WHEDCO – Urban Horizons Microturbine Gas Data

The gas data for the microturbine CHP system provided since system startup has been erroneous since startup. The reasons for the erroneous have been unclear, with possible explanations being improper 4-20 mA scaling or specifying sensor range in CFM, not CFH. To rectify this issue, the gas meter has been replaced several times, but replacing the sensor did not result meaningful data.

On May 14, 2015, the analog output gas meter was replaced with an Onicon gas flow meter with a MODBUS output. The MODBUS output allows the meter to operate independently of the data collection system, providing the following advantages over the analog meter:

- Flow data are transmitted to the data logger as digital values representing actual engineering units, eliminating the need for scaling
- Accumulated flow data are recorded at the meter, and transmitted to the data logger. This allows for the total gas flow to continue to be recorded through periods of intermittent communication with the gas meter.

Figure 1 displays the accumulated generation data for the microturbine and gas data from the new gas meter during May and June 2015. Total electrical generation increases throughout the period because the microturbine unit operated continuously. Total gas consumption data increases beginning with the meter installation and increases throughout the month, however periods of missing data are readily indentified. Missing data during June 2015 was the result of a communication issue with the meter that has been resolved. The new MODBUS meter retains the total measured gas consumption, even throughout the communication disruption.

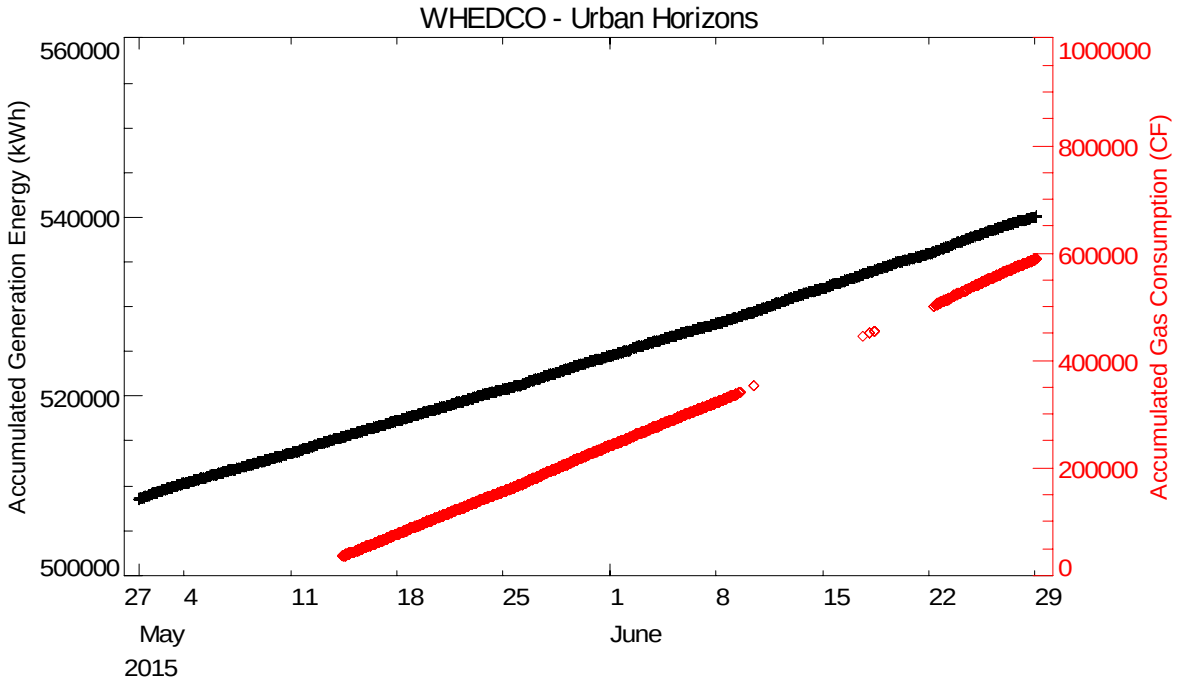

Figure 1. Accumulated Generation and Gas Consumption Values – May 2015 through June 2015

Table 1 displays the coincident energy and gas data values corresponding to the start of the gas meter data and the most recent data value. Based on the data collected, the microturbine has been operating highly unloaded, generating 24,629 kWh across the 1,095 hour period, resulting in an average power of only 22.48 kW across the period. The gas meter indicated a total gas consumption of 553,814 CF during the same period, resulting in an average gas consumption rate of 505.54 CFH. The resulting electrical efficiency at this measured operation is 14.7% HHV and 16.3% LHV. By comparison, at full load (Figure 2), the 65 kW microturbine has fuel input of 842,000 Btu/h HHV (817.4 CFH), with a resulting efficiency of 26.3% HHV and 29.2% LHV. Microturbines have a poor electrical efficiency at part load generation below 30%, and this measured data is consistent with that operation.

