Shop-Rite – Brooklyn, NY

Data Integrator Initial Data Summary

Site Description

Shop-Rite is a supermarket located in Brooklyn, NY. The facility has a 140 kW Hess engine running on natural gas. Heat is recovered from the engine by a jacket water loop as well as an exhaust HX. The useful heat recovery loads are the Yazaki absorption chiller and a desiccant dryer. The Yazaki chiller, in series with an electric chiller, provides chilled water for refrigerant subcooling. The chilled water loop also removes heat from the intercooler on the engine.

Data Description

Connected Energy (CE) provides the data for this site via comma-separated variable (CSV) files uploaded once a day. The data set consists of 90 channels. The data are provided at 15-minute intervals. CDH assigns engineering units based on the CE web site or based on previous experience. The data set includes channels for electrical generation, heat recovery performance and power quality parameters for the generator and loop equipment. Figure 1 shows an image of the CE data system used as a reference in data verification.

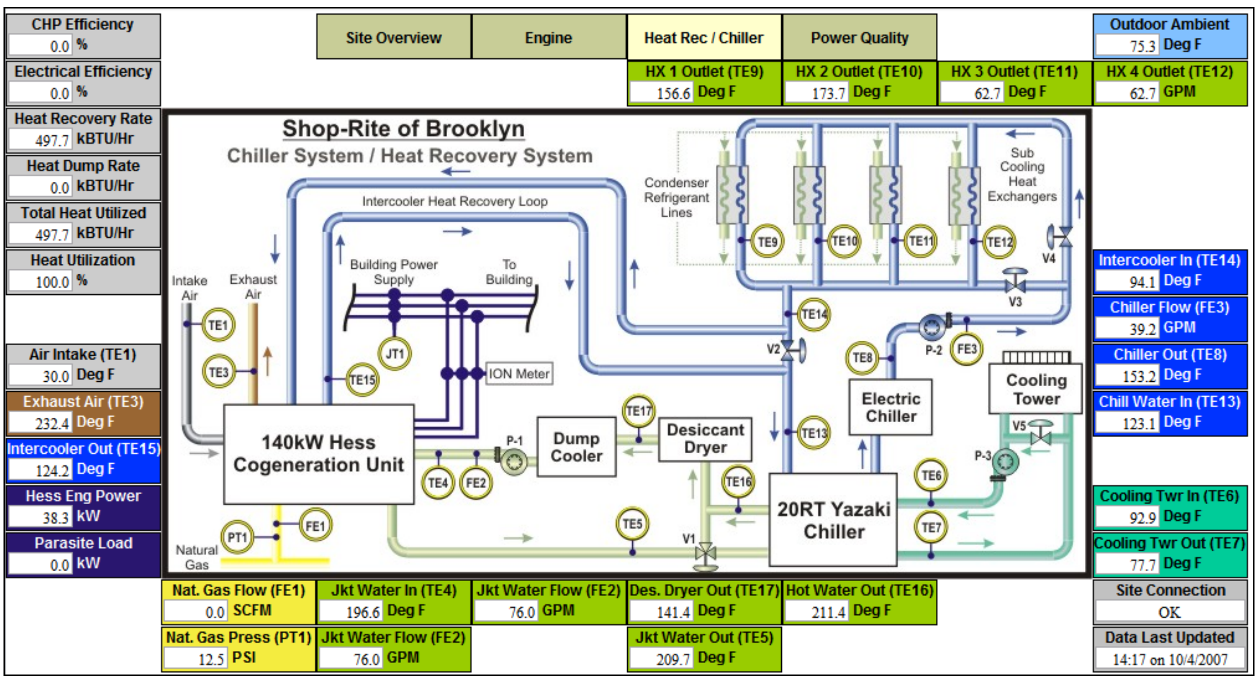

Figure 1. Screen Capture of Connected Energy Webpage

DG/CHP Integrated Data System Channels

Table 1 shows the rawdata channels used in the DG/CHP Integrated Data System for this facility.

