MONITORING PLAN

FOR

Burrstone Energy Center LLC

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Submitted to:

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

Submitted by:

Burrstone Energy Center,LLC
22 Century Hill Drive
Latham, NY 12110

CDH Energy Corp.
PO Box 641
2695 Bingley Rd
Cazenovia, NY 13035
(315) 655-1063
www.cdhenergy.com

1. Introduction

The Burrstone Energy Center's cogeneration plant includes four engine-generators that serve the electrical services for three separate facilities near Burrstone Road in Utica, NY:

- Utica College,
- St Lukes Hospital,
- St. Lukes Home.

One 1100 kW engine serves the college, two 1100 kW units serve the hospital, and a 334 kW engine serves the home. All four engines are located in a new facility near the hospital's boiler house. Each engine includes a heat recovery steam generator (HRSG) as well as heat exchangers to transfer heat from the engine jacket water to meet hot water loads in the hospital. Steam from the HRSG offsets boiler steam loads, including summertime loads for a steam-driven absorption chiller (a new steam-fired chiller was recently installed). Engine jacket water heat is used to offset service hot water loads in the hospital facility as well as drive a newly installed hot-water driven 100 ton absorption chiller in Area 7. Dump radiators reject excess heat to ambient when the return water temperature entering the engine HX is too high.

2. Data Collection

A Niagara Tridium system was installed by TBS to control system operation and collect the required monitored performance data for the CHP system. Table 1 lists the points of interest to quantify CHP system performance. Figure 1 through Figure 4 show the locations of these data points in system.

