M2G Pilot Study Report
Porter Laboratory
Nashville, Tennessee

Pilot Period:
June 26, 2014 through July 30, 2014
Location:
Porter Lab Building/Ellington Ag. Center (State of TN)
440 Hogan Road
Nashville, TN 37220
Report Date:
August 14, 2014

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Summary

Two M2G boiler optimization control units were purchased and piloted at the Porter Lab Building of the Ellington Agricultural Center in Nashville, Tennessee. The M2G devices were installed on June 26, 2014 and the pilot data was collected for the period commencing on June 26 running to July 30, 2014. Greffen Systems managed the pilot, collected and analyzed data, and produced this report. The following statistics summarize the performance of the M2G devices during the pilot period.

Porter Lab Building Nashville, Tennessee	
Summary Statistics	
Energy Use	
Bypass	664.3
Save	527.4
M2G Savings (Annualized)	**18.1%**
Average Run-time (min.)	
Bypass	2.2
Save	4.9
Average Off-time (min.)	
Bypass	1.7
Save	9.9
Average Cycles Per Day	
Bypass	290
Save	97
Reduction in Cycling	
M2G Reduction	66%

Findings from data collected to-date include the following:

- Building comfort levels are unaffected by the M2G device.
- The M2G reduced the number of boiler fires by 66% which will produce additional savings by lowering boiler maintenance costs and extending the lives of the boilers.
- Payback for the M2G is estimated at 14 months.
- Greffen expects that the M2G will deliver significant energy and carbon savings and integrate into existing building operations making the M2G a commercially viable energy efficiency technology for the Porter Lab Building.

Introduction

Greffen Technology

The M2G is an advanced intelligent boiler control that optimizes efficiency of boiler firing. An M2G unit monitors temperatures of water flowing in and out of the boiler and adjusts boiler operation to optimize energy efficiency of the overall heating delivery system. The M2G also monitors additional boiler operating data, including heat transfer rates during firing and interval periods when burners are off.

When a demand on the boiler is made, the M2G microprocessor decides whether to allow the control signal to fire the boiler or open a relay which blocks the boiler from firing. Energy efficiency is only one of the criteria used in the M2G decision-making process. Other key criteria are (1) building comfort level and (2) protection of the boiler from stresses of thermal shock. M2G logic is also designed to preserve the existing system's controls, the built in intelligence adjusts to changing conditions and operational settings without any requirement for operator adjustment or intervention. For the operator, all existing controls and procedures remain fully functional. The M2G operates silently in the background.

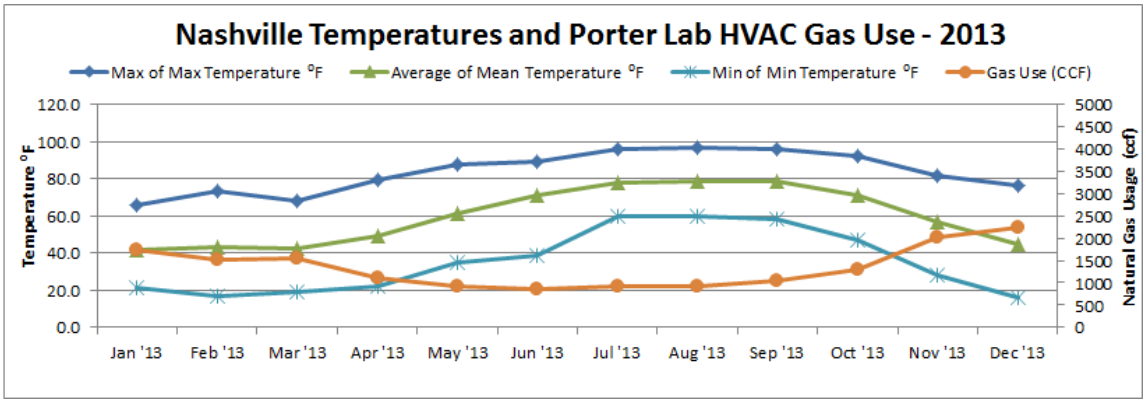
The result is energy savings while ensuring maximum performance during heavy load periods; this is accomplished with no impact on building comfort levels. Viewed from a perspective of waste heat, the M2G minimizes unneeded heat from being produced while preserving the transfer of beneficial heat into the building system.

