Rochester Airport Data Integrator Notes

This site is an international airport located in Rochester, NY. The site has two 750 kW Waukesha engines each serving one concourse of the airport. The engines have jacket water and exhaust heat recovery. The recovered heat is used to help meet the facility heating and cooling loads. Data for this site is collected by Connected Energy and provided to CDH Energy.

Data Point Details

The data at this site is provided by Connected Energy in the form of comma-separated value (CSV) files. There is one file for each day containing 15-minute timestep data for 381 data points. One data file is uploaded on a nightly basis containing the previous days data. From these 15-minute values, the hourly database is formed. It is unclear whether the 15-minute data is sampled or averaged across the interval. The details for each individual data point are outlined below.

The timestamp in the raw data files is in Eastern Local Time. This means it obeys the Standard to Daylight savings times rules for the Eastern timezone. For display purposes, we convert the timestamp from Local Time to Eastern Standard Time for all graphical figures on the website. 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.

This site is divided into two monitoring units. The East Concourse and the West Concourse, which both have a 750 kW engine running off natural gas and heat recovery to augment space conditioning loads.

Details for the East Concourse

DG/CHP Generator Output (total kWh)
The data for Generator Output comes from a 15-minute average for the power produced by the engine. The column of origin for this data point is labeled “Eng1 Power” in the data files received from Connected Energy. The data is converted from a rate to energy per interval and then summed into hourly data.

DG/CHP Generator Output Demand (peak kW)
The data for Generator Output comes from a 15-minute average for the generator demand. The column of origin for this data point is labeled “Eng1 Power” in the data files received from Connected Energy. The maximum for a given hour is assigned to the hourly database.

DG/CHP Generator Gas Input (cubic feet)
The data for Generator Gas Input comes from a 15-minute average for natural gas flow. The column of origin for this data point is labeled “CG 1 Gas Flow Meter” in the data files received from Connected Energy. The is converted from a rate to use for the interval, in cubic feet, and then summed into hourly data.

Total Facility Purchased Energy (total kWh)
The data for Facility Purchased Energy comes from an accumulator for the East Concourse import from the utility grid. The column of origin for this data point is labeled "East RGE Cumul Pwr to Site" in the data files received from Connected Energy. The difference between values is assigned as the energy import for the interval. This interval energy data is then summed into hourly data.

Total Facility Purchased Demand (peak kW)
The data for Facility Purchased Demand comes from the 15-minute average for total utility import. The column of origin for this data point is labeled "East RGE Power to Site" in the data files received from Connected Energy. The maximum for a given hour is assigned as the Total Facility Purchased Demand in the hourly data.

Other Facility Gas Use (cubic feet)
There is no information for this data channel available from the Connected Energy data.

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 data points.

Unused Heat Recovery (total MBtu/h)
There is no information for this data channel available from the Connected Energy data.

Useful Heat Recovery (total MBtu/h)
The Useful Heat Recovery comes from a 15-minute average for the East Concourse utilized heat recovery rate. The column of origin for this data point is labeled "East Conc Heat Rate**"** in the data files received from Connected Energy. The rate data is converted to energy, in MBtus, for the interval and then summed into hourly data.

Status/Runtime of DG/CHP Generator (hrs)
The engine is defined as being fully on for a 15-minute interval if the engine power output is greater than 5 kW for the period (the fully-loaded capacity is approximately 750 kW). The status is given a value of 0.25 if the generator output is above 1 kW and the status is assigned 0.0 if it is below. These status values are then summed into hourly data for the online database.

Ambient Temperature (avg °F)
The Ambient Temperature comes from a 15-minute average for outdoor temperature. The column of origin for this data point is labeled "OA Temp E Concourse" in the data files received from Connected Energy. The 15-minute average temperature is averaged into hourly data for 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 0.930 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 0.930 MBtu/cubic foot (Natural Gas).

Details for the West Concourse

DG/CHP Generator Output (total kWh)
The data for Generator Output comes from a 15-minute average for the power produced by the engine. The column of origin for this data point is labeled "Eng2 Power" in the data files received from Connected Energy. The data is converted from a rate to energy per interval and then summed into hourly data.

