Greenpark Care Center – Brooklyn, NY

Data Integrator Initial Data Summary

Site Description

Greenpark Care Center is a health care facility located in Brooklyn, NY. The site has two Tecogen 75 kW generators for generating power and recovering heat. The Greenpark Care Center operates 24 hours per day, 7 days per week, and provides long-term medical assistance to 200 patients. The facility employs 190 trained nurses, doctors, and support staff. The nursing home currently uses Con-Ed electric as the primary source of electric power to the facility. Heat is recovered from the engines for use in the building. Data for this site is collected by Connected Energy and provided to CDH Energy.

Data Description

Connected Energy provides the data for Greenpark Care Center via comma-separated variable (CSV) files uploaded once a day. The data set consists of 122 channels. CDH assigns engineering units based on the Connected Energy data system or makes assumptions based on previous experience. The set describes the electrical generation for a set of two engine generators powered by natural gas. The data at this site is just for the engines.

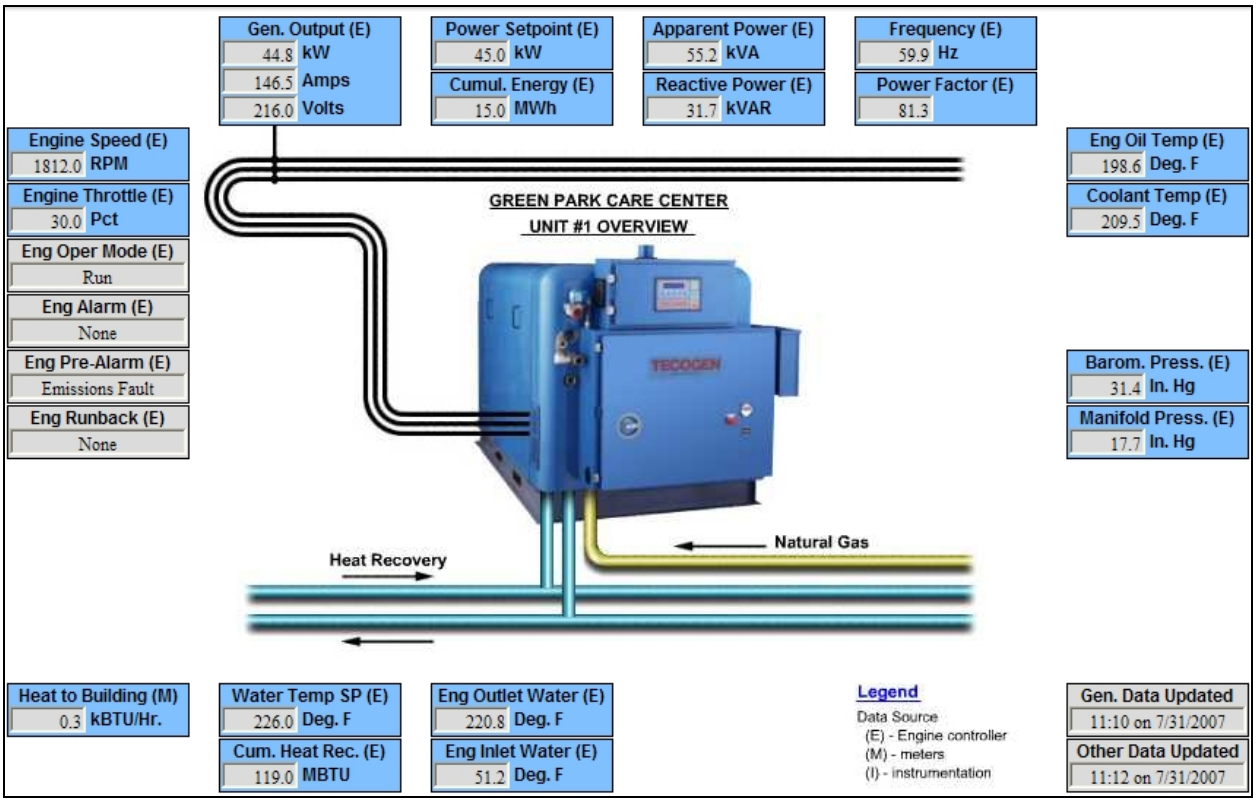

Figure 1. Screen Capture of Generator 1 of Connected Energy System

DG/CHP Integrated Data System Channels

Table 1 shows the processed data channels from rawdata used in the DG/CHP Integrated Data System for engine 1. Table 2 shows the processed data channels from rawdata used in the DG/CHP Integrated Data System for engine 2.

Table 1. Data Integrator Database Mapping for Generator 1

Integrated Data System Channel	Units of Measure	Raw Data Column Descriptions [col][1]	Raw Data Units	Calculation Formula
DG/CHP Generator Output	kWh/int	Eng 1 Cumul. Energy Produced [AR]	MWh	$=[AR]*1000$
DG/CHP Generator Output Demand	kW	Eng 1 Power, Actual [AU]	kW	$=[AU]$
DG/CHP Generator Gas Input	cuft/int	Engine #1 Cumul Gas Use [D]	ccf	$=[D]*100$
Total Facility Purchased Energy [2]	kWh/int	N/A		
Total Facility Purchased Demand [2]	kW	N/A		
Other Facility Gas Use[2]	cuft/int	N/A		
Total Facility Energy[2]	kWh/int	Calculated		
Total Facility Demand[2]	kW	Calculated		
Useful Heat Recovery	MBtu/int	Eng 1 Cumul. Heat Recovered [DA]	MMBtu	$=[DA]*1000$
Unused Heat Recovery	MBtu/int	N/A		
Status/Runtime of DG/CHP Generator	Hours/int	Eng 1 Total Operating Hours [DC]	Hours	$=[DC]$
Ambient Temperature[3]	°F	N/A	°F	N/A
Total CHP Efficiency	% LHV	Calculated	N/A	
Electrical Efficiency	% LHV	Calculated	N/A	

[1] – The Raw Data Column Description is from the Connected Energy CSV files. The corresponding column id (i.e., A, B, C…) is in square brackets and used for the calculation formula.