Table 1. Data Integrator Database Mapping

Integrated Data System Channel	Units of Measure	Raw Data Column Descriptions [col][1]	Raw Data Units	Calculation Formula
DG/CHP Generator Output	kWh/int	Generator Total Energy Product [BW]	kWh	$=[BW]$
DG/CHP Generator Output Demand	KW/int	Generator Power, Total [BX]	kW	$=[BX]$
DG/CHP Generator Gas Input	cuft/int	Natural Gas to Engine Cumul [C]	cuft	$=[C]$
Total Facility Purchased Energy	kWh/int	N/A	N/A	N/A
Total Facility Purchased Demand	KW	N/A	N/A	N/A
Other Facility Gas Use	cuft/int	N/A	N/A	N/A
Total Facility Energy	kWh/int	Calculated		
Total Facility Demand	kW	Calculated		
Useful Heat Recovery	MBtu/int	Total Heat Used Rate [AC]	MBtu/h	$=[AC]*$ 15 minutes/int ÷ 60 minutes/hour
Unused Heat Recovery	MBtu/int	Dump Cooler Heat Dump Rate [AD]	MBtu/h	$=[AD]*$ 15 minutes/int ÷ 60 minutes/hour
Status/Runtime of DG/CHP Generator	Hours/int	Calculated		
Ambient Temperature	°F	Outdoor Ambient Temp [L]	°F	$=[L]$
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 given in square brackets and shown in the calculation formulas.

Int - interval

Data Verification

Calculated Value Corroboration

Table 2 shows the calculations of heating loads for the various channels for which corroborating data was identified. For the engine channels, the Connected Energy engine diagrams for the site indicate a flow through the heat exchangers of 141 gpm. There is a cogen loop return flow rate channel for the heat recovery end use channels. For heating loads 0.5 MBtuh/gpm-F is a standard estimate of the energy input to heat water; given the flow rate and the rise in temperature, the heat input can be easily calculated. For this table, calculations within 10% of the data reported in the heat recovery column are marked as passing the check.

Table 2. Checks on Heating Load Calculations

Channel Name [Label][1]	**Corroborating Columns [Label][1]**	**Corroborating Formula**	**Passed Check**
Total Heat Used Rate [AC]	Engine Jacket Water Flow [E], Jacket Water Outlet Temp [P], Desiccant Outlet Temp [AB]	$=([P]-[AB])*0.5*[E]$	Yes
Dump Cooler Heat Dump Rate [AD]	Engine Jacket Water Flow [E], Jacket Water Inlet Temp [O], Desiccant Outlet Temp [AB]	$=([AB]-[O])*0.5*[E]$	Yes
Cogen Heat Recovery Rate [AI]	Engine Jacket Water Flow [E], Jacket Water Inlet Temp [O], Jacket Water Outlet Temp [P]	$=([P]-[O])*0.5*[E]$	Yes
Total Electrical Efficiency [BG][2]	Natural Gas to Engine Cumul [C], Total Heat Used Rate [AC], Generator Total Energy Product [BW]	$=\frac{[BW]*3.413}{[C]*0.930}$	Yes
Total CHP Efficiency [BF][2]	Natural Gas to Engine Cumul [C], Total Heat Used Rate [AC][3], Generator Power – Total [BX]	$=\frac{[BW]*3.413+[AC]/4}{[C]*0.930}$	Yes

[1] – The Raw Data Column Description listed is from the Connected Energy CSV files, the corresponding column label from Excel is in square brackets and used for reference 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.
[3] – The Heat Rate is divided by 4 to calculate the MBtus recovered per interval (see Table 1).

In Table 2, rows in red show heating loads where the CE data did not agree with the calculations. The formula for the calculation is listed in the table. All of the channels now match their corroborating formula. The Total Heat Used Rate has matched since November 28.

Other Data Questions

Channels Always Reporting Zeroes

There are some channels in the CE data set that report zero for all the data collected prior to November 28th. Some of these channels may be reporting zero as legitimate data, others could be zero because of sensors not installed yet or sensors that have failed. These include, but are not limited to:

- “Natural Gas to Engine”
- “Chiller Power Cumul and Chiller Power Rate”
- “Parasitic Power Load Cumul and Parasitic Power Load Rate”
- “Dump Cooler Heat Dump Rate”
- “Total CHP Efficiency”
- “Cogen Unit Electrical Efficiency”
- “Generator Power – Phase A”

Total Heat Used Rate

From the system diagram (Figure 1), the Total Heat Used Rate should be calculated using the "Jacket Water Outlet Temp", the "Desiccant Outlet Temp" and the "Engine Jacket Water Flow" (see Table 2). The calculated heat rate was much higher than the data reported by Connected Energy prior to November 28th. An apparent correction was made to the calculation of this channel and the data now looks correct (see Figure 2).