DG/CHP Generator Output Demand (peak kW)
The data for Generator Output comes from a 15-minute average for the generator demand. The column of origin for this data point is labeled "Eng2 Power" in the data files received from Connected Energy. The maximum for a given hour is assigned to the hourly database.

DG/CHP Generator Gas Input (cubic feet)
The data for Generator Gas Input comes from a 15-minute average for natural gas flow. The column of origin for this data point is labeled "CG 2 Gas Flow Meter" in the data files received from Connected Energy. The is converted from a rate to use for the interval, in cubic feet, and then summed into hourly data.

Total Facility Purchased Energy (total kWh)
The data for Facility Purchased Energy comes from an accumulator for the Wes Concourse import from the utility grid. The column of origin for this data point is labeled "West RGE Cumul Pwr to Site" in the data files received from Connected Energy. The difference between values is assigned as the energy import for the interval. This interval energy data is then summed into hourly data.

Total Facility Purchased Demand (peak kW)
The data for Facility Purchased Demand comes from the 15-minute average for total utility import. The column of origin for this data point is labeled "West RGE Power to Site" in the data files received from Connected Energy. The maximum for a given hour is assigned as the Total Facility Purchased Demand in the hourly data.

Other Facility Gas Use (cubic feet)
There is no information for this data channel available from the Connected Energy data.

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 data points.

Unused Heat Recovery (total MBtu/h)
There is no information for this data channel available from the Connected Energy data.

Useful Heat Recovery (total MBtu/h)
The Useful Heat Recovery comes from a 15-minute average for the West Concourse utilized heat recovery rate. The column of origin for this data point is labeled "West Conc Heat Rate**"** in the data files received from Connected Energy. The rate data is converted to energy, in MBtus, for the interval and then summed into hourly data.

Status/Runtime of DG/CHP Generator (hrs)
The engine is defined as being fully on for a 15-minute interval if the engine power output is greater than 5 kW for the period (the fully-loaded capacity is approximately 750 kW). The status is given a value of 0.25 if the generator output is above 1 kW and the status is assigned 0.0 if it is below. These status values are then summed into hourly data for the online database.

Ambient Temperature (avg °F)
The Ambient Temperature comes from a 15-minute average for outdoor temperature. The column of origin for this data point is labeled "Outside Air Temp West Conc" in the data files received from Connected Energy. The 15-minute average temperature is averaged into hourly data for 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 0.930 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 0.930 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 15-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 15-minute data before it is converted to hourly data. If any of the 15-minute data points fails the relational check, the data for the entire hour is marked as failed.

Table 2. Relational Checks for Patterson Farms

Evaluated Point	Criteria	Result
FG	WG > 0 and FG <= 0	DQ Level for FG set to 2
WG, WG_KW, SG	WG = 0 and WG_KW > 0	DQ Level for WG_KW, WG and SG set to 2
QHR	CHP Efficiency (LHV) > 100 %	DQ Level for QHR set to 2

Notes: FG – DG/CHP Generator Gas Use
WG – DG/CHP Generator Output
WG_KW – DG/CHP Generator Output Demand
QHR – Total Useful Heat Recovery
SG – Status/Runtime of DG/CHP Generator

Range Checks

These checks are applied to the 15-minute data before it is converted to hourly data. If any of the 15-minute data points fails the range check, the data for the entire hour is marked as failed.

Table 3. Range Checks for Rochester Airport

Data Point	Hourly Data Method	Upper Range Check	Lower Range Check
DG/CHP Generator Output	Sum	225 kWh	0 kWh
DG/CHP Generator Output Demand	Maximum	900 kW	0 kW
DG/CHP Generator Gas Use	Sum	3,750 cubic feet	0 cubic feet
Total Facility Purchased Energy	Sum	225 kWh	0 kWh
Total Facility Purchased Demand	Maximum	900 kW	0 kW
Other Facility Gas Use	Sum	N/A	N/A
Unused Heat Recovery	Sum	N/A	N/A
Useful Heat Recovery	Sum	3,750 MBtu	0 MBtu
Status/Runtime of DG/CHP Generator	Sum	0.25 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 fully to the ASERTTI Long-Term Monitoring Protocol. Data is provided in 15-minute intervals satisfying the protocol. In addition, this site also has most of the optional performance parameters.

