Concord Court Apartments - Data Integrator Notes

Concord Court Apartments is an affordable housing complex that contains 156 units. The brick building was built in 1973 and stands 6 stories tall. The CHP system being installed at the facility includes one (1) 100-kW InVerde 100 cogen unit provided by Tecogen. The Inverde unit includes a natural gas-fired reciprocating V8 engine, water cooled permanent magnet generator, jacket water and exhaust heat recovery systems, and self-contained inverter in a sound attenuating enclosure. The unit can provide 100 kW of continuous power, 125 kW of peak power, and 700 MBtu/h of thermal output as hot water.

Data Point Details

The monitoring system is based around the Obvius AcquiSuite data logger. All data is collected as 1 minute data and converted to hourly data.

All data on the website is presented in Eastern Standard Time.

DG/CHP Generator Output (total kWh)
The Generator Output comes from the data channel called WGT_acc. This is an accumulator for the gross generator output. The difference between consecutive intervals is used to determine the output for each hour. Parasitic loads will be accounted for with one time measurements, which will be subtracted out in data adjust.

DG/CHP Generator Output Demand (peak kW)
The Generator Output Demand comes from the data channel called WGT. These channels are averaged across each 1-minute period to determine the demand. The maximum value for each hour is then taken.

DG/CHP Generator Gas Input (cubic feet)
The Generator Gas Input comes from the data channel called FG_acc. This is an accumulator for the generator gas input. The difference between consecutive intervals is used to determine the gas use for each hour. The units of the accumulator are standard cubic feet.

Total Facility Purchased Energy (total kWh)
No data

Total Facility Purchased Demand (peak kW)
No data

Other Facility Gas Use (cubic feet)
No data

Unused Heat Recovery (total MBtu/h)
The flow rate of the DHW and dump radiator loop, supply temperature to dump radiator, and return temperature from the dump radiator, (FHW1,THW2,THW3), are used to determine the amount of heat which is rejected from the system. This is determined as a rate which is averaged across the hour.

Useful Heat Recovery (total MBtu/h)
The flow rate of the DHW and dump radiator loop, supply temperature to the DHW heat exchanger, and return temperature from the DHW heat exchanger, flow rate of the boiler loop, supply temperature to the boiler loop, and return temperature from the boiler loop, (FHW1,THW1,THW2,FHW2,THW4,THW5), are used to determine the amount of heat which is recovered from the system. This is determined as a rate which is averaged across the hour.

Status/Runtime of DG/CHP Generator (hrs)
The channels labeled as SG_d holds the generator status. It is calculated from the generators instantaneous output WG_kw. If the generator is above 30 kW for a 1 minute interval SG_d receives a 1. The SG_d values are then averaged over each hour.

Ambient Temperature (avg °F)
The Ambient temperature comes from the Weather Underground using the JFK airport as a reference location. The 15-minute data is averaged into hourly data.

Electrical Efficiency (%)
The Electrical Efficiency is calculated by dividing Generator Output (WGT) in BTU's by Generator Gas Input (FG) in BTU's. The lower heating value of natural gas used is 930 btu/cf. The expected efficiency should range from 25–35%.

Total CHP Efficiency (%)
The Total CHP Efficiency is calculated by dividing the Generator Output and Useful Heat Recovery by the Generator Gas Input. The lower heating value of natural gas used is 930 btu/cf and the expected efficiency should range 75–90%.

Data Quality Checks

The Data Quality Checks consist of three levels of verification:

- the data exist (flag=1),
- the data pass range checks (flag=2)
- the data pass relational checks (flag=3).

The methodology for applying the data quality begins by creating a contiguous database. We initially assume all data are good (flag=3) and 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 values which conflict with other data in 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".

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 interval data before it is converted to hourly data. If any of the interval data points fails the relational check, the data for the entire hour is marked as failed.

Table 2. Relational Checks

Evaluated Point	Criteria	Result
FG	WG > 25 and FGE<=0	DQ Level for FG set to 2

Notes: FG – DG/CHP Generator Gas Use
WG – DG/CHP Generator Output

Range Checks

These checks are applied to the 1-minute data before it is converted to hourly data. If any of the 1-minute data points fails the range check, the data for the entire hour is marked as failed.