[2] – There is no information for these data channels available from Connected Energy data.

[3] – Hourly Temperature from wunderground.com for the JFK airport in Brooklyn, NY has been used for the ambient temperature.

int – interval

Table 2. Data Integrator Database Mapping for Generator 2

Integrated Data System Channel	Units of Measure	Raw Data Column Descriptions [col][1]	Raw Data Units	Calculation Formula
DG/CHP Generator Output	kWh/int	Eng 2 Cumul. Energy Produced [AS]	MWh	$=[AS]$*1000
DG/CHP Generator Output Demand	kW	Eng 2 Power, Actual [AV]	kW	$=[AV]$
DG/CHP Generator Gas Input	cuft/int	Engine #1 Cumul Gas Use [E]	ccf	$=[E]$*100
Total Facility Purchased Energy[2]	kWh/int	N/A		
Total Facility Purchased Demand[2]	kW	N/A		
Other Facility Gas Use[2]	cuft/int	N/A		
Total Facility Energy[2]	kWh/int	Calculated		
Total Facility Demand[2]	kW	Calculated		
Useful Heat Recovery	MBtu/int	Eng 2 Cumul. Heat Recovered [DB]	MMBtu	$=[DB]$*1000
Unused Heat Recovery	MBtu/int	N/A		
Status/Runtime of DG/CHP Generator	Hours/int	Eng 2 Total Operating Hours [DF]	Hours	$=[DF]$
Ambient Temperature[3]	°F	N/A	°F	N/A
Total CHP Efficiency	% LHV	Calculated	N/A	
Electrical Efficiency	% LHV	Calculated	N/A	

[1] – The Raw Data Column Description is from the Connected Energy CSV files. The corresponding column id (i.e., A, B, C…) is in square brackets and used for the calculation formula.
[2] – There is no information for these data channels available from Connected Energy data.
[3] – Hourly Temperature from wunderground.com for the JFK airport in Brooklyn, NY has been used for the ambient temperature.
int - interval

Data Verification

Calculated Value Corroboration

Table 3 shows the calculations of heating loads for the various channels for which corroborating data was identified. For this table, calculations within 10% of the data reported in the heat recovery column are marked as passing the check.

Table 3. Checks on Heating Load Calculations

Column Label [col] [1]	Corroborating Columns [col][1]	Corroborating Formula	Passed Check
Eng1 Cumul. Heat Recovered [DA]	Engine #1 Gas Flow Rate [G], Eng 1 Power, Actual [AU]	$< \frac{([G]*60*0.930)-([AU]*3.413)}{4}$	No
Eng2 Cumul. Heat Recovered [DB]	Engine # 2 Gas Flow Rate [H], Eng 2 Power, Actual [AV]	$< \frac{([H]*60*0.930)-([AV]*3.413)}{4}$	No
Site Electrical Efficiency [O]	Cumul. Site Gas Use [C], Cumul Total Generator Energy [I],	$= \frac{[I]*3.413}{[C]*0.930}$	No
Site Total CHP Efficiency [N][2]	Cumul. Site Gas Use [C], Cumul Total Generator Energy [I], Heat to Building Cumul. [M]	$= \frac{([I]*3.413)+[M]}{[C]*0.930}$	No

[1] – The Raw Data Column Description is from the Connected Energy CSV files. The corresponding column id (i.e., A, B, C…) is in square brackets and used for in the calculation formula.

[2] – A Lower Heating Value (LHV) for natural gas of 0.930 MBtu/scf was assumed for Natural Gas in these calculations.

In Table 3, rows in red show efficiency channels where the efficiency could not be compared to calculations from the database. The best-guess formula for the calculation is still listed in the table. The “Site Electrical Efficiency” and the “Site Total CHP Efficiency” could not be verified and is discussed in further detail in the following section.

Electrical Efficiency

Connected Energy has a channel in their database labeled "Site Electrical Efficiency". Electrical efficiency is defined as the ratio of electrical power output from the system to the energy input of the system. The energy input is the engine fuel. Taking the corroborating formula for "Site Electrical Efficiency" from Table 3, the results do not match the efficiency data channel. The comparison of these two is shown in Figure 2 and it can be seen that for certain periods the electrical efficiency reported by Connected Energy channel is lower than the calculated efficiency.

