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M E M O

DATE: May 28, 2013
TO: Massachusetts Custom Gas Evaluation Group
FROM: Stephen Achilles, Sue Haselhorst, Chad Telarico
RE: **STANDARD BOILER RESEARCH PLAN AND INTERVIEW RESULTS**

This document summarizes the plan, execution, and the decision to re-scope the Task 26 Boiler Baseline Assessment for the Massachusetts Energy Efficiency Programs' Large Commercial & Industrial Evaluation.

This study was commissioned to identify the base line boiler features and operation for both prescriptive and custom boiler measures. Boiler replacements constitute about 15-25% of custom and 25-50% of the prescriptive program savings. Boiler control measures, which could also be influenced by this research, constituted another 3-5% of the LCI portfolio savings. The average savings for the replacement of a boiler in the PY2010 impact evaluation was 6% of baseline gas usage (the average percentage reduction for seventeen sites with boiler replacements). A change in baseline by 1% would translate to about a 20% increase in savings based on an original savings rate of 6%.

The research was intended to encompass two elements: first boiler distributors were to be interviewed to determine the characteristic features of new code-compliant boilers and also to provide leads for standard code-compliant boilers. Secondly, a sample of standard code compliant boilers would be metered to determine characteristic performance, with a particular interest in cycling boilers (vs. modulating firing rate).

The surveys were designed, as part of the original scope, to work with friendly entities for the purpose of acquiring a general picture of boiler features and for help in recruiting sites. The survey was not designed as a systematic survey of all potential market actors, therefore, these results may be biased. The survey results suggest a low market share for code-minimum efficiency boilers¹.

The second stage of research was expected to be M&V of non-program boilers. However, *the team was unsuccessful at locating any customer both with a relatively recently installed standard efficiency boiler and willing to participate in the study* through distributors, contractors, and other efficiency partners contacted.

¹ The survey only speaks to current sales and installations. It does not speak to the existing installed base of boilers in Massachusetts.

It is important to note that the initial scoping does not provide conclusive evidence on the absence of standard efficiency boilers in the Massachusetts market, and further research on existing installed stock and recent sales data is warranted. Consequently, the Evaluation Working Group agreed to re-direct some of the funds not spent on metering to a boiler market investigation which would encompass a more rigorous interview sample, seek manufacturer sales data, and utilize other techniques to provide a more reliable view of the market. The results of this investigation will be presented and/or filed at a later date.

The remainder of this memo presents the survey results, the market actor comments on the program, and a description of the respondents in more detail. The final section summarizes the findings of an earlier condensing boiler market assessment.

BOILER INTERVIEW INTRODUCTION

The purpose of this activity was to ascertain the characteristics of non-program-eligible boilers recently sold in Massachusetts through interviews of market actors, and to then seek their assistance in identifying host sites for metering. In particular, the Evaluation Team had hypothesized that the non-program boiler market was distinguished not only by lower combustion efficiency ratings, but also by other features, such as firing rate control, and that using an “offset efficiency” with presumed similar part load performance might not be an adequate means of calculating a baseline for high efficiency boiler savings.

This activity would characterize the cycling profile of the non-program boilers to determine the average cycling rate for single and multi-staged boilers as compared to the variable fired boilers typical for high efficiency boilers. The firing control impacts the frequency of purging and subsequent purge losses. The study would also attempt to determine an empirically based offset to account for in-field measured versus rated combustion efficiencies.

Interviewees were selected from participating program vendors and from firms identified via manufacturer’s directories. Individuals within firms were queried about the features of low-end boilers as well as other aspects of the market. Interviews were completed with individuals from seven firms.

In summary, respondents reported that there is no characteristic difference in either load management strategy or features between less efficient boilers and program eligible boilers. While, the lack of a pattern suggests that the shape of the efficiency vs. firing rate curve is similar for both types of boilers, the magnitude of the efficiency difference between field measurement and rated efficiency has not been resolved.

