Schwab House Data Integrator Notes

This site is a CHP system, operated by Aegis Energy, which includes four (4) AEGEN ThermoPower 75 75 kW engine generator units. Thermal output from the units will be used to meet various space heating and domestic hot water loads in the facility, and run a hot-water absorption chiller during the summer. A dump radiator will reject any unneeded thermal energy. Data collection and monitoring for this site is completed by CDH Energy Corp.

Data Point Details

The data at this site is collected using an Obvius data logger and field installed sensors. Sample for each data channel are taken on the order of once per second, and 1,440 1-minute data records are produced for the raw data collected from this site. This raw data is summed, averaged, or the maximum value is taken for each set of 60-records, resulting in the hourly data uploaded to the Data Integrator website. The resulting hourly data is uploaded on a nightly basis. The details for each individual data point are outlined below.

The timestamp in the raw data files is in GMT, which is converted to Eastern Standard Time. All graphical figures on the website are presented in Eastern Standard Time. 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.

<u>DG/CHP Generator Output (total kWh)</u>
The data for Generator Output is computed based on the measurements from four (4) Veris H8035-300 power transducers. The incremental difference in energy output measured in accumulated kWh is summed for the four engines. The parasitic power for the system is measured by a Veris H8053-300 power transducer on the dedicated 208 VAC parasitic load panel. This energy is subtracted from sum of the engine power transducers, to result in the net power output for the system. This 1-minute energy data is then summed into hourly data.

<u>DG/CHP Generator Output Demand (peak kW)</u>
The data for Generator Output Demand is computed based on the instantaneous power reading from the four (4) engine generator power transducers. The sum of the four power readings minus the average power of the parasitic power transducer (in kWh/h) are reported on a 1-minute basis. The maximum 1-minute demand for a given hour is assigned to the hourly database.

<u>DG/CHP Generator Gas Input (cubic feet/hour)</u>
The data for Generator Gas Input is based on measurements provided by a pulse output installed on the Con Ed billing meter. The gas consumption is measured as accumulated CF, and the incremental difference in the accumulator is computed for the gas use per interval. The 1-minute raw data is then summed into hourly data.

Total Facility Purchased Energy (total kWh)
The data for total facility purchased energy is collected directly from the Con Ed DMS system, that polls the billing meter every 15-minutes. The data is converted from kW to kWh by multiplying it by the data interval (1 minute / 60 minutes/h). The 15-minute timestamps from the DMS system are synchronized to the one-minute data timestamps in the database. This 1-minute energy data is then summed into hourly data.

Total Facility Purchased Demand (peak kW)
The data for total facility purchased demand is collected directly from the Con Ed DMS system, that polls the billing meter every 15-minutes. The maximum 1-minute demand for a given hour is assigned to the hourly database.

Other Facility Gas Use (cubic feet)
There is no data available for this point.

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 Energy and Demand points.

Unused Heat Recovery (total MBtu)
The unused heat recovery is calculated by the recorded temperature difference across the glycol piping header where the dump radiator heat exchanger is located, and the flow through the glycol piping header. The heat transfer is calculated on a 1-minute basis, then summed into hourly data.

Useful Heat Recovery (total MBtu)
The useful heat recovery is calculated by the recorded temperature difference across the load heat exchangers (leaving the CHP system and before the dump radiator HX), and the flow through the glycol loop. The heat transfer is calculated on a 1-minute basis, then summed into hourly data.

Status/Runtime of DG/CHP Generator (hrs)
The turbine arrays are defined as, being fully on for a 1-minute interval if the generated power is greater than 90 kW for the period. The status is given a value of 1/60 if the generated output is above 90 kW. The 1-minute data is then summed into hourly data for the online database.

Ambient Temperature (avg °F)
The Ambient Temperature comes from hourly sampled conditions at JFK International Airport available at http://www.wunderground.com. The hourly data from the weather underground (which is often recorded at irregular time intervals) is assigned to the closest hour for the Ambient Temperature in 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 0.920 MBtu/cubic foot (Natural Gas).

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 0.920 MBtu/cubic foot (Natural Gas).

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 1-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 1-minute data before it is converted to hourly data. If more than 75% of the 1-minute data points fail 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 equipment separately. We are using a threshold of 95% repeating values because some values can reset to zero during the repeating periods.

Table 2. Relational Checks for 110East 59th Street

Evaluated Point	Criteria	Result
WG	FG > 6 and WG <= 0	DQ Level for WG set to 2
FG	WG > 0.5 and FG <=0	DQ Level for FG set to 2

Notes: FG – DG/CHP Generator Gas Use
WG – DG/CHP Generator Output
WG_KW – DG/CHP Generator Demand
SG – Status/Runtime of DG/CHP Generator

Range Checks

These checks are applied to the 1-minute data before it is converted to hourly data. If more than 75% of the 1-minute data points fail the range 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.

Table 3. Range Checks for 110East 59th Street

Data Point	Hourly Data Method	Upper Range Check	Lower Range Check
DG/CHP Generator Output	Sum	8 kWh/min	0 kWh/min
DG/CHP Generator Output Demand	Maximum	500 kW	0 kW
DG/CHP Generator Gas Use	Sum	200 cubic feet/min	0 cubic feet
Total Facility Purchased Energy	Sum	25 kWh/min	0 kWh/min
Total Facility Purchased Demand	Maximum	1500 kW	0 kW
Other Facility Gas Use	Sum	N/A	N/A
Unused Heat Recovery	Sum	100 MBtu/min	0
Useful Heat Recovery	Sum	100 MBtu/min	0 MBtu
Status/Runtime of DG/CHP Generator	Sum	4./60 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 to the ASERTTI Long-Term Monitoring Protocol with the following exception: the Inlet Air Temperature is not measured. For analysis, the outdoor air temperature from a nearby weather station has been substituted. All other required performance parameters are reported in 1-minute averages and sums or can be calculated.

Monitoring Notes

September 3, 2009

Obvius data logger installed, data logging begins

January 28, 2010

Con Ed gas data added to monitoring system.

Out of specification 4-20 mA RTD temperature sensors for all three glycol loop readings were replaced with calibrated 10k Type II Thermistors. See “Adjustments to Past Aegis CHP Thermal Data at The Schwab House.pdf” for more information.

March 31, 2010

Parasitic power subtracted from CHP system electrical output throughout entire data set back to September 2009. CHP electrical output now represents “net output”.

Added field calibration corrections for glycol loop temperature when RTDs were installed (September 3, 2009 – January 28, 2010).

March 24, 2011

Modified the threshold for relational checks and range checks so that 75% passing data is required to pass an hour instead of 100%. Fixed an issue where gas use was flagged as failing a relational check when power should have been flagged.