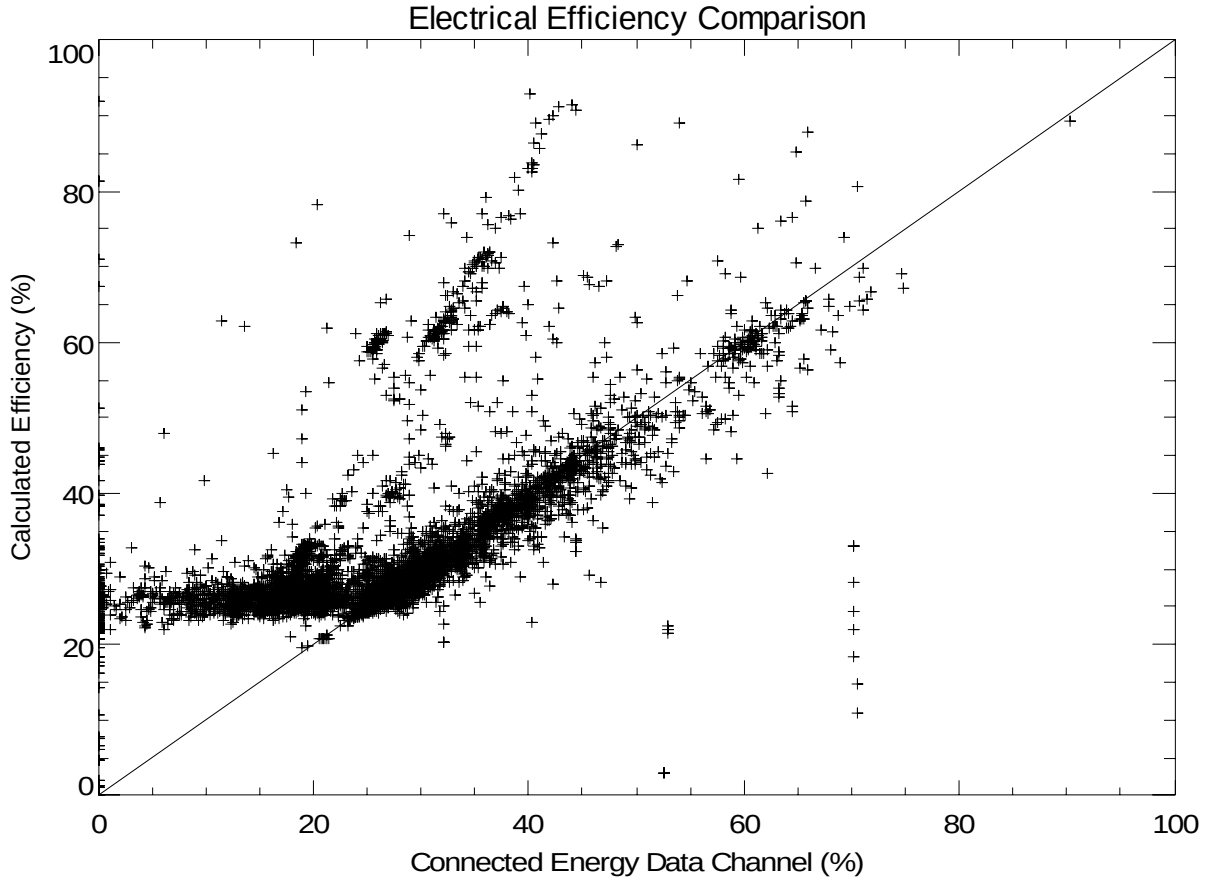

Figure 2. Plots of Calculated CHP Efficiency vs. Connected Energy CHP Efficiency Data

From the corroborating formula we see that the channels used for the calculation of electrical efficiency are “Cumul Total Generator Energy” and “Cumul Site Gas Use”. The time series plots for “Cumul Total Generator Energy”, “Cumul Site Gas Use” and “Site Electrical Efficiency” are shown in Figure 3. The areas circled in red are for the same time period. On the “Cumul Total Generator Energy” and the “Cumul Site Gas Use” plots show normal operation of the system. For the same time period the site Electrical Efficiency shows values that are very low. This could be the reason why we see that in Figure 2 there are many points that do not match the electrical efficiency, hence showing a lower value than the calculated value.

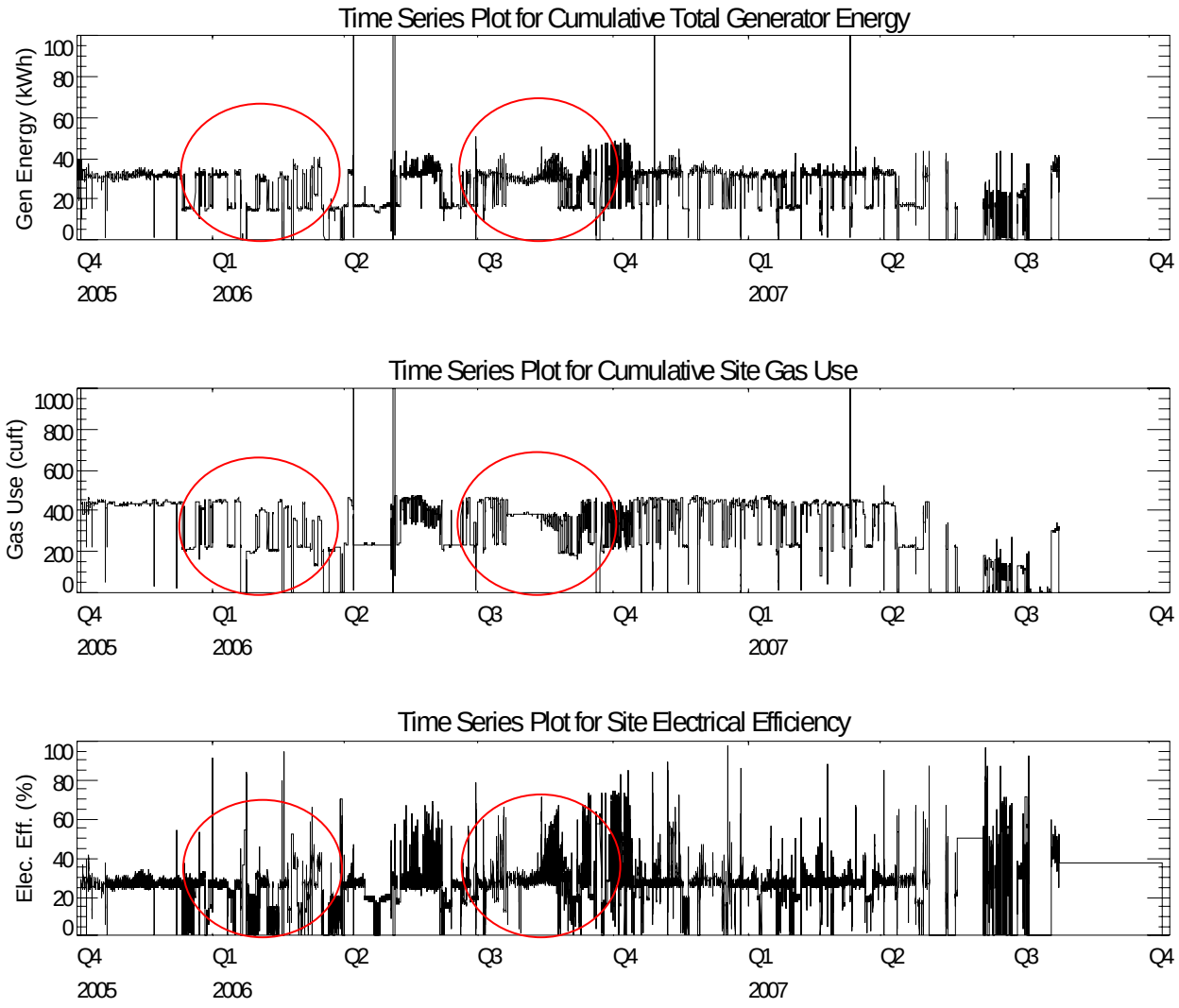

Figure 3. Plots of “Cumul Total Generator Energy”, “Cumul Site Gas Use” and “Site Electrical Efficiency”

CHP Efficiency

From Table 3, the channels used for the calculation of CHP Efficiency are "Cumul Total Generator Energy", "Cumul Site Gas Use" and "Heat To Building Cumul". We see a similar trend to the electrical efficiency where CHP efficiency does not match the input channels, which are showing normal operation. This results in a large number of periods where the calculated value of CHP efficiency is higher than the reported value as shown in Figure 4.