Table 1. Coincident Accumulated Energy and Gas Values

Date/Time	Accumulated Generation (kWh)	Accumulated Gas Use (CF)
5/14/2015 10:45	515,455	35,349
6/29/2015 2:15	540,084	589,163
Difference	24,629	553,814
Total Hours	1,095.50	1,095.50
Average Rate (kW, CFH)	22.48	505.54
Energy Flow (Mbtu/h HHV)	76.73	520.70
FCEelec HHV	14.7%	
Energy Flow (Mbtu/h LHV)	76.73	470.15
FCEelec LHV	16.3%	

Table 2. Performance Ratings

Parameter	C65 CARB & Low NOx	All Other C65
Net Power Output	65 (+0/-3) kW net	65 (+0/-2) kW net
Net Efficiency (LHV)	28 (± 2)%	29 (± 2)%
Nominal Net Heat Rate (LHV)	12,900 kJ /kWh (12,200 Btu /kWh)	12,400 kJ /kWh (11,800 Btu /kWh)
Nominal Generator Heat Rate (LHV)	12,100 kJ /kWh (11,400 Btu /kWh)	11,600 kJ /kWh (11,000 Btu /kWh)
Nominal Steady State Fuel Flow (HHV) Notes (1) and (2)	919,000 kJ/hr (871,000 Btu/hr)	888,000 kJ/hr (842,000 BTU/hr)

Figure 2. Capstone C65 Ratings

Using the average data collected in May and June 2015 to establish an average CF/kW for the unit would result in an understatement of system performance, due to the extreme part load the system is operating at presently.

Converting the new accumulated gas data to interval data allows for performance of the turbine to be examined across the various loading presently occurring. Figure 3 displays the new interval gas flow (expressed in CFH) compared to the turbine output (in kWh/h or interval kW). The data shows a mostly linear trend with generation (red trend line), however this trend may overstate gas consumption at high and low electrical output. A single change-point model was fit to the data, to better reflect the "knee" observed in the gas data around 18 kW (green trend line).

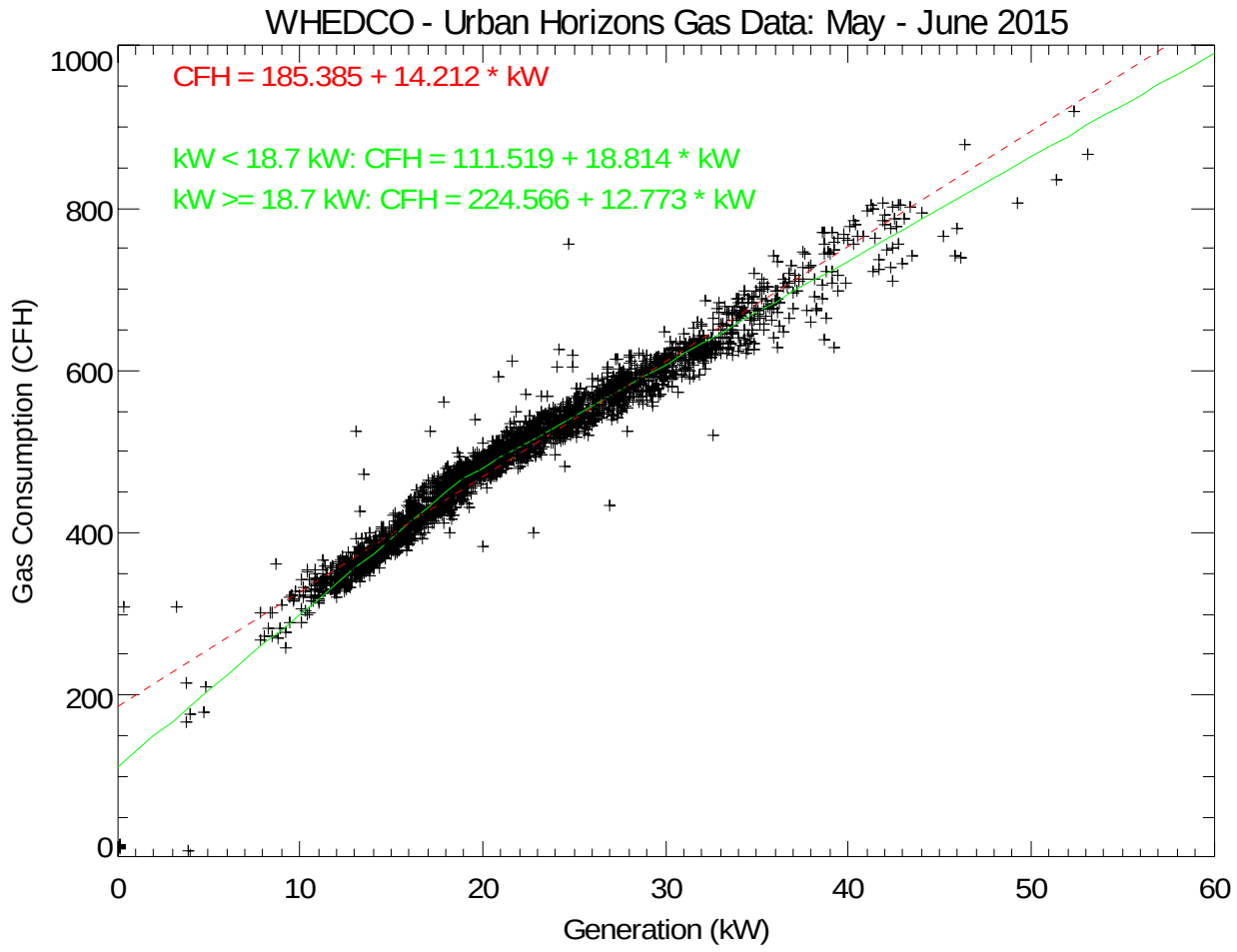

Figure 3. Gas Consumption Variation with Generation – New Gas Meter

This change-point model is the best representation of the actual performance of the system collected to date. It is recommended that the total volume of gas measured by the meter (the accumulated data) be compared to **one or more months of billing data** to ensure accuracy. Once accuracy of the new meter is established, the change-point model can be used to replace **all** back data, resulting in over two years of accurate performance data collected on the system.