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Cornell University Site - Data Integrator Notes

The Cornell Combined Heat and Power Project (CCHPP) involves the construction of a combined heat and power facility based on two new dual fuel Gas Turbine Generators (GTG) and natural gas duct fired Heat Recovery Steam Generators (HRSG) for the purpose of supplying the Cornell University (Ithaca, New York) campus with both electricity and heating steam. The electrical production will displace electricity previously purchased from the local utility company, New York State Electric & Gas (NYSEG) and the heating steam production will displace steam produced by the existing Central Heating Plant (CHP) boilers which are fired with coal, oil and/or natural gas. The CCHPP also has the capability of exporting excess power production to NYSEG. The CCHPP will be wholly developed, owned, and operated by Cornell University.

Data Point Details

Cornell University logs data at 15-minute intervals. The data is uploaded to the CDH servers where it is processed. The data is then aggregated into hourly data and uploaded to the NYSERDA CHP web site.

The timestamp in the raw data files is in Eastern Standard Time.   All data on the website is presented in Eastern Standard Time.

DG/CHP Generator Output (total kWh)
The Generator Output is obtained from the columns in the raw data file labeled "GTG1_Output kw" and "GTG2_Output kw". These kW readings are divided by the intervals per hour to obtain the kWh per interval. They are then added together and summed across the hour to obtain the total kWh produced for each hour.

DG/CHP Generator Output Demand (peak kW)
The Generator Output Demand is obtained from the columns in the raw data file labeled "GTG1_Peak Output kw" and "GTG2_Peak Output kw". These readings are added together for each interval and the maximum for each hourly period is used as the demand from the generator.

DG/CHP Generator Gas Input (cubic feet)
The data for Generator Gas Input is obtained from the columns in the raw data file labeled "GTG1_Natural Gas Fuel Input kcf" and "GTG2_Natural Gas Fuel Input kcf". The data is provided in units of kcf/h and the data is summed and converted to cf/h for each interval between the two channels. The data is then averaged across the hour to determine the Generator gas input for each hour. It should be noted that this system imploys duct burners to boost steam production periodically. The fuel consumption for the duct burners is displayed under "other facility gas use". The steam produced from the duct burners cannot be separated from the steam produced by the generators at this time.

Total Facility Purchased Energy (total kWh)
No data is available for this point

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Total Facility Purchased Demand (peak kW)
No data is available for this point

Other Facility Gas Use (cubic feet)
The data for Other Facility Gas Use is obtained from the columns in the raw data file labeled "HRSG1_Natural Gas Input CF" and "HRSG2_Natural Gas Input CF". The data is provided in units of cf/h and is summed between the two channels for each interval. The data is then averaged across each hour to find the total hourly fuel use. This fuel use is comprised of the natural gas used in the duct burners to boost steam production.

Unused Heat Recovery (total MBtu)
Unused Heat Recovery is obtained from the column in the raw data file labeled "Unused Steam to SCB". The raw data is provided in units of klb/h, which is converted to lb/h and multiplied by the calculated enthalpy for low pressure steam (.978 MBtu/lb). The 15 minute data is then averaged to obtain hourly data.

Useful Heat Recovery (total MBtu/h)
The Useful heat Recovery is obtained from the columns in the raw data file labeled "HRSG1_HP Steam", "HRSG1_LP Steam", "HRSG2_HP Steam", and "HRSG2_LP Steam". The data is provided in units of klb/h, which is converted to lb/h and multiplied by the calculated enthalpy for low pressure steam (.978 MBtu/lb) or high pressure steam (1.205 MBtu/h). The data is then summed across the channels for each interval. The result has the unused heat recovery subtracted from it and the 15 minute data is then averaged to obtain hourly data.

Status/Runtime of DG/CHP Generator (hrs)
The generator is defined as being fully on for a 15-minute interval if the generator output is greater than 5000 kW (the fully-loaded capacity is 15 MW). The status is given a value of +1 for each generator that is above the threshold. The 15-minute data is then averaged into hourly data for the online database.

Ambient Temperature (avg °F)
The Ambient temperature comes from the Weather Underground using the Ithaca 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 (WG) in BTU's by Generator Gas Input (FGE) 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%. This value will periodically be higher on the website as the fuel used in the duct burners in not included, however the steam produced by the duct burners is included.

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 > 200 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 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

Data Point	Hourly Data Method	Upper Range Check	Lower Range Check
DG/CHP Generator Output	Sum	8000 kWh	0 kWh
DG/CHP Generator Output Demand	Maximum	32000 kW	0 kW
DG/CHP Generator Gas Use	Average	380000 cf/h	0 cf/h
Total Facility Purchased Energy	Sum	0 kWh	0 kWh
Total Facility Purchased Demand	Maximum	0 kW	0 kW
Other Facility Gas Use	Average	240000 cf/h	0 cf/h
Unused Heat Recovery	Average	340000 Mbtu/h	0 MBtu/h
Useful Heat Recovery	Average	340000 MBtu/h	0 MBtu/h
Ambient Temperature	Average	130°F	-30°F

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

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Site Notes:

2/24/11:
The data has been posted on the website.
The gas use for the #1 generator, between 8/14/2010 and 10/25/2010, is frequently a repeating number or lower than the output of the generator. The gas use for that period is currently being blanked. Before that period the data is recorded in units of ccf/h for both generators.

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Appendix:

Table 4. Raw data relations to CDH Point names

CDH Tag	Raw Data Header 1	Raw Data Header 2
WG1	GTG1_Output kwh	GTG1_Output kw
WG_KW1	GTG1_Peak Output kw	GTG1_Peak Output kw
FG1	GTG1_Natural Gas Fuel Input CCF	GTG1_Natural Gas Fuel Input kcf
FO1	GTG1_Oil Fuel inout gallons	GTG1_Oil Fuel inout gallons
WG2	GTG2_Output kwh	GTG2_Output kw
WG_KW2	GTG2_Peak Output kw	GTG2_Peak Output kw
FG2	GTG2_Natural Gas Fuel Input CCF	GTG2_Natural Gas Fuel Input kcf
FO2	GTG2_Oil Fuel inout gallons	GTG2_Oil Fuel inout gallons
FSHP1	HRSG1_HP Steam	HRSG1_HP Steam
FSLP1	HRSG1_LP Steam	HRSG1_LP Steam
FGS1	HRSG1_Natural Gas Input CCF	HRSG1_Natural Gas Input CF
FSHP2	HRSG2_HP Steam	HRSG2_HP Steam
FSLP2	HRSG2_LP Steam	HRSG2_LP Steam
FGS2	HRSG2_Natural Gas Input CCF	HRSG2_Natural Gas Input CF
FSD	Unused Steam to SCB	Unused Steam to SCB