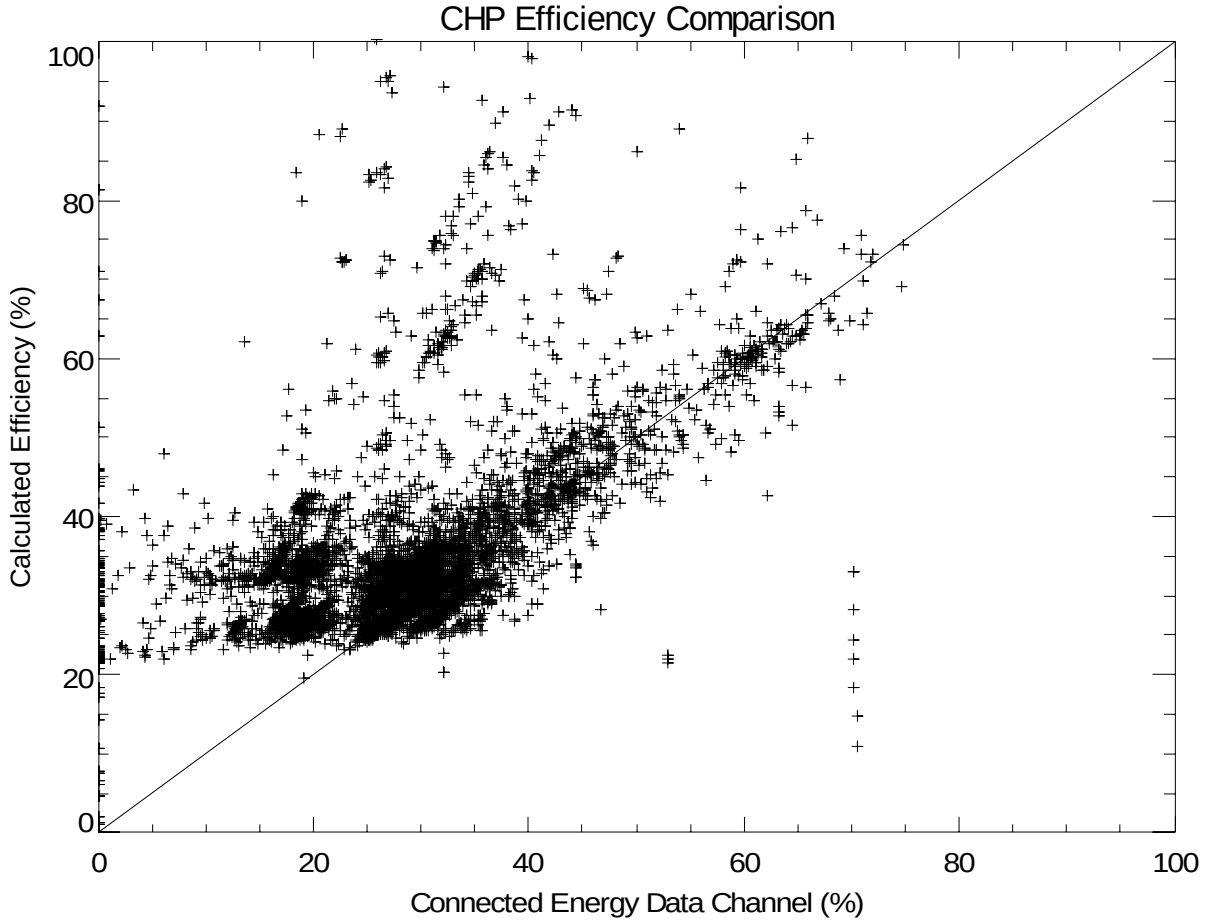

Figure 4. Plot of Calculated CHP Efficiency vs. CE CHP Efficiency Data Channel

Other Data Questions

Total Generator Power

There are some data channels in the dataset that, according to their description, appear to be the same thing however the values being reported are different. One example of these is the "Total Generator Power" and "Actual Power" channels. Figure 5 shows a time series of the two data channels and the total of the Engine 1 and Engine 2 power channels. The "Total Power" matches the sum of the two individual generator channels while there is significantly more scatter in the "Total Generator Power" channel. The "Total Power" is believed to be more accurate.