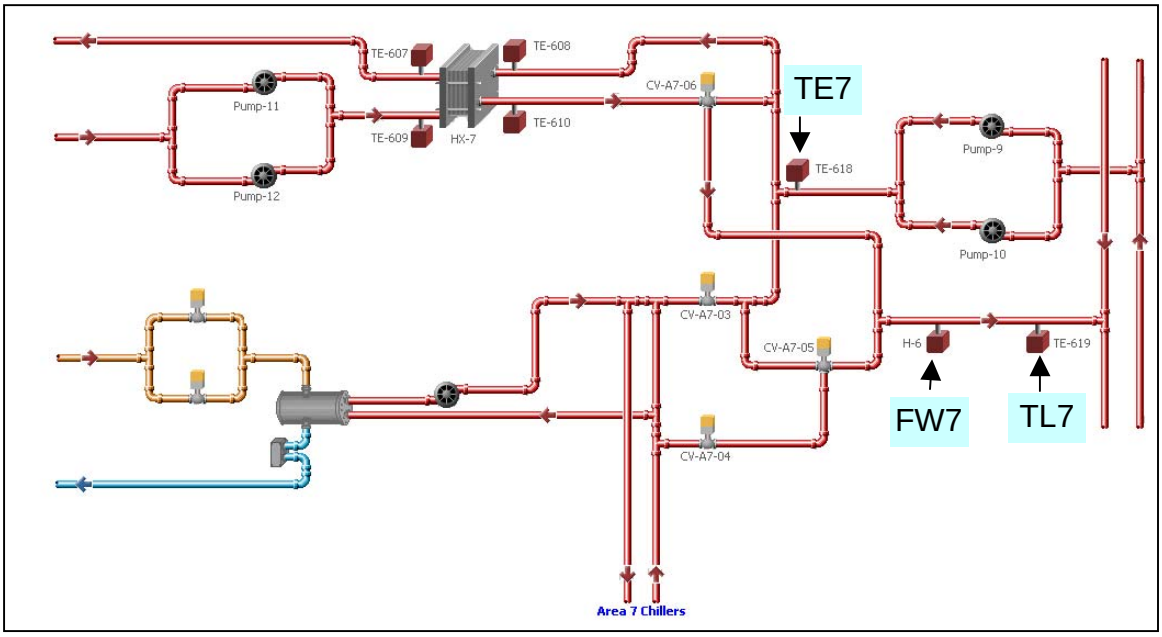

Figure 1. Schematic Showing Data Collected for Area 7 Hot Water Loop

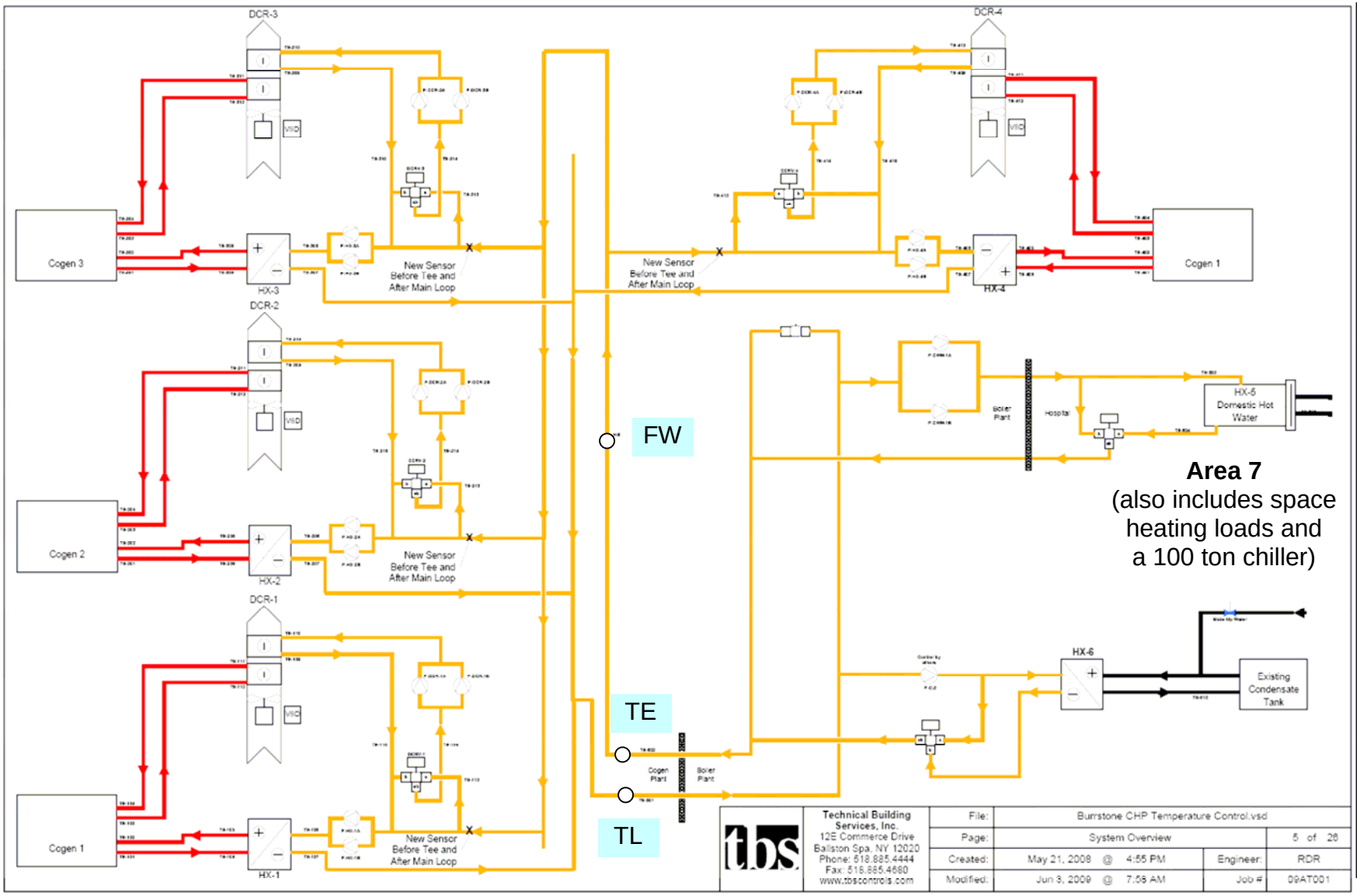

Figure 2. Schematic Showing Location of