The Porter Lab Building

Centrally located at 440 Hogan Road, Nashville, Tennessee the Porter Building is part of the Ellington Agricultural Center located 10 miles south of downtown Nashville.

The Nashville climate is hot during summer when high temperatures tend to be in the high 80's and cold during winter when high temperatures tend to be in the 60's, but drop to the high 40's in the coldest months. The warmest month of the year is July with an average maximum temperature of 89 degrees Fahrenheit, while the coldest month of the year is January with an average *minimum* temperature of 28 degrees Fahrenheit. Temperature variations between night and day tend to be moderate year round and average 20 degrees. Averages are only part of the story, the region is subject to wide swings in temperature, particularly in the spring and fall seasons.

The facility is primarily used for laboratory use. The building is served by two forced draft Bryan boilers each with a 5.5 mmBTU capacity. The boilers and ancillary equipment are located in an equipment room located on the first floor of the building. A BMS system manages the operation of the boilers through enablement. Firing control is local for each boiler based on aquastat temperature at each boiler. The boilers operate year round. The boilers serve the HVAC system for the space heat for occupants and visitors of the building.



Pilot Installation and Methodology

The M2G was installed on the side of the existing boiler control cabinet. The primary burner control circuit was routed through the M2G. A boiler control unit controls the boiler by means of this primary thermostat circuit. Gas consumption was determined from measurement of the gas control valve operation on the boiler. It was noted that the boiler room systems are a mixture of controls, some subsystems are original, others have been added more recently. The M2G installation was accomplished without impacting existing controls.

In addition to the M2G, a timer was installed which allowed the unit to operate in either of two modes. In the "save" mode of operation the M2G unit operates normally. In "bypass" mode the M2G is powered, but its ability to modify boiler firing and timing is blocked electronically. In bypass mode the boiler operates just as it would were the M2G technology not installed. The timer toggles save and bypass modes alternately on a 24 hour basis.

Data was collected on boiler operations using a third party Dent data logger which measured the gas valve operation for the boiler. The data was collected with time and date information for each change in boiler status. Each time the boiler turns on or off the event was recorded with the date, time, and action. The collected data was analyzed and a comparison of boiler operation was made with and without the M2G device operation.

The pilot period covered 35 days, 17 days were bypass days (no adjustment of boiler operation based on measured building demand) and 18 were save days (the M2G was operative). Weather for the period varied considerably as far as seasonal variation goes, but was still in the normal range for summer weather. The maximum temperature for the period was 95°F and the minimum temperature was 61°F. Sixteen of the 35 pilot days saw high temperatures in the 90's. There were no heating degree days during the period, the normal means of normalizing data. Statistical bias from temperature variations was not found and no temperature correction factors were applied.

Data Collection, Analysis and Findings

Energy Consumption

Time of use data was collected during the pilot period. Boiler firing was recorded including start time and end time. Analysis of the time of use data was performed to determine gas consumption. The customer provided annual energy consumption data for calculation of the payback period. Normal variations in operations were observed including a few days of operation with a single boiler. Each of the boilers experienced a few days of off line status during the pilot period. Whether this is normal and routine is unclear, regardless, the M2G produced savings on days a single boiler as well as days both boilers were operating.