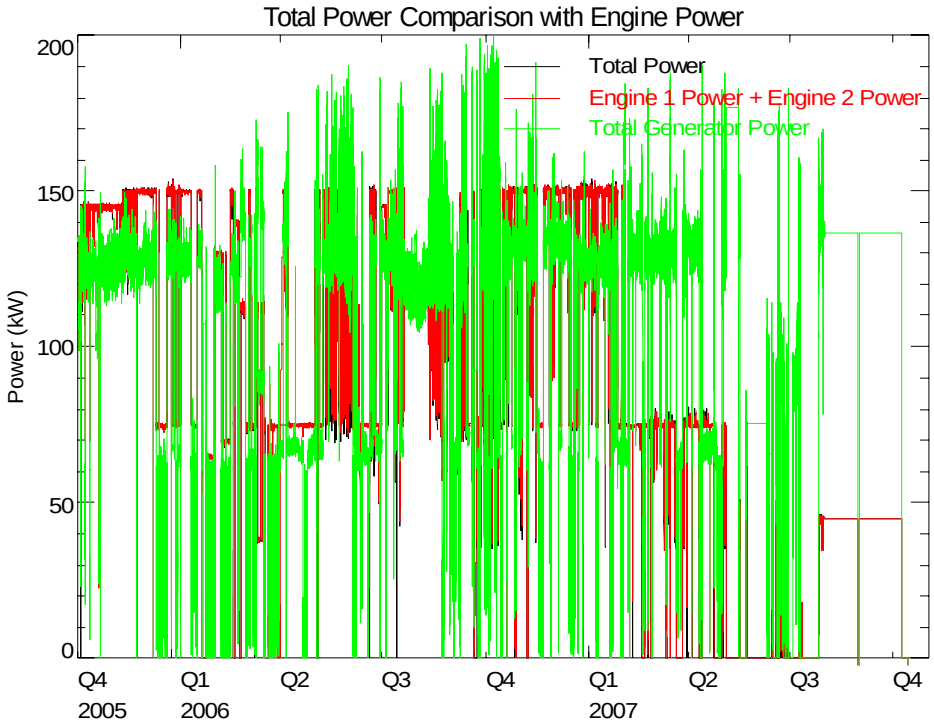

Figure 5. Time Series of Several Total Generator Demand Data

Engine 1 Cumul. Heat Recovered

From Table 3, the corroborating formula for "Eng 1 Cumul. Heat Recovered" is presented graphically in Figure 6. By definition heat recovered should be less than the available heat after combustion and production of electricity. From the figure below we see that for engine 1 the heat recovered is greater than the leftover fuel input for the entire period.

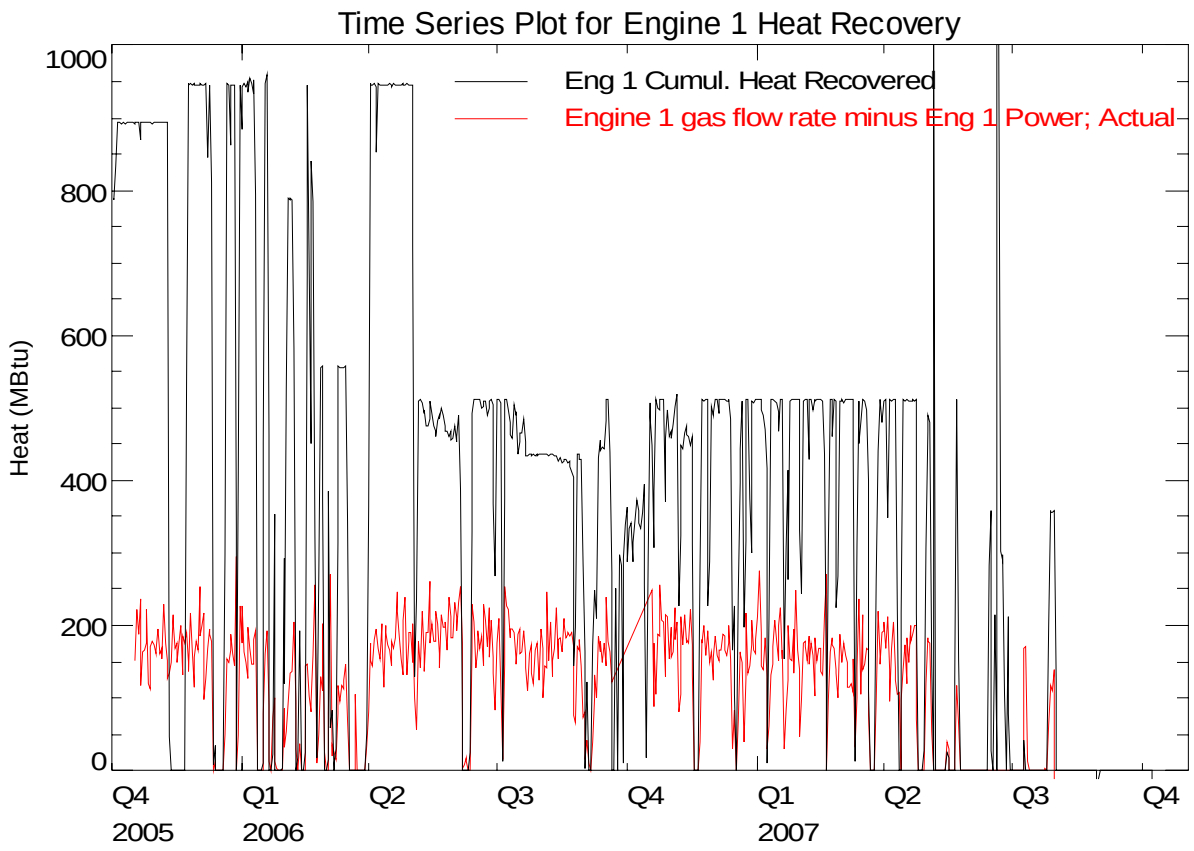

Figure 6. Engine 1 Heat Recovery Corroborating Formula Check

Engine 2 Cumul. Heat Recovered

From Table 3, the corroborating formula for "Eng 2 Cumul. Heat Recovered" is presented graphically in Figure 7. From the figure below we see that for engine 2 the heat recovered is greater than the heat generated until the third quarter (Q3) of 2006 after which heat generated is marginally more than the heat recovered. Heat recovery data for engine 2 seems to be reporting correct data after the third quarter (Q3) of 2006 until the engine fails to report new data (see Figure 8).