Measured Points in Hot Water Loop

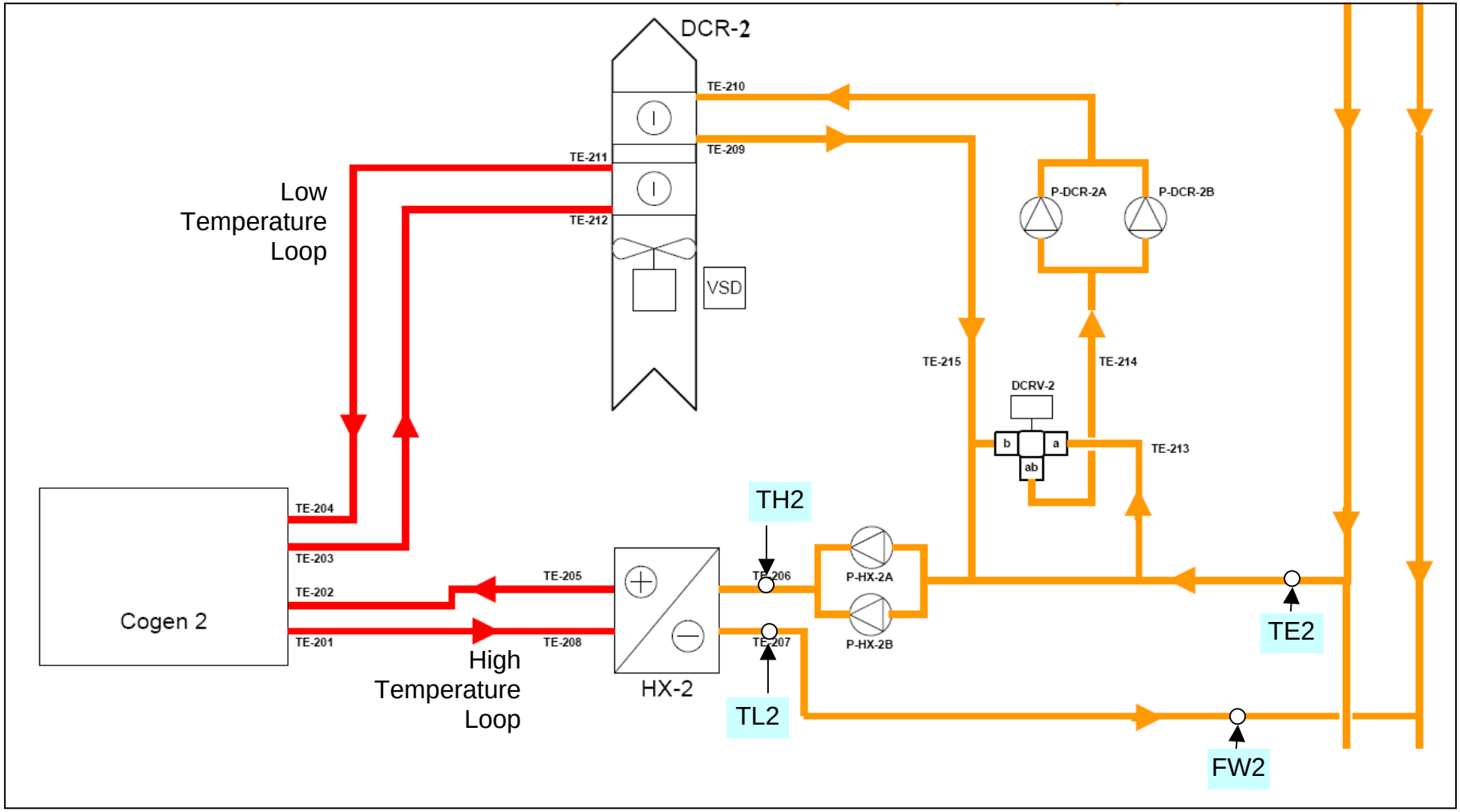

Figure 3. Schematic Showing Data Point Locations for Hot Water Loops on Cogeneration Unit #2 (typical of 1 through 4)

