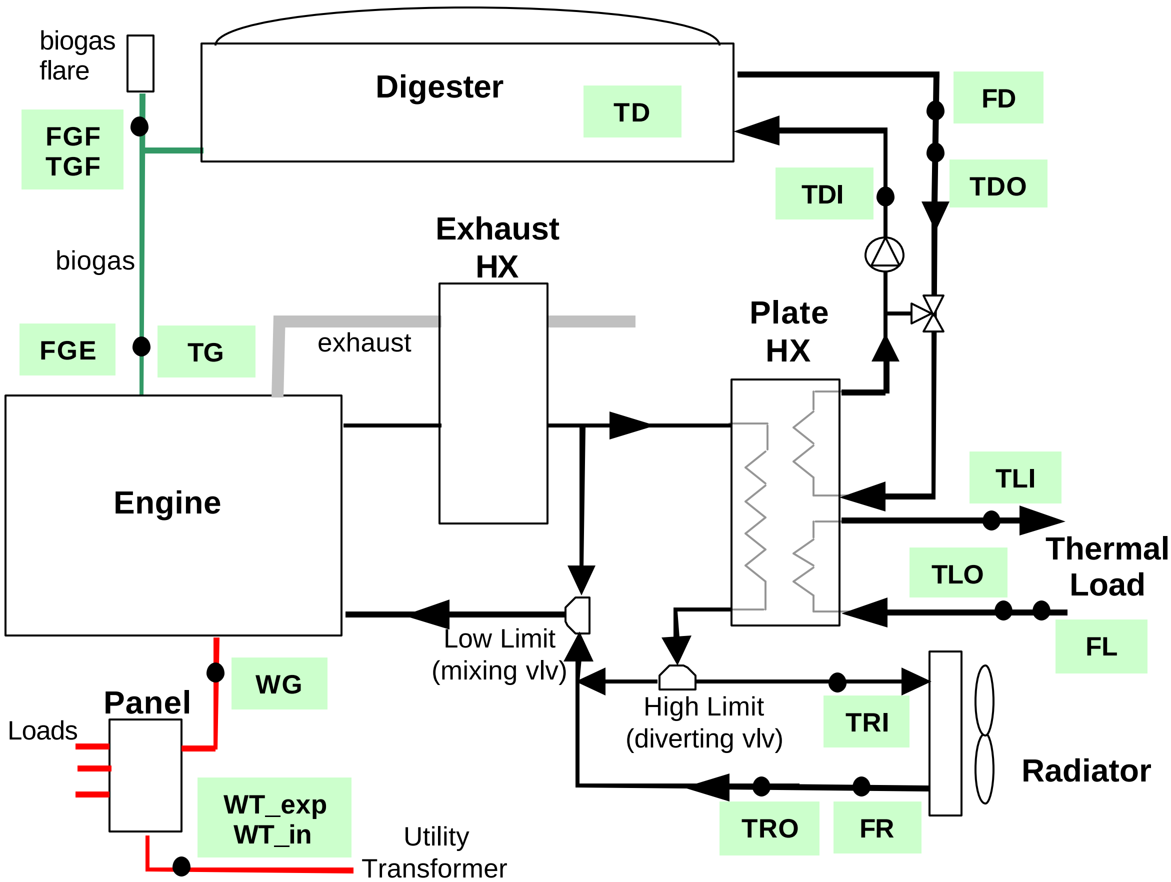


Figure 3. Schematic Biogas System

Monitoring System

Figure 3 also shows the location of monitored data points that are included to measure system performance. The data point name or tag corresponding to each sensor is shown as the text box on the schematic. The data points are also listed in Table 2. The type of sensor used to measure each point is also specified. The next section talks about process and rationale for selecting these points.

We will install a Campbell Scientific CR10 at each site to measure these points. The datalogger will scan each point at 5-second intervals and record summed or averaged data for each 15-minute interval. Data will be collected by modem twice each day. The data will be loaded into CDH data base system, uploaded to a project specific web site, and sent into the NYSERDA integrated database system.

