AA Dairy Data Integrator Notes

This site is a dairy farm located in the Central New York town of Candor. A 130 kW Caterpillar engine generator uses digester gas to produce electricity and useful heat recovery. The heat recovered from the engine is used to heat the digester. The digester breaks down farm waste (mainly manure) and, instead of traditional waste removal, produces a combustible gas for the farm to use. Digester gas that cannot be utilized by the engine is burnt in a flare. Data for this site is collected by Connected Energy and provided to CDH Energy.

Data Point Details

The data at this site is provided by Connected Energy in the form of comma-separated value (CSV) files. There is one file for each day containing 15-minute timestep data for 59 data points. One data file is uploaded on a nightly basis containing the previous days data. From these 15-minute values, the hourly database is formed. It is unclear whether the 15-minute data is sampled or averaged across the interval. The details for each individual data point are outlined below.

The timestamp in the raw data files is in Eastern Local Time. This means it obeys the Standard to Daylight savings times rules for the Eastern timezone. For display purposes, we convert the timestamp from Local Time to Eastern Standard Time for all graphical figures on the website. This means that during the Daylight Savings Time period from the first Sunday in April until the last Sunday in October the monitored data plots, CSV output and standardized PDF reports are in Eastern Standard Time and do not obey Daylight Savings time rules. Presenting data in Standard Time throughout the year is common practice for graphical time series plotting because it eliminates skipping an hour in April and duplicating an hour in October.

DG/CHP Generator Output (total kWh)

The data for Generator Output comes from a 15-minute accumulator for the total power produced by the engine. The column of origin for this data point is labeled "Generator Cumulative Power" in the data files received from Connected Energy. The difference between consecutive records is assigned as the energy produced by the engine for that interval. This 15-minute energy data is then summed into hourly data.

DG/CHP Generator Output Demand (peak kW)

The data for Generator Output comes from a 15-minute average for the generator demand. The column of origin for this data point is labeled "Generator Real Power" in the data files received from Connected Energy. The maximum for a given hour is assigned to the hourly database.

DG/CHP Generator Gas Input (cubic feet)

The data for Generator Gas Input comes from a 15-minute accumulator for biogas flow. The column of origin for this data point is labeled "BioGas Flow Cumul" in the data files received from Connected Energy. The difference between consecutive records is assigned as the gas consumed by the engine for that interval. This 15-minute gas data is then summed into hourly data.

Total Facility Purchased Energy (total kWh)
The data for Facility Purchased Energy comes from accumulators for the power imported from the utility grid and exported to the utility grid. The columns of origin for this data point are labeled "Grid Energy to Farm Cumul" and "Grid Energy from Farm Cumul" in the data files received from Connected Energy. The difference between consecutive records is taken as the amount exported or imported for the interval. The amount exported is then subtracted from the amount imported to calculate the net utility purchased energy. This 15-minute energy data is then summed into hourly data.

Total Facility Purchased Demand (peak kW)
The data for Facility Purchased Demand comes from the 15-minute average for total utility import and total utility export. The columns of origin for this data point are labeled "Grid Power to Farm" and "Grid Power from Farm" in the data files received from Connected Energy. The utility export is subtracted from the utility import to calculate the average net facility import. The maximum for a given hour is assigned as the Total Facility Purchased Demand in the hourly data.

Other Facility Gas Use (cubic feet)
The facility gas use comes from an 15-minute average for the biogas flow to the flare. The column of origin for this data point is labeled "BioGas to Flare Flow Rate" in the data files received from Connected Energy. The flow rate is converted to gas use per interval. This interval gas use data is then summed into hourly data.

Total Facility Energy (total kWh) and Total Facility Demand (peak kW)
These two data points are the sum of the DG/CHP Generator Output and Total Facility Purchased data points.

Unused Heat Recovery (total MBtu/h)
The Unused Heat Recovery comes from the 15-minute average for dump cooler heat rate. The column of origin for this data point is labeled "Dump Cooler Heat Dump Rate" in the data files received from Connected Energy. The rate data is converted to energy, in MBtus, for the interval and then summed into hourly data.

Useful Heat Recovery (total MBtu/h)
The Unused Heat Recovery comes from a 15-minute average for the utilized heat recovery rate. The column of origin for this data point is labeled "Utilized Heat Recovery Rate**"** in the data files received from Connected Energy. The rate data is converted to energy, in MBtus, for the interval and then summed into hourly data.

Status/Runtime of DG/CHP Generator (hrs)
The engine is defined as being fully on for a 15-minute interval if the engine power output is greater than 1 kW for the period (the fully-loaded capacity is approximately 180 kW). The status is given a value of 0.25 if the generator output is above 1 kW and the status is assigned 0.0 if it is below. The 15-minute data is then summed into hourly data for the online database.

Ambient Temperature (avg °F)

The Ambient Temperature comes from a 15-minute average for outdoor temperature. The column of origin for this data point is labeled "Ambient Temp" in the data files received from Connected Energy. The 15-minute average temperature is averaged into hourly data for the online database.

Total CHP Efficiency (%)
The Total CHP Efficiency is calculated from the online hourly database as the sum of the Useful Heat Recovery and the DG/CHP Generator Output, converted from kWh to MBtus, divided by the DG/CHP Generator Gas Input. The gas input is converted to MBtus using the Lower Heating Value (LHV) of the fuel which is 0.600 MBtu/cubic foot (BioGas).