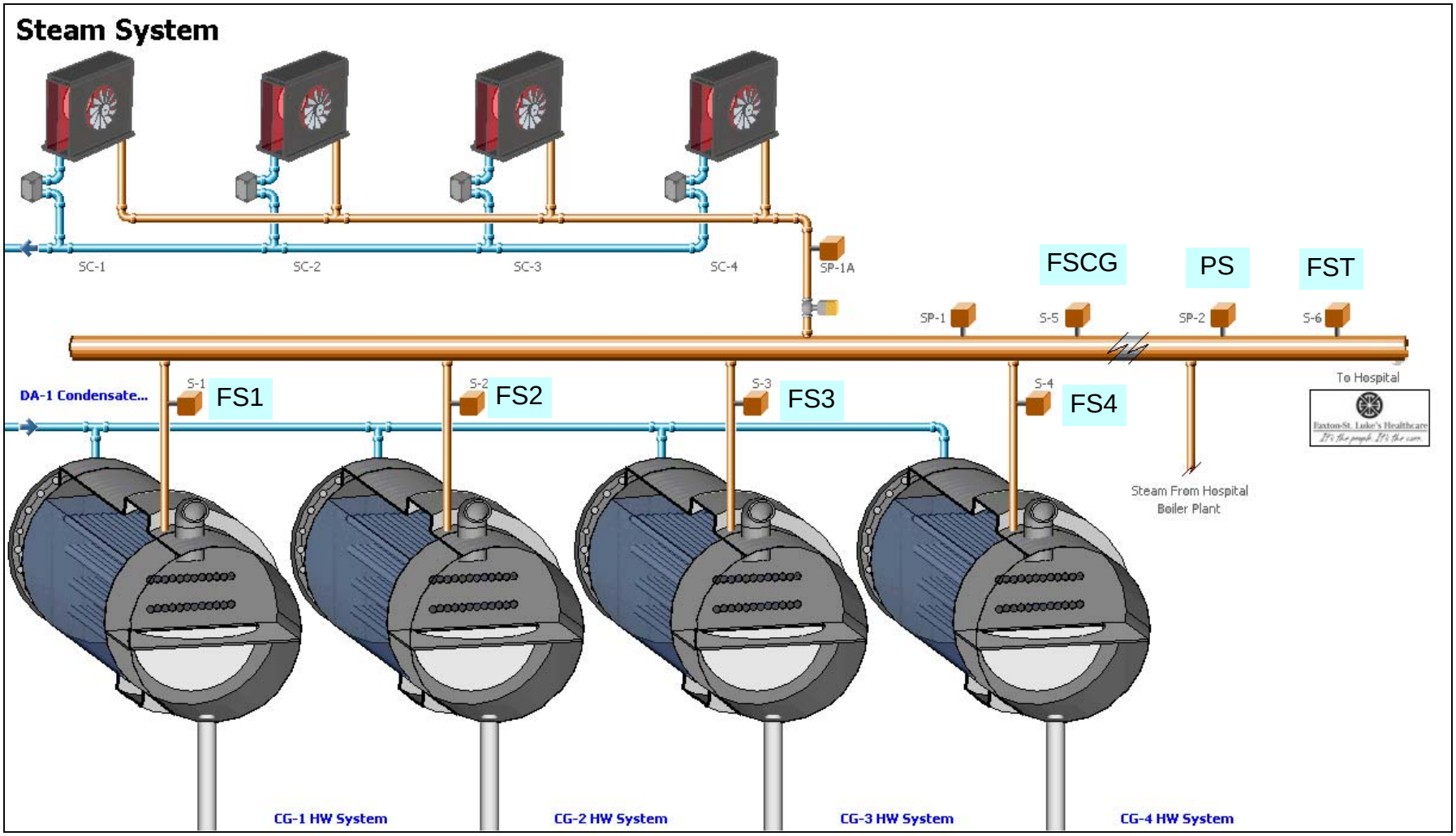

Figure 4. Schematic Showing Data Point Locations for Steam System

Table 1a. List of Data Points Collected from the TBS System

Data Point	TBS "tag" Name	Eng Units	Notes
TAO	Local Outside Dry Bulb	F	
FG1	CG-1 Gas Flow F-2	cf/h	
FG2	CG-2 Gas Flow F-3	cf/h	
FG3	CG-3 Gas Flow F-4	cf/h	
FG4	CG-4 Gas Flow F-5	cf/h	
FG	Cog Plant Gas Flow F-1	cf/h	Combined Eng Gas Flow
FGB	Boiler Plant Hourly Gas Usage	cf/h	Hospital boiler gas use
FW1	CG-1 Water Flow H-1	Gpm	
FW2	CG-2 Water Flow H-2	Gpm	
FW3	CG-3 Water Flow H-3	Gpm	
FW4	CG-4 Water Flow H-4	Gpm	
FW	Cog Plant Water Flow H-5	Gpm	Combined HW flow
FW7	Area 7 Area 7 H-6	Gpm	Flow to Area 7 loads
FS1	CG-1 Steam Flow S-1	lb/h	
FS2	CG-2 Steam Flow S-2	lb/h	
FS3	CG-3 Steam Flow S-3	lb/h	
FS4	CG-4 Steam Flow S-4	lb/h	
FSCG	Steam Condenser Steam Flow S-5	lb/h	Net flow from engines
FST	Boiler Steam Steam Flow S-6	lb/h	Total steam load
PS	Boiler Steam SP-2	Psi	
TH1	CG-1 Sec ENT Temp TE-106	F	TH = entering HX
TH2	CG-2 Sec ENT Temp TE-206	F	
TH3	CG-3 Sec ENT Temp TE-306	F	
TH4	CG-4 Sec ENT Temp TE-406	F	
TL1	CG-1 Sec LVG Temp TE-107	F	TL = leaving HX
TL2	CG-2 Sec LVG Temp TE-207	F	
TL3	CG-3 Sec LVG Temp TE-307	F	
TL4	CG-4 Sec LVG Temp TE-407	F	
TE1	CG-1 Loop ENT Temp TE-113B	F	TE = before dump rad
TE2	CG-2 Loop ENT Temp TE-213B	F	
TE3	CG-3 Loop ENT Temp TE-313B	F	
TE4	CG-4 Loop ENT Temp TE-413B	F	
TL	Cog Plant Loop Lvg Temp TE-601	F	Combined leaving temp
TE	Cog Plant Loop Ent Temp TE-602	F	Combined return temp
TL7	Area 7 TE-619 Area 7 LVG Loop Temp	F	
TE7	Area 7 TE-618 Area 7 ENT Loop Temp	F	

Table 1b. List of Data Points Collected from the TBS System