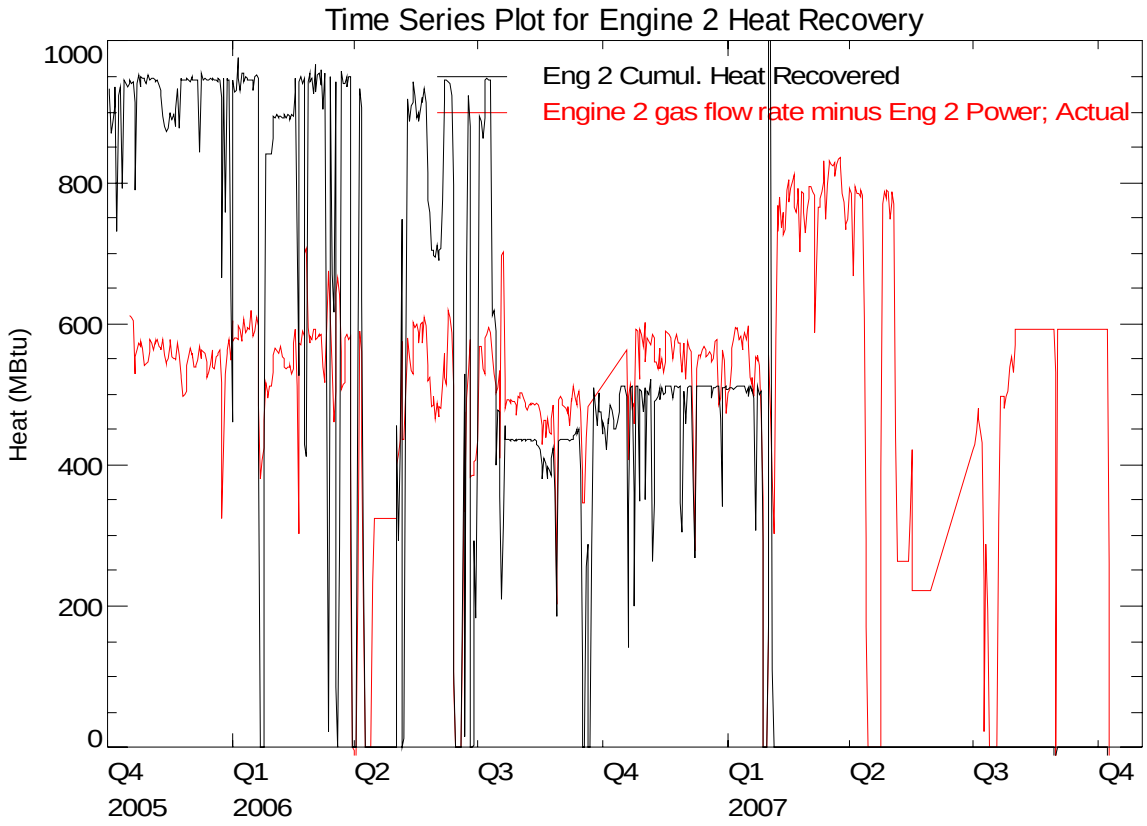

Figure 7. Time Series Plot of Cogen Return after Dump Temp

Engine 2 Operation

The individual channels for Engine 2 are as shown in Figure 8. From the Figure we see that all the channels (i.e., "Eng 2 Cumul. Energy Prod.", "Eng 2 Power; Actual", etc.) cease reporting good data from the beginning of February 2007 with the exception of "Engine #2 Cumul Gas Use".

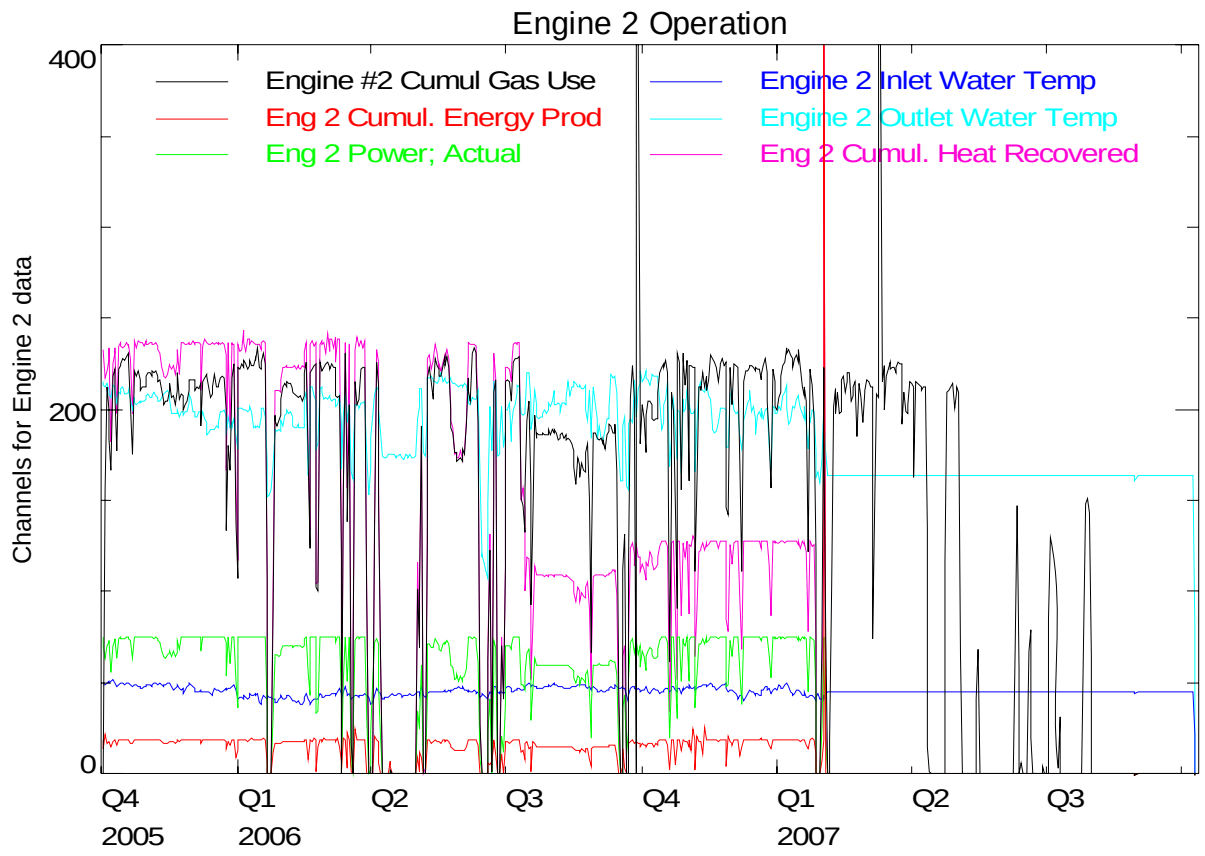

Figure 8. Plot of Data for Engine 2

Assumptions

1. The "Site Total CHP Efficiency" and "Site Electrical Efficiency" data channels do not match the calculation from source data. A calculation from the source data will be used for the online data system.
2. "Engine #1 Cumul Gas Use" and "Engine #1 Gas Flow Rate" channels are reported twice in the raw data file headers and it will be assumed that the second occurrence of each represents data for engine 2.