Regarding market share, energy efficient (program eligible) systems were reported to constitute about 85% of the new boiler sales in Massachusetts, with most of those systems receiving incentives. Four respondents reported that the ratio is reversed in adjacent states where eligible boilers represent only about 20% of the market

The survey also collected data on applications, finding that most boilers are replacements, most systems are hydronic (produce hot water as the thermal medium as compared to steam), and that suppliers react to simply market needs rather than target sectors. Some pricing data was collected as well.

SUMMARY OF FINDINGS

This section summarizes the results of the interviews by topical areas and also by the type of firm.

Installation of Energy Efficient Boilers is Prevalent in Massachusetts

Efficient boilers were defined as boilers that received energy efficiency incentives. There was notable consistency in the stated market share for efficient boilers in Massachusetts. It is clear that efficient boilers are the norm in the commercial boiler market in Massachusetts.

Role	Percentage of Program Boilers Sold	of Eligible Mean
Distributor (4)	80%–100%	90%
Contractor (2)	80%–90%	85%
Sales (3)	80%–90%	85%
Total	80%–100%	>85%

Several respondents stated that larger commercial buildings and government entities exclusively buy energy efficient models. When asked what markets were not buying efficient boilers, the respondents consistently answered “low-end multi-family housing units.”

Distinguishing Boiler Control Features

The hypothesis that boiler sales would be tiered by features was not supported by the respondents. There are minimal differences in features for commercial boilers, especially in the small and medium market. The large and very large boiler markets are differentiated by more substantial and mandatory (prescribed by contract) controls systems. The more-advanced units have more control of valves and the speed of the pumps. Outdoor reset capability is a feature that will be included in more-advanced boilers. The very large units will have the same features as the large units. One respondent noted that one of his product lines would be introducing a boiler with energy efficiency features that would distinguish it in the market.

The biggest challenge for the installer of medium and larger units is integrating with the building controls system. When the building system is commissioned, said one respondent, “You can almost guarantee problems with the boiler will be created.”

Stand-Alone Units Are Rare

Almost all commercial installations are multiple units serving a single distribution system. Some respondents noted that single units are used in two situations. The first is small multi-family building in which the buyer is seeking the lowest-cost option. The second is in smaller buildings in which there is not sufficient space for multiple boilers.

In multiple boiler installations, two boilers were installed about 50%–60% of the time, three units were installed about 20%–25% of the time, and four or more boilers 20% of the time. A sample response was: “People are using boilers for heat. They want to have redundancy in the system.”

Boiler Size

There was general agreement that it was appropriate to characterize the market by size of boiler, due to the relationship between size and pricing. Almost all firms had characterized boilers into three sizes segments, and some that dealt with the larger boilers had four. However, less than half of the interviewees had transactions in the largest boiler size.

	Small	Medium	Large	Very Large

Distributor (4)	<0.5–1.2MBtu	<1.0□1.5MBtu	>2MBtu	N.D.
Contractor (2)	N.D.	2M	6M	12M
Sales (3)	<0.4M	<1.2MBtu	1.2□3MBtu	4□6MBtu
Total	<0.4□1.2MBtu	1.0□2MBtu	1.2–6MBtu	4M+ Btu

Replacement-Driven Market

Replacement boilers make up the lion’s share of the market. One distributor reported that 50% of his sales were new construction in the last year, a surprising volume due to his involvement in several school projects. The number was considered an anomaly that will not be repeated next year.

Role	Percent Construction	New	Median
Distributor (4)	25%□50%		25%
Contractor (2)	0%–30%		10%
Sales (3)	0%–10%		10%
Total	0%–10%		15%

It was clear that there are many very old boilers in Massachusetts, according to the respondents. The oldest boiler was said to be well over 50 years old.

Role	Range of Replaced Boiler	Median
Distributor (4)	25□50+ years	30 years
Contractor (2)	20–30 years	25 years
Sales (3)	15□25 years	25 years
Total	15□50+ years	25 years

Hot Water Dominates Market

Respondents indicated that more than 80% of the boilers sold were hydronic boilers, and the rest were steam. “The market for steam continues to shrink.”