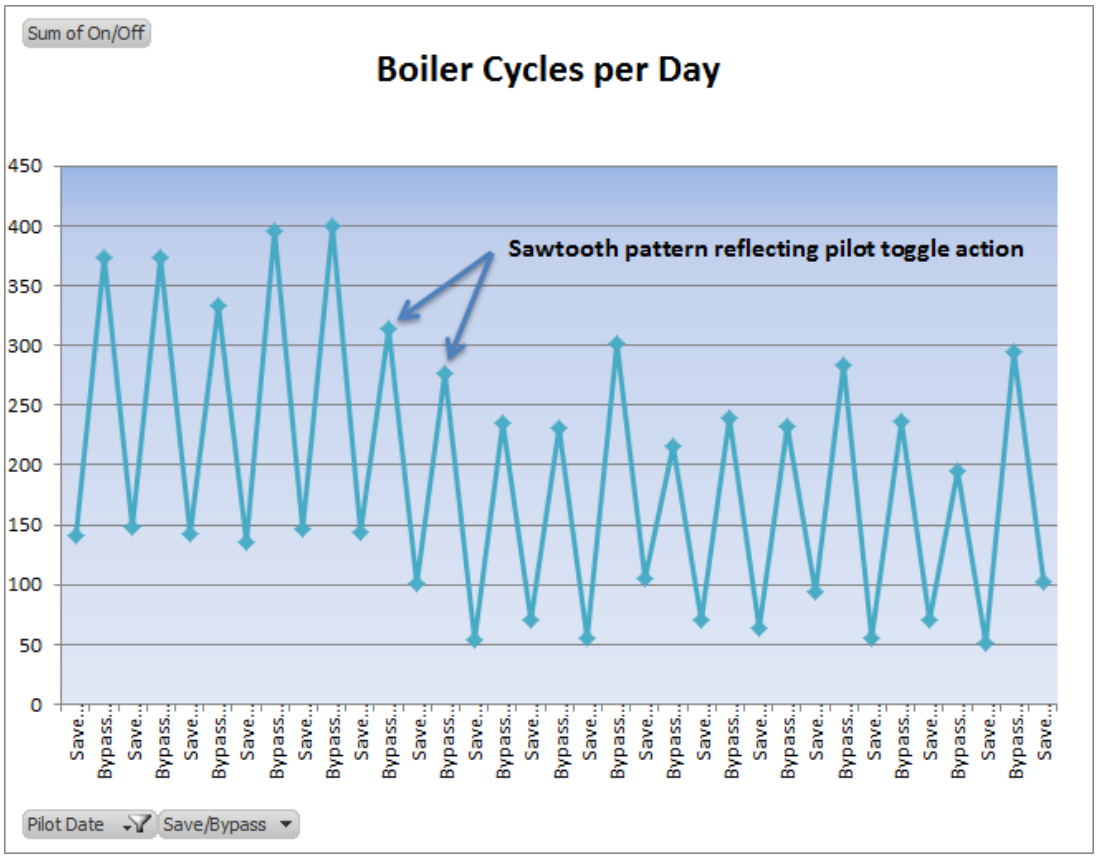
M2G Pilot Statistics — Porter Lab Building	
Parameter	Value
Firing Rate drop with M2G active	66% reduction
Pilot Period Reduction in Gas Consumption	26% reduction
Increase in Average Off-Time	8.2 min
Total Estimated Energy Savings	**18.1% reduction**
Payback Period	**14 Months**

The M2G operated well under a wide range of weather conditions considered “normal” loading conditions for summer periods. The boilers run year round and the pilot period is representative of a significant portion of the year. However, HVAC winter operations are by nature significantly different from warm weather operation. Review of 2013 billing data indicates that the pilot period typically sees boiler operation at a level of approximately 68% of average monthly gas consumption, and at a value of about 40% of the coldest winter month in which peak consumption is experienced. An annual adjustment factor of 30% was applied (downward) to the pilot period results to estimate the annual savings the M2G will provide in year round operation. This adjustment factor is based on numerous factors including:

- Consistency of operational performance data during the pilot period
- Specific experience with M2G technology in similar use facilities (laboratories)
- Experience in similar installations with similar weather variation
- Review and analysis of customer provided utility bill data

Performance

Operation of the M2G provided reduction in fuel consumption with no effect on building temperatures nor any other impacts on performance. The pilot results validate the technology's performance with this boiler installation. The M2G was generally observed holding off the boiler for most or all of the maximum 15 minute period which is programmed into the unit. This indicates that (1) rapid temperature drops corresponding to significant unmet demand did not occur, (2) no significant absolute temperature dips were realized, (3) in cases where demand was significant the M2G allowed operation to continue without affecting HVAC building service levels. No complaints or other anecdotal evidence of reduced service were reported in the pilot period. The M2G significantly reduced the number of cycles and increased the duration and efficiency of heat transfer.



Conclusions

The M2G delivered significant savings on natural gas for the pilot period. This was accomplished by reducing the number of boiler firings by 66% and more efficient boiler operation for use in the building. The boiler met demand with less energy consumed, lower carbon emissions, and with no effect on building comfort levels experienced. Expected annual energy savings are 18.1%.

The M2G should provide additional savings by lowering boiler maintenance costs due to the decrease in wear resulting from the reduction of boiler fires. The energy savings and environmental benefit is expected to provide a 14 month payback period on the investment.

Greffen has demonstrated potential for M2G delivery of significant energy and carbon savings. These savings are accomplished by installation of a technology that easily integrates into existing building operations. The M2G is therefore a commercially viable and proven energy efficiency technology for Porter Labs in Nashville, Tennessee.