Summary Questions

Here is a summary of the questions from a review of the data set:

1. How is the heat recovery for each engine calculated? The reported values exceed the maximum possible heat recovery (i.e. fuel input minus power output).
2. Why do virtually all of the data channels for engine 2 (with the notable exception of "Engine #2 Cumul Gas Use") stop reporting good data since February 2007?
3. Do "Eng 1 Cumul. Heat Recovered" and "Eng 2 Cumul. Heat Recovered" represent useful heat recovery only? Or does it include useful and unused heat recovery?

Recommendations

The data for this site has been included in the DG/CHP System. There is a still a question as to what the cumulative heat recovered channels represent; they are currently included in the DG/CHP System as useful heat recovery. If this assumption is not correct, than that data needs to be removed.

Data Channel Summary

Table 4. Summary of Data Channels From CE

Connected Energy Data Channel	Units	Column Label	Accumulator	Min	Max	Avg
Cumul. Site Gas Use	cuft	C	Yes	0.00	10,774,193	363.57
Engine #1 Cumul Gas Use	cuft	D	Yes	0.00	5,883,410	169.55
Engine #1 Cumul Gas Use	cuft	E	Yes	0.00	5,379,850	141.78
Site Gas Use, MTD	cuft	F	Yes	-57,211	3,881,027	462.57
Site Gas Use, YTD	cuft	G	Yes	0.00	0.00	0.00
Site Gas Flow Rate	cfm	H	No	0.00	36.80	11.17
Engine #1 Gas Flow Rate	cfm	I	No	0.00	22.60	5.62
Engine #1 Gas Flow Rate	cfm	J	No	0.00	48.40	5.50
Cumul Total Generator Energy	kWh	K	Yes	0.00	834,821	46.82
Total Generator Power	kW	L	No	0.00	199.57	105.31
CentryPIA Battery Status	-	M	No	0.00	1.00	0.69
Heat to Building Rate	MBtuh	N	No	0.00	270.25	5.40
Heat to Building Cumul	MBtu	O	Yes	0.00	93,409,525,760	666,040
Site Total CHP Efficiency	%	P	No	0.00	97.40	10.31
Site Electrical Efficiency	%	Q	No	0.00	97.30	12.71
Eng 1 O2 Sensor	-	R	No	0.00	923.10	314.54
Eng 2 O2 Sensor	-	S	No	0.00	884.92	356.41
Eng 1 Voltage, Average	V	T	No	0.00	227.33	212.52
Eng 1 Voltage, Phase 1-2	V	U	No	0.00	240.91	215.00
Eng 1 Voltage, Phase 1-3	V	V	No	0.00	226.60	211.63
Eng 1 Voltage, Phase 2-3	V	W	No	0.00	236.68	211.03
Eng 2 Voltage, Average	V	X	No	0.00	226.65	213.25
Eng 2 Voltage, Phase 1-2	V	Y	No	0.00	229.49	214.32
Eng 2 Voltage, Phase 1-3	V	Z	No	0.00	228.63	213.43
Eng 2 Voltage, Phase 2-3	V	AA	No	0.00	225.84	211.84
Eng 1 Logic Voltage	mV	AB	No	0.00	5,081	4,836
Eng 2 Logic Voltage	mV	AC	No	0.00	5,164	4,888
Eng 1 Analog Voltage	mV	AD	No	0.00	11,826	11,446
Eng 2 Analog Voltage	mV	AE	No	0.00	11,780	11,413
Eng 1 Battery Voltage	mV	AF	No	0.00	14,165	13,144
Eng 2 Battery Voltage	mV	AG	No	0.00	13,799	13,223
Eng 1 Current, Average	Amps	AH	No	0.00	254.61	165.80
Eng 1 Current, Phase 1	Amps	AI	No	0.00	367.10	164.11
Eng 1 Current, Phase 2	Amps	AJ	No	0.00	452.07	163.31
Eng 1 Current, Phase 3	Amps	AK	No	0.00	448.10	170.27
Eng 2 Current, Average	Amps	AL	No	0.00	390.15	140.82
Eng 2 Current, Phase 1	Amps	AM	No	0.00	468.30	137.69
Eng 2 Current, Phase 2	Amps	AN	No	0.00	356.86	141.18
Eng 2 Current, Phase 3	Amps	AO	No	0.00	257.88	143.61
Eng 1 Power Setpoint	kW	AP	No	0.00	75.00	65.05
Eng 2 Power Setpoint	kW	AQ	No	0.00	75	58.83