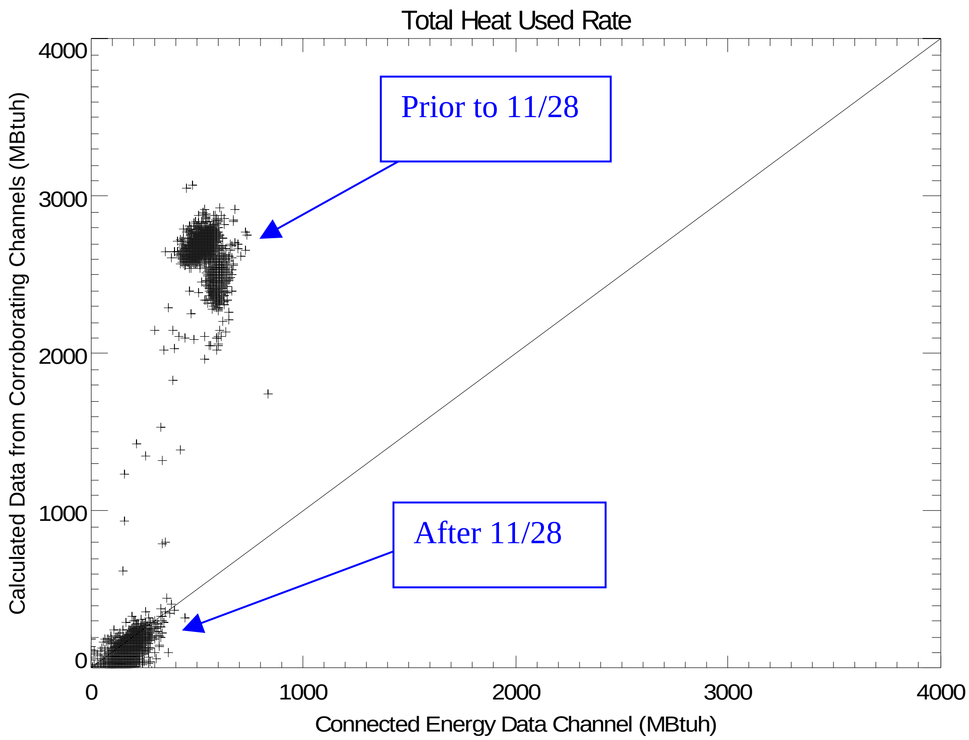

Figure 2. Time Series Plot of Electric Booster Inlet and Outlet Temperature

Jacket Water Loop Temperatures

Figure 3 shows a time series plot of the jacket water loop temperatures for the data collected so far. The Jacket Water Outlet Temp and the Yazaki Hot Water Outlet Temp are always the same, indicating the chiller is not running. The Desiccant Outlet Temp is lower than the Jacket Water Inlet Temp, from the Connected Energy diagram, that should not be possible.

Figure 3. Time Series of Jacket Water Loop Temperatures

Chilled Water Loop Temperatures

Figure 4 shows a time series plot of the chilled water loop temperatures for the data collected so far. The Chilled Water Outlet Temp is higher than the Chilled Water Inlet Temp, from the Connected Energy diagram, that should not be possible. Chilled water temperatures are also too high for a traditional chilled water system.