Table 3. Range Checks

Data Point	Hourly Data Method	Upper Range Check	Lower Range Check
DG/CHP Generator Output	Sum	250 kWh	-1 kWh
DG/CHP Generator Output Demand	Maximum	1000 kW	-5 kW
DG/CHP Generator Gas Use	Sum	2500 cf	0 cf
Total Facility Purchased Energy	Sum	-	-
Total Facility Purchased Demand	Maximum	-	-
Other Facility Gas Use	Sum	-	-
Unused Heat Recovery	Average	4000 Mbtu	-50 MBtu
Useful Heat Recovery	Average	4000 MBtu	-50 MBtu
Ambient Temperature	Average	130°F	-30°F

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

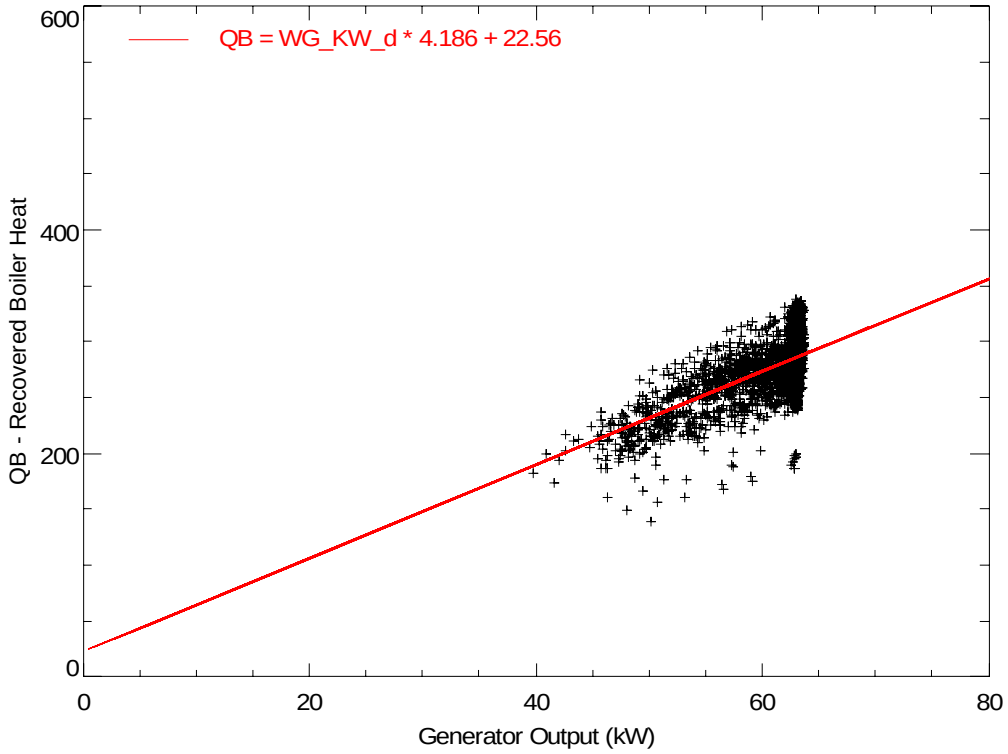
Site Notes:

3/10/2012 - The data has been posted on the website.

3/22/2012 – FHW2 flowmeter was not working properly initially, and was reading < 10 gpm. This was corrected by stipulating flowrate based on average flow from period of good readings on March 9 and March 10, 2012. Flow is stipulated when generator output is greater than 0 kW and when FHW2 is less than 10 gpm.

7/25/2013 – THW5 temperature sensor went bad November 1, 2012. CDH was on site to replace the temperature sensor July 24, 2013. The inaccurate temperatures have been zeroed out and recovered heat calculations modified during this time period.

Typical Heat Recovery Calcs	Heat Recovery Calcs While THW5 is Invalid *(November 1, 2012 thru July 24, 2013)*
$QHW = k * FHW1 * (THW1 - THW2)$ $QB = k * FHW2 * (THW4 - THW5)$ $QU = QB + QHW$	$QHW = k * FHW1 * (THW1 - THW2)$ $QB = WG\_KW\_D * 4.18 + 22.56$ $QU = QB + QHW$



To calculate the boiler heating portion of the heat recovery, while THW5 was invalid, a linear relationship was developed for boiler heat as a function of the generator power output. This relationship was derived using valid data from April 19, 2012 thru November 1, 2012. The calculated boiler heat recovery is then added to the hot water heating portion of recovered heat to arrive at the total heat recovery for the system.

Now that the temperature sensor, THW5, has been replaced the useful heat recovery is back to the typical calculated heat recovery.