Data Point	TBS "tag" Name	Eng Units	Notes
WCOL	College Utility Demand Total	kW	College facility meter
WCOL_im	College Utility kWH Import	kWh	
WCOL_ex	College Utility kWH Export	kWh	
WCOL_gen	College Genset Demand Total	kW	"Net" power generated
WCOL_gen_ex	College Genset kWH Export	kWh	"Net" energy generated
WCG1	College CG-1 Total kW	kWh	
WCG1_cum	College CG-1 kWH Produced	kWh	
WHSP1	Hosp Util 1 Demand Total	kW	Hospital facility meter
WHSP1_im	Hosp Util 1 kWH Import	kWh	
WHSP1_ex	Hosp Util 1 kWH Export	kWh	
WHSP2	Hosp Util 2 Demand Total	kW	
WHSP2_ex	Hosp Util 2 kWH Export	kWh	
WHSP2_im	Hosp Util 2 kWH Import	kWh	
WHSP_gen	Hospital Genset Demand Total	kW	"Net" power generated
WHSP_gen_ex	Hospital Genset kWH Export	kWh	"Net" energy generated
WCG2	Hospital CG-2 Total kW	kWh	
WCG2_cum	Hospital CG-2 kWH Produced	kWh	
WCG3	Hospital CG-3 Total kW	kWh	
WCG3_cum	Hospital CG-3 kWH Produced	kWh	
WHOM	Home Utility Demand Total	kW	Home facility meter
WHOM_im	Home Utility kWH Import	kWh	
WHOM_ex	Home Utility kWH Export	kWh	
WHOM_gen	Home Genset Demand Total	kW	"Net" power generated
WHOM_gen_ex	Home Genset kWH Export	kWh	"Net" energy generated
WCG4	Home CG-4 Total kW	kW	
WCG4_cum	Home CG-4 kWH Produced	kWh	

Notes: All kWh readings are cumulative. "Net" refers to generator out minus parasitic power use

Data Collection

The data listed above will be made available at www.becchp.com. This server uses the Niagara Ax/Obix Framework, which is supplied by Tridium. Data are logged at 15-minute intervals. At least once per day, CDH will contact this server, retrieve the newest data, and post it to the CHP website.