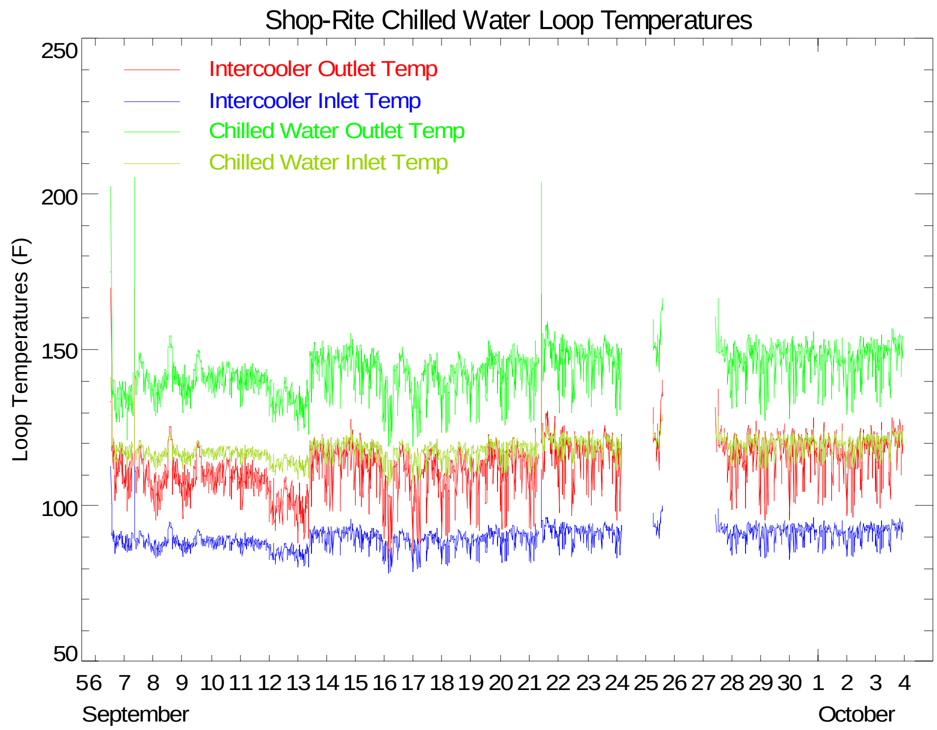

Figure 4. Time Series of Chilled Water Loop Temperatures

Assumptions

There are no notable assumptions for the data at this site.

Summary Questions

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

1. Why is the Desiccant Outlet Temp lower than the Jacket Water Inlet Temp when the system diagram indicates that is not possible?
2. Why is the Chilled Water Outlet Temp higher than the Chilled Water Inlet Temp?

Recommendations

There are no outstanding problems with this dataset and it has been loaded into the DG/CHP database. Data will be shown in the data system beginning with November 28th, data before the data has been provided but is not reliable enough for inclusion.

Database Details

Table 3. Connected Energy Data Channel Summary

Connected Energy Data Channel	CE Schematic Label	Units	Column Label	Accum-ulator	Min	Max	Avg
Natural Gas to Engine Cumul		cuft	C	Yes	0	138800	195.45
Natural Gas to Engine	FE1	cfm	D	No	0	15.79	11.5
Engine Jacket Water Flow	FE2	gpm	E	No	0	86	72.14
Chilled Water Loop Flow	FE3	gpm	F	No	16.08	41.04	35.72
Chiller Power Cumul		kWh	G	No	0	8	0.58
Parasitic Power Load Cumul		kWh	H	No	0	19297.8	3.13
Chiller Power Rate		kW	I	No	0	5.47	0
Parasitic Power Load Rate		kW	J	No	0	324.68	16.99
Natural Gas Supply Pressure	PT1	psi	K	No	10.71	16.61	14.41
Outdoor Ambient Temp		F	L	No	7.01	60.09	31.07
Hess Intake Air Temp	TE1	F	M	No	16.61	30	30
Hess Exhaust Air Temp	TE3	F	N	No	49.2	243.44	205.33
Jacket Water Inlet Temp	TE4	F	O	No	56.51	245.01	160.72
Jacket Water Outlet Temp	TE5	F	P	No	49.05	203.92	169.91
Cooling Tower Inlet Temp	TE6	F	Q	No	36.41	112.76	58.36
Cooling Tower Outlet Temp	TE7	F	R	No	34.31	99.54	54.69
Chilled Water Outlet Temp	TE8	F	S	No	30.18	102.3	45.17
Subcooler HX1 Temp	TE9	F	T	No	44.54	89.09	57.77
Subcooler HX2 Temp	TE10	F	U	No	56.64	92.24	67.35
Subcooler HX3 Temp	TE11	F	V	No	41.48	85.78	54.79
Subcooler HX4 Temp	TE12	F	W	No	41.77	86.06	55.03
Chilled Water Inlet Temp	TE13	F	X	No	13.69	85.42	53.53
Intercooler Inlet Temp	TE14	F	Y	No	17.02	87.92	55.61
Intercooler Outlet Temp	TE15	F	Z	No	37.69	106.09	56.02
Yazaki Hot Water Outlet Temp	TE16	F	AA	No	57.29	238	205.13
Desiccant Outlet Temp	TE17	F	AB	No	30	221.65	167.3
Total Heat Used Rate		MBtuh	AC	No	0	2845.36	132.92
Dump Cooler Heat Dump Rate		MBtuh	AD	No	0	738.11	287.28
Cogen Heat Recovery Rate kW		kWe	AE	No	0	665.5	100.39
Heat Utilization		%	AF	No	0	99.81	30.21
Total CHP Efficiency		%	AG	No	0	100	62.35
Cogen Unit Electrical Efficiency		%	AH	No	0	43.32	25.26
Cogen Heat Recovery Rate		MBtuh	AI	No	0	2271.99	341.62
Generator Voltage - Average		V	AJ	No	0	122.76	112.06
Generator Voltage - Phase A		V	AK	No	0	123.36	112.3
Generator Voltage - Phase B		V	AL	No	0	122.66	111.86
Generator Voltage - Phase C		V	AM	No	0	122.69	112
Generator Voltage - Phase to Ph		V	AN	No	0	212.75	194.1
Generator Voltage - Phase A-B		V	AO	No	0	212.71	194.12
Generator Voltage - Phase B-C		V	AP	No	0	212.65	193.72