Process boilers were rare. Most respondents had not sold a boiler for just process in the last year. The only people to note sales of boilers to support manufacturing processes were sales people. Boiler sales for process ranged from 0 to less than 10%. “The manufacturing is all leaving Massachusetts.”

Little Vertical Segmentation

With the exception of one contractor, most firms did not target specific vertical markets. One contractor was organized by utility service areas and then select market segments (hospitals, commercial buildings, municipal, and others) in that utility’s service territory. The remaining companies pursued all deals. “We are largely driven by the contractor community. We will pursue any deal that they bring forward.”

Pricing

Pricing differences were minimal, especially at the lower end of the market. One respondent said, “These (small and medium) boilers are now a commodity product. There are no real differences.” The prices noted below are for boilers and do not include installation.

Role	Small	Medium	Large	Very Large
	<0.4–1.2MBtu	1.0–2MBtu	1.2–6MBtu	4M+ Btu
Distributor (4)	\$10k□16k	\$26k□27k	\$40k	\$85k–90k
Contractor (2)	N.D.	\$26k.	\$45k	\$70k
Sales (3)	N.D.	\$29k□30k	\$55k	\$85k
Total	\$10k□16k	\$25k□30k	\$40k□55k	\$70k□90k

Margins range from 15%□18%. While there was some concern in expressing pricing information, respondents’ comments about margins were very guarded. Three people provided information on margins and another four confirmed the 15%□18% number.

Respondents stated that installation costs generally ran ~40% of the purchase cost of the boiler. However, unique situations could create increases of up to 50% in the installation cost. The challenges were often due to a building design that would make it difficult to install or vent the boiler.

Respondents noted that the energy efficiency incentive covered the majority of the price difference between a standard and a program eligible boiler.

Installation of Non-Code Compliant or Used Boilers Appears To Be Rare

Each respondent reported that no used boilers or non-code compliant boilers are being installed. Here are two response excerpts: “I have seen some people using a used boiler as a temporary fix for a few weeks while they wait for their new boiler.” “People are nervous about liability.”

One respondent noted that they have heard of a few non-code compliant boilers being installed. “This is sometimes being done in seasonal and rental properties.”

RESPONDENT VIEW OF THE GAS PROGRAM

There was generally high praise for the boiler program in Massachusetts. The respondents reported that what they liked most about the program; here are some excerpts:

- “People would not buy without the incentives. It would not make sense.”
- “The incentive generates sales. It was a big boost in a down economy. It got people to buy efficient boilers.”
- “The incentive covers most of the price difference, which makes it a good buy for customers to buy efficient boilers.”
- “The gas program is more prescriptive and it’s really easy to work with.”
- “The gas network really works well. I (contractor) can get answers easily and almost every buyer knows about the program.”
- “Standardization across all the programs makes it a lot easier.”
- “You get rebates on every boiler. Almost every job has multiple boilers and in other states they provide a cap and then it just doesn’t make sense.”

- “They generate interest in the market. People know to ask for boiler incentives.”

Here are some responses to what they liked least about the program:

- “The incentive amount dropped last year. People are concerned it will drop again. You put together a bid which may take several months and I am not confident that it won’t change again.”
- “Paperwork. It’s not that bad, but there is still too much.”
- “Nothing really.”
- “There is a lot of concern with the new (efficiency) ratings.”
- “It’s hard to get answers from utility reps.”
- “There is a lot of misunderstanding around 96% efficiency. They don’t understand how it will perform in real life.”
- “The cap. Larger size jobs are limited in the rebate. If it saves energy why penalize.”

Multi-State Feedback

There were four interviews that involved people whose territory included the state of Massachusetts and one or more neighboring states. These interviews generated more energy, enthusiasm, and discussion than any other topic. When asked to compare programs in different states, the respondents gave the unanimous opinion that the Massachusetts programs were, by far, the most effective.

While the Massachusetts market is characterized by respondents as having ~85% energy efficient boilers as a percent of total commercial boiler sales, the market share was reported as being 20% or lower in adjacent states. According to one respondent, “It’s pretty much the inverse of Massachusetts. There is not much of a program. People don’t know about the incentives when they are buying and the incentives are not worthwhile.” A salesperson simply said, “Most of my business is [not in Massachusetts]. Massachusetts is the program leader. Congratulate them on a good program.”