Monitoring Notes

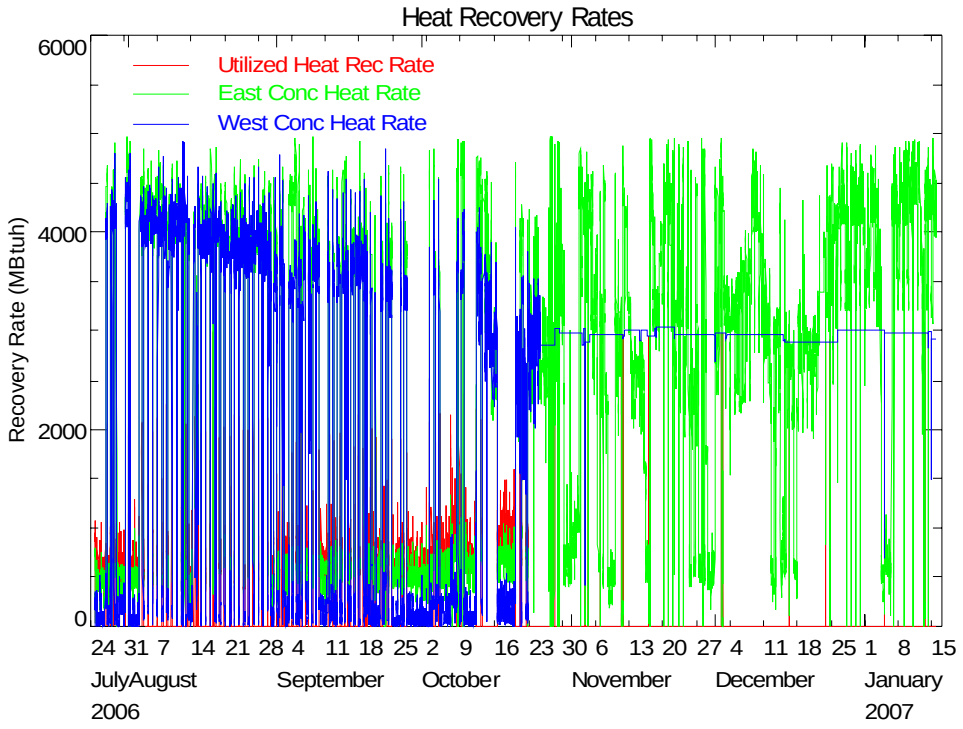
December 20, 2006

CDH begins receiving daily file uploads from Connected Energy for this site.