Connected Energy Data Channel	CE Schematic Label	Units	Column Label	Accum-ulator	Min	Max	Avg
Generator Voltage - Phase C-A		V	AQ	No	0	213.68	194.44
Generator Voltage Unbalance		V	AR	No	0	0.31	0.22
Generator Voltage Total THD - Phase A		%	AS	No	0	31.54	1.62
Generator Voltage Total THD - Phase B		%	AT	No	0	22.76	1.59
Generator Voltage Total THD - Phase C		%	AU	No	0	38.96	1.51
Generator Voltage Odd THD - Phase A		%	AV	No	0	4.2	1.51
Generator Voltage Odd THD - Phase B		%	AW	No	0	4.5	1.5
Generator Voltage Odd THD - Phase C		%	AX	No	0	3.4	1.42
Generator Voltage Even THD - Phase A		%	AY	No	0	6.9	0.18
Generator Voltage Even THD - Phase B		%	BZ	No	0	6.7	0.17
Generator Voltage Even THD - Phase C		%	BA	No	0	5.9	0.17
Generator Current - Average		A	BB	No	0	268.74	171.47
Generator Current - Phase A		A	BC	No	0	257.37	164.45
Generator Current - Phase B		A	BD	No	0	268.69	175.37
Generator Current - Phase C		A	BE	No	0	267.37	174.54
Generator Current - Neutral		A	BF	No	0	0	0
Generator Current Unbalance		A	BG	No	0	13.44	4.12
Generator Current Total THD - Phase A		%	BH	No	0	57.67	1.91
Generator Current Total THD - Phase B		%	BI	No	0	40.87	1.88
Generator Current Total THD - Phase C		%	BJ	No	0	2.01	1.3
Generator Current Odd THD - Phase A		%	BK	No	0	9.19	1.68
Generator Current Odd THD - Phase B		%	BL	No	0	12.05	1.93
Generator Current Odd THD - Phase C		%	BM	No	0	10.94	1.7
Generator Current Even THD - Phase A		%	BN	No	0	44.36	0.38
Generator Current Even THD - Phase B		%	BO	No	0	38.83	0.36
Generator Current Even THD - Phase C		%	BP	No	0	35.75	0.34
Generator Current Crest Factor - Phase A		dB	BQ	No	0	2.15	1.3
Generator Current Crest Factor - Phase B		dB	BR	No	0	1.82	1.3
Generator Current Crest Factor - Phase C		dB	BS	No	0	8.71	0.94
Generator Current K Factor - Phase A		-	BT	No	0	1	0.93
Generator Current K Factor - Phase B		-	BU	No	0	1	0.93
Generator Current K Factor - Phase C		-	BV	No	0	0	0
Generator Total Energy Product		kWh	BW	Yes	0	18.42	12.95
Generator Power - Total		kW	BX	No	0	79.12	51.76
Generator Power - Phase A		kW	BY	No	0	25.48	16.67
Generator Power - Phase B		kW	CZ	No	0	26.37	17.52
Generator Power - Phase C		kW	CA	No	0	26.64	17.56
Generator Apparent Power - Total		kVA	CB	No	0	96.84	61.94
Generator Apparent Power - Phase A		kVA	CC	No	0	31.76	19.87
Generator Apparent Power - Phase B		kVA	CD	No	0	33.1	21.1
Generator Apparent Power - Phase C		kVA	CE	No	0	32.8	21.03
Generator Reactive Power		kVAR	CF	No	0	53.99	34.06
Generator Reactive Power - Phase A		kVAR	CG	No	0	17.15	10.81
Generator Reactive Power - Phase B		kVAR	CH	No	0	17.39	11.76

Connected Energy Data Channel	CE Schematic Label	Units	Column Label	Accum-ulator	Min	Max	Avg
Generator Reactive Power - Phase C		kVAR	CI	No	0	18.14	11.58
Generator Power Factor - Total		-	CJ	No	-0.8	1	-0.68
Generator Power Factor - Phase A		-	CK	No	-0.9	1	-0.68
Generator Power Factor - Phase B		-	CL	No	-0.8	1	-0.68
Generator Power Factor - Phase C		-	CM	No	-0.9	1	-0.68
Generator Frequency		hz	CN	No	0	61.02	55.93