MEMD CALIBRATION STUDY: BOILER TUNE-UPS

Study Results from Phase II

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AGENDA

Research Objectives and Methodology

Key Findings

Detailed Findings

- Boiler Efficiency Savings
- Low vs. High Fire
- Contractor Feedback

Recommendations and Discussion

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MEASURE CALIBRATION

Measure calibration refers to the process where third-party evaluators conduct Michigan-specific research to analyze the per-unit savings impacts for current MEMD measures.

Past calibration studies have included:

- → Lighting Hours-of-Use
- → Home Energy Reports
- → Baseline Housing Study (ongoing)
- → Thermostats
- → Appliance Recycling
- → Lighting Controls

RESEARCH BACKGROUND

Currently, assumed boiler tune-ups savings are measured based on a baseline of a non-serviced boiler. Some facilities regularly perform boiler tune-ups, leading to uncertain savings estimates. Boiler tune-up measures account for:

CONSUMERS ENERGY

108,152 MCF/year

15.8% of gas savings claimed in the Business Solutions Prescriptive Program

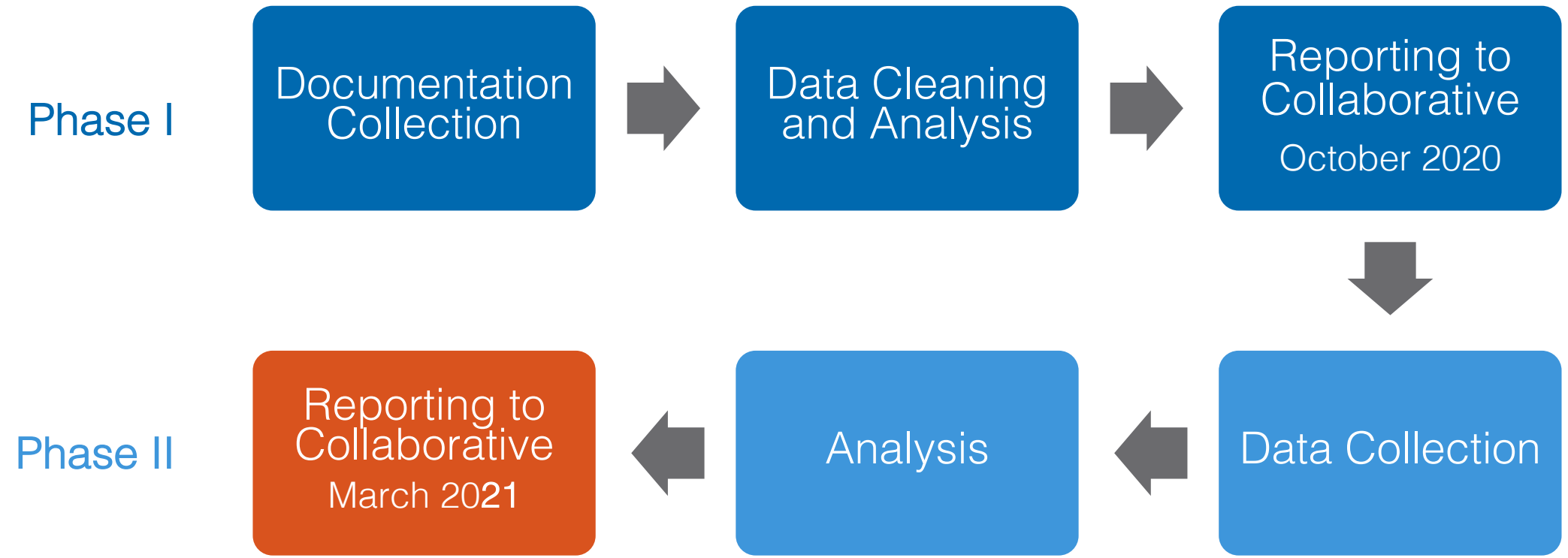
DTE

57,357 MCF/year

9% of gas savings claimed as a part of the C&I Prescriptive Program

RESEARCH TIMELINE

This is a presentation of Phase II results:



PHASE I RESEARCH OBJECTIVES

Phase I of the calibration research sought to:

- → Verify if the MEMD assumption of a 2% boiler efficiency improvement from weather sensitive and process boiler tune-ups is backed by current program data.
- → Review calculation assumptions such as hours of use and baseline boiler efficiency.
- → Review the work papers and calculation methodologies for clarity and accuracy.
- → Review program applications for completeness and accuracy.

