

Study 16-RES16: HEHE Condensing Equipment Barriers

Type of Study: Technology Evaluation
Evaluation Conducted by: Navigant Consulting
Lexicon Energy Consulting
Date Evaluation Conducted: 4/3/2017

Study Objective and Summary of Results:

The primary objective of this study was to evaluate the energy savings and costs associated with installing outdoor reset controls to determine the extent to which these and other controls could mitigate the non-condensing problem identified in the 2014 HEHE Impact Evaluation¹. The 2014 evaluation showed that condensing boilers were not achieving maximum energy savings, in part due to installation practices and controls configuration. The evaluation team chose to focus the field portion of this study on outdoor reset controls because they are the most common control strategy for modulating boiler supply temperature in the U.S. Most condensing boilers ship with controls and sensors; the lack of effectively programmed controls observed in the previous study suggested that simply installing and adjusting outdoor reset controls properly could yield additional savings with relatively low effort. The evaluation team conducted interviews with boiler and controls manufacturers to better understand other control strategies and also interviewed contractors to better understand barriers to installing proper controls for condensing equipment.

The study provides the following key findings:

- Changing the outdoor reset curve does produce savings, but the savings are lower than anticipated. The evaluation team observed that sites with significant changes in the outdoor reset curve could produce a 0.5%-1.5% improvement in the efficiency of the condensing boiler, which results in approximately a 5%-15% improvement in measure savings or 5 to 15 therms.
- The evaluation team estimates that a moderate outdoor reset curve with temperatures of 180°F supply at 0°F outdoors and 120°F supply at 50°F outdoors would produce an average efficiency improvement of 0.3% relative to the typical operation observed in the 2014 study.
- The best scenario for improving condensing boiler efficiency is to reduce the load before adjusting controls, whether outdoor reset or other supply temperature modulation technology.
- The evaluation team found two manufacturers in the U.S. that currently offer control systems capable of modulating supply temperature based on indoor temperature feedback and outdoor temperature—Tekmar and Bosch. The U.S. boiler market is relatively small and these offerings are not likely to take off

¹ *High-Efficiency Heating Equipment Impact Evaluation*, Final Report, March 2015. <http://ma-eaac.org/wordpress/wp-content/uploads/High-Efficiency-Heating-Equipment-Impact-Evaluation-Final-Report.pdf>.

without regulatory or program pressure. The evaluation team did not identify any studies with energy savings estimates for implementing advanced supply temperature modulation technologies.

Core Initiatives to which the Results of the Study Apply:

- Residential Heating and Cooling (Gas Only)
- Residential Home Energy Services (Gas Only)

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The PAs should run cost-effectiveness calculations based on a conservative savings estimate of 3 therms and incremental cost of \$250 for controls programming only.

Recommendation 2: If screening this measure demonstrates it is cost-effective, the PAs should consider developing program offerings aimed at increasing the prevalence of more efficient outdoor reset control settings and proper installation of outdoor sensors.

Recommendation 3: The PAs should conduct a high-level screening of smarter supply temperature modulation technologies assuming an optimistic 3% efficiency increase (30 therms) and cost of \$750.

Recommendation 4: If the screening shows that this could be cost-effective, the evaluation team recommends conducting additional evaluation literature research on the savings potential of these technologies.

Recommendation 5: The PAs should consider a research study to evaluate the potential for a pilot program aimed at homes with condensing boilers that would offer detailed audits, completion of all necessary weatherization upgrades and adjustment of outdoor reset control settings once these upgrades are completed. Metering participants' boilers before and after upgrades and control setting adjustments could determine whether improved boiler efficiency provides a boost to envelope savings.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affected Program Results and Its Significance:

This study will help the PAs determine whether to pursue further research or make programmatic changes to claim additional savings from condensing boiler installations.

Overview of Study Method:

Table 1 summarizes the evaluation activities for this study.

Table 1. Summary of Evaluation Approach

Activity and Sample	Rationale
Analysis of existing and secondary data (pre-analysis) <i>60 sites</i>	Use site-specific data to inform data collection needs and assign initial likelihood of controls-only solution viability for each site. Screen out sites with load constraints due to non-controls barriers (not enough insulation and/or distribution). Review manufacturing installation documents and related literature to confirm optimal outdoor reset control strategies. Develop site-specific optimized outdoor reset controls for controls-only sites and estimates of efficiency improvement as a result of optimized outdoor reset controls.
Installation site visits and solution viability assessment <i>17 controls-only sites</i> <i>10 audit sites</i>	Determine if the optimized outdoor reset control settings should be adjusted prior to implementation, install metering equipment at controls-only sites, conduct audit, and develop a list of solutions for sites that are not candidates for optimized outdoor reset controls.
Retrieval site visits	Retrieve metering equipment from controls-only solution sites.
Analysis of boiler metering data	Determine the new efficiency curves for each site and estimate the percentage improvement in performance resulting from optimized outdoor reset controls.
Cost estimates	Develop a list of solutions (emitter/envelope improvements) and cost estimates for sites that are not candidates for optimized outdoor reset controls.
Contractor surveys and analysis <i>41 surveys</i>	Assess current installation practices, barriers to implementing optimized controls, and possible program solutions.
Manufacturer interviews <i>5 interviews</i>	Better understand advanced control strategies for boilers used in Europe and what barriers these technologies face in the United States.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix X, Study 16-XX.