Electrical Efficiency (%)
The Electrical Efficiency is calculated from the online hourly database as the DG/CHP Generator Output, converted from kWh to MBtus, divided by the DG/CHP Generator Gas Input. The gas input is converted to MBtus using the Lower Heating Value (LHV) of the fuel which is 0.600 MBtu/cubic foot (BioGas).

Data Quality Checks

The Data Quality Checks consist of three levels of verification: does the data exist, does the data pass reasonable range checking and does the data pass relational checks. The methodology for applying the data quality begins by creating a contiguous database. This is necessary to maintain compatibility between the many sites on the server. Next, the data received for this site is fit into the database, in this case we are using 15-minute data. For any period where there is data, the data quality level is set to 3 for "Passes Relational Checks". We then work backwards to identify data that does not meet Relational and/or Range Checking.

The next step is to apply the relational checks. Relational checks attempt to identify data which is uncorroborated by the rest of the data set. For instance, data received indicating a DG/CHP Generator output when the gas use is zero is suspect. For data failing a relational check, the data quality level is set to 2 for "Data Passes Range Checks" or 1 for "Data Exists".

The last step is evaluating the range checks. The range checks consist of reasonable high and low values based on facility and DG/CHP Generator information. Data that falls outside the defined range for the database value has its data quality level set to 1 for "Data Exists."

It is necessary to work backwards when applying data quality checks to insure that data gets set to the lowest applicable data quality level. It is possible for data to pass the relational check and fail the range check and such data will be set to a data quality level of 1 for "Data Exists."

Table 1. Data Quality Definitions

Data Quality Levels	Description	Definition
3	Passes Relational Checking	This data passes Range Checks and Relational Checks. This is the highest quality data in the data set.
2	Passes Range Checks	This data passes the Range Checks but is uncorroborated by Relational Checks with other values.
1	Data Exists	This data does not pass Range Checks. This data is found to be suspect based on the facility and/or CHP equipment sizing.
0	Data Does Not Exist	This data is a placeholder for maintaining a contiguous database only.

Details on the Range and Relational Checks are found below.

Relational Checks

These checks are applied to the 15-minute data before it is converted to hourly data. If any of the 15-minute data points fails the relational check, the data for the entire hour is marked as failed. When there is a failure to obtain new data, the data set repeats the old value. We can identify this bad data through a relational check for repeating data on the whole data set. We are using a threshold of 95% repeating values because some values reset to zero during the repeating periods.

Table 2. Relational Checks for AA Dairy

Evaluated Point	Criteria	Result
FG	WG > 0 and FG <= 0	DQ Level for FG set to 2
WG, WG_KW, SG	WG = 0 and WG_KW > 0	DQ Level for WG_KW, WG and SG set to 2
WG, WG_KW, FG, WT, WT_KW, FT, QHR, QD, SG, TAO	> 95% of columns "BioGas Flow" through "Connection Status" repeat previous data record	DQ Level for WG, WG_KW, FG, WT, WT_KW, FT, QHR, QD, SG and TAO set to 1

Notes: FG – DG/CHP Generator Gas Use
WG – DG/CHP Generator Output
WG_KW – DG/CHP Generator Output Demand
WT – Total Facility Purchased Energy
WT_KW – Total Facility Purchased Demand
QHR – Total Useful Heat Recovery
QD – Total Dumped Heat Recovery
SG – Status/Runtime of DG/CHP Generator
TAO – Ambient Temperature

Range Checks

These checks are applied to the 15-minute data before it is converted to hourly data. If any of the 15-minute data points fails the range check, the data for the entire hour is marked as failed.

Table 3. Range Checks for AA Dairy

Data Point	Hourly Data Method	Upper Range Check	Lower Range Check
DG/CHP Generator Output	Sum	37.5 kWh	0 kWh
DG/CHP Generator Output Demand	Maximum	130 kW	0 kW
DG/CHP Generator Gas Use	Sum	4,000 cubic feet	0 cubic feet
Total Facility Purchased Energy	Sum	50 kWh	-37.5 kWh
Total Facility Purchased Demand	Maximum	200 kW	-130 kW
Other Facility Gas Use	Sum	1,000 cubic feet	0 cubic feet
Unused Heat Recovery	Sum	500 MBtu	0 MBtu
Useful Heat Recovery	Sum	500 MBtu	0 MBtu
Status/Runtime of DG/CHP Generator	Sum	0.25 hrs	0 hrs
Ambient Temperature	Average	130°F	-30°F

Notes: Data failing the Range Check has the data quality level set to 1 for "Data Exists"

ASERTTI Protocol Adherence

This site adheres fully to the ASERTTI Long-Term Monitoring Protocol. Data is provided in 15-minute intervals satisfying the protocol. In addition, this site also has most of the optional performance parameters.

Monitoring Notes

December 20, 2006

CDH begins receiving daily file uploads from Connected Energy for this site.

January 12, 2007

CDH finishes reviewing data. There is no gas data in any of the five flow/accumulator channels. CDH Energy asks Connected Energy to look into the issue.