PHASE I RESEARCH FINDINGS

Phase I of the calibration research found:

- → Boiler tune ups had an average efficiency increase of 1.4% from the analyzed program data, compared to the current 2.0% assumption in the MEMD.
- → Building performance and efficiency improvements varied among building types, with assembly, hospitals, hotels, and schools being the building types showing lowest efficiency improvements.
- → The hours-of-use data collected from the program applications indicated work paper and calculation assumptions for HVAC boilers were reasonable.

PHASE II BACKGROUND:

RESEARCH OBJECTIVES AND METHODOLOGY

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PHASE II RESEARCH OBJECTIVES

This phase of the calibration research sought to:

1. Understand why schools provide lower boiler tune-up savings and if there are process improvements that can be made to increase savings.
2. Verify if the data collected in Phase I is representative of boiler tune-up efficiency improvements and if collecting additional data on underrepresented building types changes how schools compare to other building types.
3. Determine if the high fire data collected on applications is applicable to the efficiency improvements seen at part load.
4. Understand contractor practices, experiences and elicit any process improvements that could improve data collection.

RESEARCH TASKS

PHASE I: Program Material Review

- → Document collection of hours of use, capacity, and pre- and post-tune-up boiler efficiency
- → Analysis of relevant data
- → Reporting of results to MPSC

PHASE II: Field Data Collection and Analysis

- → Contractor outreach and data collection of boiler efficiency and hours of use
- → Contractor site observations to verify data collected in Phase I and Phase II
- → Analysis of relevant data
- → Reporting of results to MPSC

RESEARCH TASKS

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PHASE II: Field Data Collection and Ana

- → Contractor outreach and data collection of boiler [illegible] and hours of use
- → ~~Contractor site observations to verify data collected in Phase I and Phase II~~
- → Analysis of relevant data
- → Reporting of results to MPSC

Unable to recruit any on-site visits due to COVID-19 restrictions and seasonality.

However, lack of on-site data had little impact on our assessment of savings.

PHASE II RESEARCH METHODOLOGY

The research team reviewed program applications for 437 new boilers (total of 1,201 projects) from building types underrepresented in Phase I and analyzed them to improve estimates of boiler tune-up efficiency improvements.

Facilities were randomly sampled based on building types that were underrepresented in the Phase I sample. Data collected from program applications included:

- → Facility type
- → Boiler size
- → Hours of operation
- → Pre- and post- tune-up boiler efficiencies

PHASE II RESEARCH METHODOLOGY

In Phase II, the research team collected high- and low-fire combustion tests for 17 boilers from both before and after the tune-up to determine if efficiency gains at high fire are representative of efficiency gains at part load. We gathered:

- → Low-, medium- and high-fire combustion tests
- → Boiler size
- → Hours of operation

Note: Low, medium, and high fire are the readings at their respective firing rates for positional boilers (boilers that have discrete firing modes). For modulating boilers, we used the following definitions: <40%=low fire, >80%=high fire, and ~50%-60%=medium fire.

PHASE II RESEARCH METHODOLOGY

In Phase II, the research team attempted to recruit contractors for site observations to better understand why schools have lower savings and observe contractor practices and processes to help inform any program improvements that could be made.

→ However, the interviews were able to fill the gap to help us understand the results from Phase I.

The research team also conducted 7 interviews with contractors to gain insight on why schools have lower savings and gather feedback on the program in general.

WHAT WE FOUND:

KEY FINDINGS FROM PHASE II

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KEY FINDINGS

Phase II confirms the findings of Phase I: an average efficiency increase of 1.34% from the analyzed program data, compared to the current MEMD assumption of 2%. Larger boilers were found to have even lower efficiency increases.

- → Savings per tune-up is 1.34% ± 0.11% (1.39% in Phase I)
- → Bigger boilers have lower efficiency improvements – contractors suggested they may have dedicated staff or receive more regular maintenance
- → More than 76.6% (76.0% in Phase I) of applications had less than 2% savings.

KEY FINDINGS

When we collected additional application data from underrepresented building types; schools did not change significantly, while other building types typically regressed towards the mean.

→ Contractors suspected new high efficiency condensing boilers with linkageless controls prevented significant energy efficiency improvements from boiler tune-ups in schools, however the program data on high efficiency boilers does not support this assertion.