Connected Energy Data Channel	Units	Column Label	Accumulator	Min	Max	Avg
Eng 1 Cumul. Energy Produced	kWh	AR	Yes	0.00	1,946,860	380.36
Eng 2 Cumul. Energy Prod	kWh	AS	Yes	0.00	1,779,960	204.29
Total Power	kW	AT	No	0.00	154.20	93.09
Eng 1 Power, Actual	kW	AU	No	0.00	79.94	52.51
Eng 2 Power, Actual	kW	AV	No	0.00	80.13	45.15
Eng 1 Power, Apparent	kVA	AW	No	0.00	94.68	62.67
Eng 2 Power, Apparent	kVA	AX	No	0.00	95.14	53.35
Eng 1 Power, Reactive	kVAr	AY	No	0.00	52.29	34.17
Eng 2 Power, Reactive	kVAr	AZ	No	0.00	57.99	28.30
Eng 1 Power Factor	-	BA	No	0.00	86.23	64.61
Eng 2 Power Factor	-	BB	No	0.00	88.87	53.76
Eng 1 Voltage Angle, Phase 1-2	deg	BC	No	0.00	68.85	61.31
Eng 1 Voltage Angle, Phase 2-3	deg	BD	No	0.00	110.94	59.44
Eng 2 Voltage Angle, Phase 1-2	deg	BE	No	0.00	66.88	59.97
Eng 2 Voltage Angle, Phase 2-3	deg	BF	No	0.00	61.49	58.84
Eng 1 Current Angle, Phase 1	deg	BG	No	0.00	307.58	232.46
Eng 1 Current Angle, Phase 2	deg	BH	No	0.00	322.81	43.55
Eng 1 Current Angle, Phase 3	deg	BI	No	0.00	188.64	137.02
Eng 2 Current Angle, Phase 1	deg	BJ	No	0.00	301.07	190.81
Eng 2 Current Angle, Phase 2	deg	BK	No	0.00	316.79	36.40
Eng 2 Current Angle, Phase 3	deg	BL	No	0.00	243.44	113.91
Eng 1 Barometric Abs Press	ft-H2O	BM	No	0.00	31.40	29.40
Eng 2 Barometric Abs Press	ft-H2O	BN	No	0.00	30.80	17.19
Eng 1 Manifold Abs Press	psi	BO	No	0.00	31.05	24.43
Eng 2 Manifold Abs Press	psi	BP	No	0.00	30.60	15.31
Eng 1 Speed	rpm	BQ	No	0.00	2,003.52	1,411.17
Eng 2 Speed	rpm	BR	No	0.00	1,849.13	1,160.32
Eng 1 Temperature Setpoint	F	BS	No	0.00	236.00	221.50
Eng 2 Temperature Setpoint	F	BT	No	0.00	234.99	219.73
Eng 1 Enclosure Temp	F	BU	No	0.00	195.66	140.27
Eng 2 Enclosure Temp	F	BV	No	0.00	175.08	122.37
Eng 1 Oil Temperature	F	BW	No	0.00	224.50	174.37
Eng 2 Oil Temperature	F	BX	No	0.00	223.36	167.27
Eng 1 Inlet Water Temp	F	BY	No	0.00	58.09	45.85
Eng 2 Inlet Water Temp	F	BZ	No	0.00	53.60	43.91
Eng 1 Coolant Temp	F	CA	No	0.00	224.72	182.47
Eng 2 Coolant Temperature	F	CB	No	0.00	233.31	180.04
Eng 1 Outlet Water Temp	F	CC	No	0.00	248.74	190.87
Eng 2 Outlet Water Temp	F	CD	No	0.00	233.79	185.09
Eng 1 Catalyst Outlet Temp	F	CE	No	0.00	168.17	93.90
Eng 2 Catalyst Outlet Temp	F	CF	No	0.00	141.97	83.76
Eng 1 Catalyst Inlet Temp	F	CG	No	0.00	168.18	87.85
Eng 2 Catalyst Inlet Temp	F	CH	No	0.00	143.71	75.42
Eng 1 Customer Temp #1	F	CI	No	0.00	36.38	24.30
Eng 2 Customer Temp #1	F	CJ	No	0.00	31.60	22.29

Connected Energy Data Channel	Units	Column Label	Accumulator	Min	Max	Avg
Eng 1 Customer Temp #2	F	CK	No	0.00	36.29	24.31
Eng 2 Customer Temp #2	F	CL	No	0.00	31.40	22.30
Eng 1 Customer Temp #3	F	CM	No	0.00	36.59	24.29
Eng 2 Customer Temp #3	F	CN	No	0.00	31.40	22.22
Eng 1 Customer Temp #4	F	CO	No	0.00	36.37	24.26
Eng 2 Customer Temp #4	F	CP	No	0.00	31.49	22.20
Eng 1 Customer Temp #5	F	CQ	No	0.00	36.30	24.28
Eng 2 Customer Temp #5	F	CR	No	0.00	31.49	22.28
Eng 1 Customer Temp #6	F	CS	No	0.00	36.48	24.29
Eng 2 Customer Temp #6	F	CT	No	0.00	31.30	22.20
Eng 1 Customer Temp #7	F	CU	No	0.00	36.30	24.31
Eng 2 Customer Temp #7	F	CV	No	0.00	31.30	22.27
Eng 1 Customer Temp #8	F	CW	No	0.00	36.60	24.29
Eng 2 Customer Temp #8	F	CX	No	0.00	31.40	22.20
Eng 1 Frequency	hz	CY	No	0.00	61.19	58.31
Eng 2 Frequency	hz	CZ	No	0.00	60.10	58.31
Eng 1 Cumul. Heat Recovered	MBtu	DA	Yes	0.00	21,657,540	2,152.49
Eng 2 Cumul. Heat Recovered	MBtu	DB	Yes	0.00	14,088,920	461.82
Eng 1 Total Operating Hours	hrs	DC	Yes	0.00	27,192	0.56
Eng 1 Oper Hours, MTD	hrs	DD	Yes	0.00	0.00	0.00
Eng 1 Oper Hours, YTD	hrs	DE	Yes	0.00	0.00	0.00
Eng 2 Total Operating Hours	hrs	DF	Yes	0.00	23,904	0.62
Eng 2 Oper Hours, MTD	hrs	DG	Yes	0.00	0.00	0.00
Eng 2 Oper Hours, YTD	hrs	DH	Yes	0.00	0.00	0.00
Eng 1 Total Starts	-	DI	Yes	0.00	1,081.21	0.02
Eng 2 Total Starts	-	DJ	Yes	0.00	1,115.15	0.02
Eng 1 Long Term Block Learn	-	DK	No	0.00	199.99	83.64
Eng 2 Long Term Block Learn	-	DL	No	0.00	197.36	76.20
Eng 1 Short Term Block Learn	-	DM	No	0.00	199.99	123.82
Eng 2 Short Term Block Learn	-	DN	No	0.00	199.71	122.58
Eng 1 Fuel Valve Position	-	DO	No	0.00	500.00	37.71
Eng 2 Fuel Valve Position	-	DP	No	0.00	500.00	132.26
Eng 1 Throttle	-	DQ	No	0.00	100.00	39.98
Eng 2 Throttle	-	DR	No	0.00	100.00	32.67