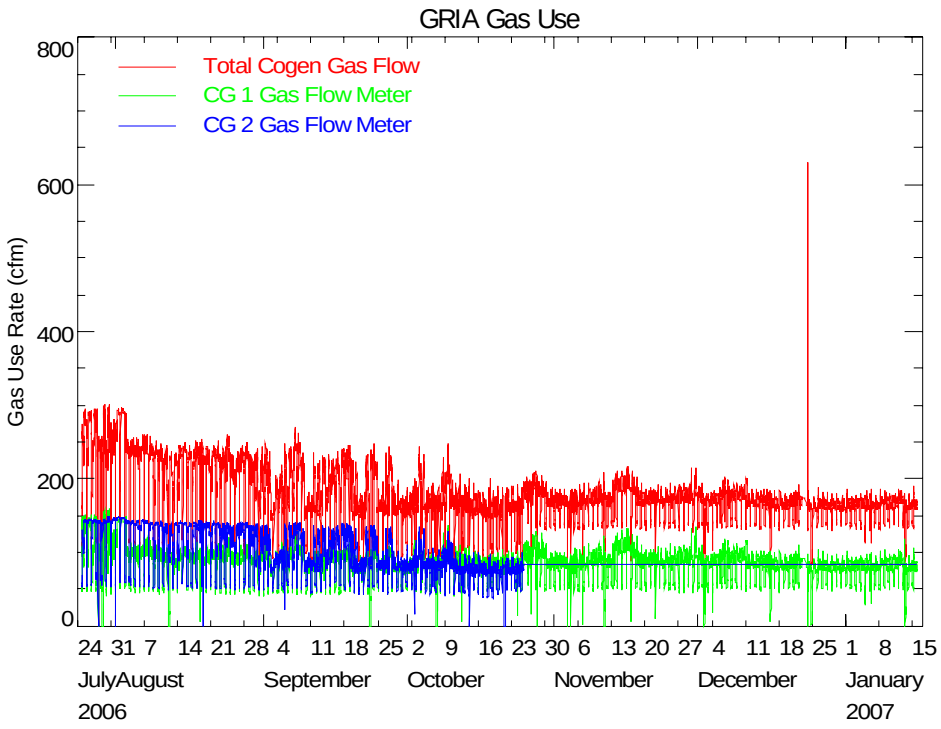
January 12, 2007

CDH finishes reviewing data. There is no utility power import data for this site. This is consistent with what is found on the CE webpage. The heat rates for the west and east concourse are larger than the Utilized Heat Rec Rate. This brings up several questions about these data points:

- Are these data points presented in the same units?
- Is the East and West Conc. HR information about building heating loads or cogeneration heat recovery rates?
- Why does the West Conc. HR show sparse data (i.e. repeats indicating data loss) after October while the East Conc. HR look normal?
- The Utilized Heat Rec Rate shows sparse data after October during the same periods as the West Conc. HR indicating they are related. Why is the Utilized HR incalculable when the West Conc. HR is incalculable if the Utilized HR is lower?



Similar to the heat recovery rates, the cogen gas flow data is inconsistent. The gas flow rates for generator 2 shows many periods of repeating data beginning in October. The Total Cogen Gas Flow data appears to be the simple sum of the two CG Flow Meters, and thus includes the repeating data.



There are many channels that have large periods of repeating data or show no data other than zeroes. These include, but are not limited to:

- East Conc Gas Cumul Flow
- East Conc Gas Flow Accum
- East Conc Gas Rollover
- East Conc Gas Flow Accum
- Main Trm Gas Flow Accum
- Main Trm Gas Flow Rollover
- West Conc Heat Rate (Since Oct 06)
- West Concourse CG Flow
- East Concourse CG Flow
- Eng1 Phase A Voltage
- Eng1 Phase B Voltage
- Eng1 Phase C Voltage
- CG1 Gas Flow Cumul
- Eng2 Phase A Voltage
- Eng2 Phase B Voltage
- Eng2 Phase C Voltage
- CG 2 Gas Flow Meter (Since Oct 06)
- CG2 Gas Flow Cumul
- Eng1 Gen. Ph A Neutral Volts
- Eng1 Gen. Ph B Neutral Volts
- Eng1 Gen. Ph C Neutral Volts
- Eng2 Gen. Ph A Neutral Volts
- Eng2 Gen. Ph B Neutral Volts
- Eng2 Gen. Ph C Neutral Volts
- Eng2 Phase A KVA
- Eng2 Phase B KVA
- Eng2 Phase C KVA
- Eng1 Phase A kVAR
- Eng1 Phase B kVAR
- Eng1 Phase C kVAR
- Eng2 Phase A kVAR
- Eng2 Phase B kVAR
- Eng2 Phase C kVAR
- Eng1 Bus Output Frequency
- Eng2 Bus Output Frequency
- Tot RGE Cumul Gas to Site
- Main RGE Cumul Gas Dtherm
- East Conc RGE Cumul Gas
- East RGE Cumul Gas Dtherm
- Main RGE Cumul Gas
- Main RGE Cumul Gas Dtherm
- Total RGE Gas Flow to Site
- East Conc RGE Gas Flow
- Main RGE Gas Flow
- Tot RGE Cumul Pwr to Site
- East RGE Cumul Pwr to Site
- West RGE Cumul Pwr to Site
- Total RGE Power to Site

- Eng1 Bus Ph A Neutral Volts
- Eng2 Bus Ph A Neutral Volts
- Eng1 Phase A KVA
- Eng1 Phase B KVA
- Eng1 Phase C KVA
- East RGE Power to Site
- West RGE Power to Site

Assuming the east and west concourse heat rates represent heat recovery, the calculated CHP Efficiency for each wing is too high. For the east concourse, the calculated CHP Efficiency (using an LHV of 930 Btu/cf) is routinely between 110 and 120%. The calculated efficiency for the west concourse is around 90% with several periods above 100%. For the online database, the heat recovery for periods of chp efficiency over 100% are marked as failing a relational check for plotting and are omitted in the standardized reporting.