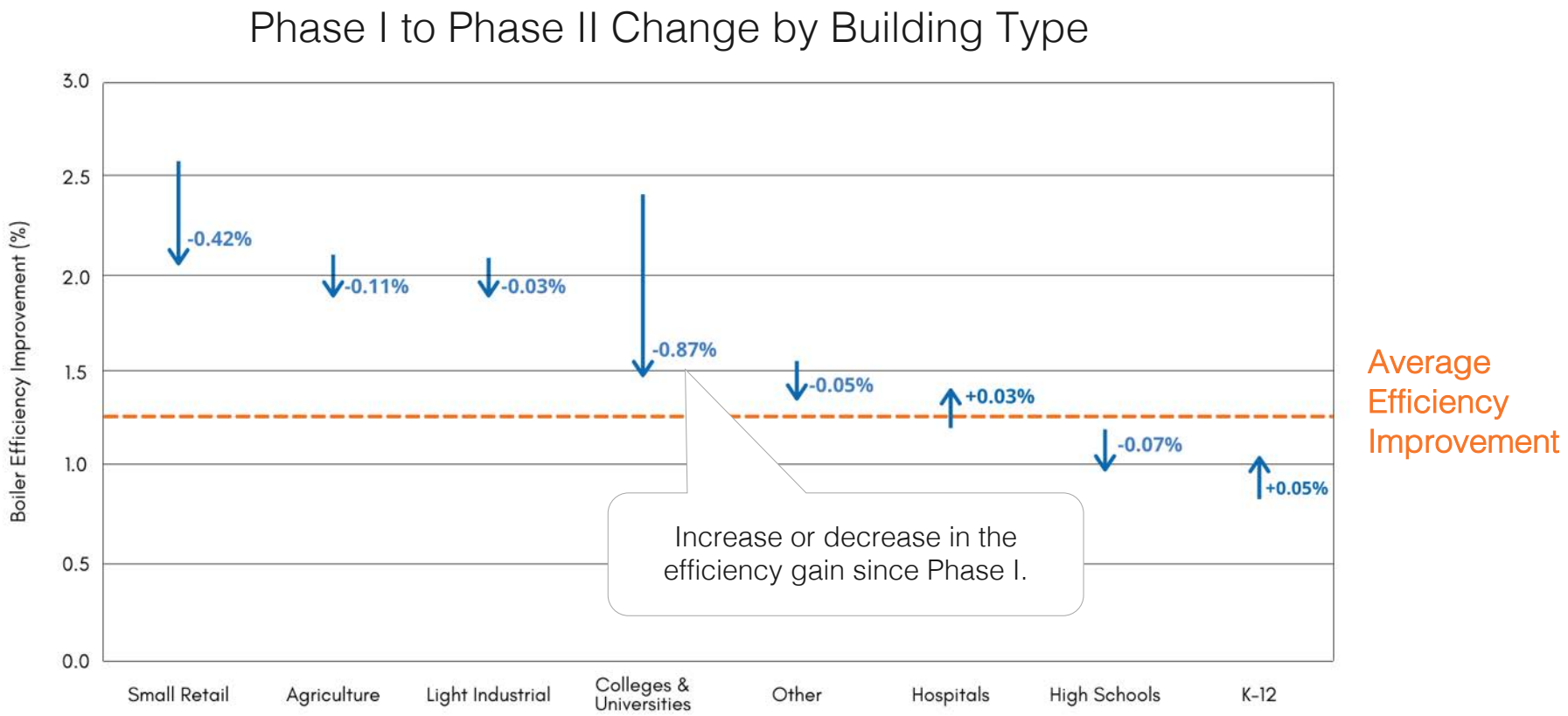
KEY FINDINGS

The school vs non-school split decreased, and the non-school boilers are now statistically different from the MEMD assumptions.

- → Schools saw efficiency improvements of 1.03% ± 0.12% (0.99% in Phase 1)
- → Non-school, non-process boilers saw efficiency improvements of 1.61% ± 0.18% (1.88% in Phase I), which is now statistically different than the MEMD value.

KEY FINDINGS

Additional data collected indicated that most building types converged to the mean with additional data collected



KEY FINDINGS

All interviewees stated that they provide boiler tune-ups as part of the state-required annual CSD-1 (controls and safety devices) testing even though CSD-1 only requires a tune-up every third year.