3. Data Analysis

The data above will be loaded into NYSERDA CHP Integrated Data System (chp.nyserda.org). This system will appear as three separate facilities on the web site. The table below indicates how the data in Table 1 will be used in the NYSERDA website database.

Table 2. Data Used in NYSERDA CHP Website

Utica College

NYSERDA Database Value	Calculation procedure
Facility Power (kW)	= **WCOL**
(kWh)	= **WCOL_im** - **WCOL_ex** (note 1)
Generator Power (kW)	= **WCOL_gen**
(kWh)	= **WCOL_gen_ex**
Generator Gas Input (cf)	= **FG1**
Useful Heat Recovery (MBtu)	= K_1***FW1***(**TL1** - **TE1**) + K_2***FS1** (note 2,3)
Unused Heat Recovery	= K_1***FW1***(**TE1** - **TH1**)

St. Luke's Hosptial

NYSERDA Database Value	Calculation procedure
Facility Power (kW)	= **WHSP1** + **WHSP2**
(kWh)	= **WHSP1_im** + **WHSP2_im** - **WHSP1_ex** - **WHSP2_ex** (note 1)
Generator Power (kW)	= **WHSP_gen**
(kWh)	= **WHSP_gen_ex**
Generator Gas Input (cf)	= **FG2** + **FG3**
Useful Heat Recovery (MBtu)	= K_1***FW2***(**TL2** - **TE2**) + K_1***FW3***(**TL3** - **TE3**) + K_2***FS2** + K_2***FS3** (note 2,3)
Unused Heat Recovery	= K_1***FW2***(**TE2** - **TH2**) + K_1***FW3***(**TE3** - **TH3**)

St. Luke's Home

NYSERDA Database Value	Calculation procedure
Facility Power (kW)	= **WHOM**
(kWh)	= **WHOM_im** - **WHOM_ex** (note 1)
Generator Power (kW)	= **WHOM_gen**
(kWh)	= **WHOM_gen_ex**
Generator Gas Input (cf)	= **FG1**
Useful Heat Recovery (MBtu)	= K_1***FW4***(**TL4** - **TE4**) + K_2***FS4** (note 2,3)
Unused Heat Recovery	= K_1***FW4***(**TE4** - **TH4**)

Notes: 1 - The website convention is that exported facility power is negative
2 - K_1 - 0.49 MBtu/ºF-gpm
K_2 - hfg for steam at pressure **PS**. Approx. 1.00 MBtu/lb at 120 psig
3 - All heat is actually used in the Hospital, this value is produced by the engine in this facility

While all heat is actually used in the hospital, we plan to put the heat associated with the engines in each facility into the "Useful" and "Unused" Heat Recovery variables for that facility. This will allow the CHP efficiency to have meaning in each case.

Other useful relationships for checking and understanding the data from Burrstone are given below:

- **FG** should equal the sum of **FG1, FG2, FG3** and **FG4**
- The difference between **FSCG** and sum of **FS1, FS2, FS3** and **FS4** corresponds to the about of steam dumped by the steam condensers
- The difference between **FST** and **FSCG** is the amount of steam provided by ST Luke's boilers.
- The variable **WCOL_gen** and **WCOL_gen_ex** correspond to the "Net" power produced by the Cogen Unit #1. **WCG1** and **WCG1_cum** correspond to the "gross" generator output for Cogen #1.
- The variable **WHSP_gen** and **WHSP_gen_ex** correspond to the "Net" power produced by the Cogen Units #2 and #3. **WCG2** and **WCG2_cum** correspond to the "gross" generator output for Cogen #2. **WCG3** and **WCG3_cum** correspond to the "gross" generator output for Cogen #3.
- The variable **WHOM_gen** and **WHOM_gen_ex** correspond to the "Net" power produced by the Cogen Unit #4. **WCG4** and **WCG4_cum** correspond to the "gross" generator output for Cogen #4.
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