Table 2. Monitored Points at Emerling and Sunny Knoll

Chan Type	Logger Channel	Name	Description	Sensor Type	Eng Units	Instrument	Supplied by
pulse	MUX1	WT_in	Main Meter (import/consume)	PMI	kWh/kW	ION 6200, 600 amp CTs	CDH
pulse	MUX2	WT_exp	Main Meter (export)	PMI	kWh/kW		
pulse	MUX3	WG	Generator Output	Veris	kWh/kW	Veris-8053-400	CDH
pulse	MUX4	FGE	Engine Gas Use	Roots	cf	Roots	RCM
pulse	P1	FD	Digester HW Flow	Mag Flow	gpm	Sparling FM618-041	RCM
pulse	P2	FR	Radiator HW Flow	Mag Flow	gpm	Sparling FM618-031	RCM
analog	A1	FL	Load HW Flow	Mag Flow	gpm	Sparling FM618-021	RCM
analog	A2	FGF	Flare Gas Flow	Mass Flw	lb/h	Fox Thermal Instruments FT2	RCM
analog	A3	TGF	Flare Gas Temperature	Mass Flw	^F	Fox Thermal Instruments FT2	RCM
analog	A4	TD	Digester Temperature	thermistor	^F	Thermalogic P01-300 4805 (1122G02253GL)	RCM
analog	A5	TDI	Digester Temp IN	thermistor	^F		
analog	A6	TDO	Digester Temp OUT	thermistor	^F		
analog	A7	TRI	Radiator Temp IN	thermistor	^F		
analog	A8	TRO	Radiator Temp OUT	thermistor	^F		
analog	A9	TLI	Load Temp IN	thermistor	^F		
analog	A10	TLO	Load Temp OUT	thermistor	^F		
analog	A11	TAO	Outdoor Temperature	RTD	^F	Mamac, 4-20ma output	CDH
analog	A12	TG	Biogas Temperature	RTD	^F	Mamac, 4-20ma output	CDH

The electrical output of the engine (**WG**) will be measured with a pulse-output power transducer. The biogas input to the engine (**FGE**) will be measured by a roots gas meter that provides pulse output proportional to the volume flow (we will assume the heat value is 600 Btu/ft^3 HHV). The gas temperature (**TG**) will be used to correct to standard gas volume (if required). From these measurements we can calculate the engine efficiency and compare it to the manufacturers specifications. Some biogas will be flared. A mass flow meter (**FGF, TGF**) will measure this potion of the biogas production that is not used. We will not directly record the propane or natural gas flowrate, though we will manually enter the propane delivery logs or gas bills in order to account for periods when the backup fuel is used.

The thermal output used to heat the digester will be determined from the flow and temperature difference (**FD, TDI, TDO**). The data logger will integrate these readings every scan interval to determine the thermal output. We will also measure and integrate the heat that is rejected to the dump radiator (**FR, TRI, TRO**) as well as the heat provided to the thermal loads in the milkhouse (**FL, TLI, TLO**). The total heat supplied to the digester, dump radiator and other thermal loads will be summed and compared to the expected thermal output from the engine.

The digester temperature (**TD**) and ambient temperature (**TAO**) will be compared to the digester heat input to assess the impact of ambient on digester heat loss.

Power flow through the main utility meter may at times be flowing from the utility to the farm (consumption; import mode) and at other times flow from the farm to the utility (export mode). A ION 6200 bi-directional power meter will be installed on the main utility service to record power use when the farm is consuming power (**WT_in**) and exporting power (**WT_exp**). A separate pulse output is provided for each direction.

The parasitic power consumption of various components in the system will be determined by one-time power readings with a hand-held meter capable of measuring true power. Table 3 lists the one-time measurements we expect make at each site.

Table 3. One-Time Measured Data Collected

Name	Description	Eng Units	Sensor Type
WENG	Engine Power (pump, etc.)	kWh	Handheld Pwr Meter
WDP	Digester Pump	kWh	Handheld Pwr Meter
WF	Radiator Fan Power	kWh	Handheld Pwr Meter

Project Web Site

CDH create a web site that for each farm that provides access to all the data collected at each site. The website will provide detailed plots of tables of the collected data from the site that will be updated twice daily (at 2 am and 2pm). An example web page is available at http://cdhenrgy.user.openhosting.com/cdhenergy.com/butler_hospital/butler_hospital.py (username/password: butler/purcomfort).

The data will loaded into the integrated website at chp.nyserda.org on a daily basis. This *subset* of the collected data will allow this site to be compared to others in the NYSERDA database.

APPENDIX A

DAS Details

This appendix will contain wiring schematics and other details about the monitoring system (To be finalized once the monitoring system is installed)