When asked why the difference the responses fell into two categories, participants gave the following responses:

- Incentives:
 - “The incentive in Massachusetts covers most of the additional cost to upgrade to an efficient boiler. It makes the decision a lot easier.”
 - “The difference between Massachusetts and other states is thousands of dollars. The other states must not want people to buy energy efficient boilers. The incentive [in other states] doesn’t make a difference.”
 - “If the rebates stop in Massachusetts we will have an issue. People will definitely stop buying efficient boilers.”
- Awareness:
 - “I got regular calls from the program in Massachusetts. I had a dinner with many contractors and invited a person who did a dog and pony show about the program. In [neighboring state] I would have no idea who to call.”
 - “In Massachusetts almost all customers are aware of the rebate program and [they] ask about it. In [neighboring states] I don’t think many people know about the program.”
 - “[neighboring state] has a program, but I really couldn’t tell you anything about it. They require an audit and then they just drag you through the mud.”

- “There are lots of publications in Massachusetts and I do not recall seeing materials in [neighboring state]. I don’t know how they go to market in [neighboring state].”

One sales representative discussed the implications of these differences following Hurricane Sandy. “Burnham was shipping thousands of units to Long Island and New Jersey. Not a single one was energy efficient. They just went and put in a bunch of low efficiency units. It will be 30 years before you have a chance to replace those boilers.”

METHODOLOGY

ERS completed eight interviews, of which seven provided useful data. The dropped interview had several non-responses. After our review, we determined that the data appeared suspect. The following table summarizes the firms called.

Company	Role	Territory	Interview Status	Units Sold in Mass
Firm A (3), 3 branches	Distributor	Western Mass., Southeast Mass., & Northeast Mass.	2 completes	8, 12, refused
Firm B	Distributor	New England	1 complete	~145
Firm C	Contractor	Mass. and Rhode Island	1 complete	14
Firm D	Contractor	New England and Upstate New York	1 complete	22
Firm E	Sales	Western Mass. and Upstate New York	1 complete	~55
Firm F	Sales	Southeast Mass. and Rhode Island		Refused
Firm G	Sales	Worcester County and east	1 complete	~1,250 (included residential)

More than 160 phone calls were made. There was an average of more than three appointments scheduled for every interview completed. More than twenty-five people were approached; ten provided interviews, three people refused, and the balance did not respond. Distributors were the most difficult group to interview.

Interviewees were classified into three categories:

1. Distributors are defined as organizations that sell multiple products and maintain a substantial inventory of related equipment. We spoke with individuals with responsibility for sales and/or branch operations.
2. Contractors are defined as being engaged in the sale and installation of products, including boilers.
3. Sales are defined as individuals whose sole responsibility is the sale of boilers and related products only, and where the firm does not carry an equipment inventory.

Boiler Brands Represented

The companies that were interviewed handled almost all brands of commercial and industrial boilers. One distributor, Firm A, stated that they were capable of ordering any brand that was available in the United States.

Role	Brands Handled
Distributor (4)	Advantage, Buderus, Burnham, Camus, Cleaver-Brooks, Fulton, Lochinvar, Munchkin, Peerless, Weil-McClain
Contractor (2)	Brooks, Camus, Cleaver-Brooks, Fulton, Weil-McClain
Sales (3)	Burnham, New Yorker, Thermal Solutions, Viessmann

Previous Market Penetration Study

The Project 10 study entitled “HVAC Market Characterizations and Penetration Analysis – Final Report” reported a market assessment of condensing gas boilers. This study found that about 95% of all *condensing* boilers sold in Massachusetts were eligible boilers (AFUE 90% or greater) and that about 50% of those received incentives. This study interviewed 32 distributors and contractors.

This study did not, however, answer how many *non*-condensing boilers are sold in the market where code requires a minimum thermal efficiency of 80%. In the custom gas program non-condensing boilers that perform better than code are eligible for an incentive and therefore this result is not directly transferable to the custom program.