- → CSD-1 is required for all boilers in the state of Michigan over 400 MBH in size.
- → 400 MBH is enough capacity for approximately 10,000-15,000 sq. ft. of space.
- → Tune-ups only take an extra ~10-20 minutes per boiler.

KEY FINDINGS

The difference in the efficiency improvements from low fire and high fire readings was not statistically significant.

- → Collected data for low and high fire on 17 boilers.
- → Contractors believe that low-fire readings better represent the typical boiler operation better than high-fire readings.

DETAILED PHASE II FINDINGS

BOILER EFFICIENCY IMPROVEMENTS

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BOILER EFFICIENCY IMPROVEMENTS BY FACILITY TYPE

Overall, the efficiency gain at most facilities was less than 2.0%.

Facility Type	Average Boiler Efficiency Improvement	Number of Projects (New in Phase II)
K-12 Schools	1.01%	377 (56)
Non-schools	1.61%	423 (119)
Small Office	2.77%	12 (9)
Small Retail	2.10%	15 (5)
Light Industrial	1.99%	18 (7)
Agriculture	1.98%	26 (9)
Hotel	1.95%	25 (3)
Large Office	1.77%	23 (0)
Grocery	1.64%	5 (2)
College/University	1.55%	75 (43)
Other	1.48%	106 (16)
Hospital	1.41%	46 (15)
Assembly	1.22%	16 (3)
Heavy Industrial	0.33%	2 (1)
Full-Service Restaurant	0.17%	6 (6)
Total	1.34%	803 (175)

CONTRACTOR INTERVIEWS: SCHOOLS

Contractors suspected new high efficiency condensing boilers with linkageless controls prevented significant energy efficiency improvements from boiler tune-ups in schools.

- A linkageless control system uses a burner with multiple servo motors for each valve and damper (instead of an actuator with a mechanical linkage to all the dampers and valves) to more accurately control fuel and air ratios.
- Linkageless controls benefit less from tune-ups as:
  1. There are fewer opportunities for mechanical-positioning accuracy degradation.
  2. Linkage systems accrue more wear, are more difficult to maintain to give proper fuel-to-air ratios, so they require more tuning.
  3. The servo motors used in linkageless applications are very accurate.
- Contractors estimated these boilers are in 40% - 50% of schools and growing.

DOES THE DATA SUPPORT THIS?

Based on our analysis, high efficiency (>87% efficiency post-tune-up) boilers had slightly reduced efficiency improvements compared to low efficiency boilers in terms of efficiency improvements.

- → High efficiency boiler efficiency improvement = **1.16% ± 0.23% (n=197)**
- → Standard efficiency boiler efficiency improvement = **1.41% ± 0.12% (n=547)**

This may explain some, but not all the differences seen in schools.

CONTRACTOR INTERVIEWS: SCHOOLS

Contractors suspected new high efficiency condensing boilers with linkageless controls prevented significant energy efficiency improvements from boiler tune-ups in schools.

> *[I would expect] less improvement at schools than an industrial plant. Schools have upgraded the equipment, so things are more accurate. Industrials haven't upgraded to linkageless, so their performance degrades more quickly if they don't regularly calibrate. Schools are linkageless and that will maintain the efficiency better without adjustments.*

> *We don't tend to do schools. They're phasing out typical boilers for condensing boilers which we don't do much testing on. They don't have much play on them to require calibration.*

CONTRACTOR INTERVIEWS: STATE REQUIREMENTS

All interviewees stated that they provide boiler tune-ups in parallel with state required annual CSD-1 (controls and safety devices) testing.

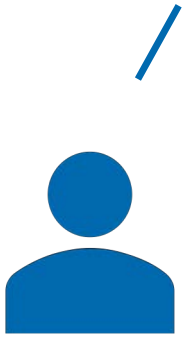
- → CSD-1 testing is required annually for all boilers in Michigan over size 400 MBH. Tune-ups only take an extra ~10-20 minutes per boiler.
- → Some contractors said participating in the programs is useful from a marketing perspective, but all said they do not offer CSD-1 testing independently from tune-ups.
- → Several interviewees did mention they think that some of their competitors do not always do tune-ups as part of CSD-1 testing.

Baseline assumption that that boilers accrue two years of degradation between tune-ups is likely incorrect, reducing savings.

CONTRACTOR INTERVIEWS: STATE REQUIREMENTS

All contractors we interviewed stated that they bundle boiler tune-ups with state required annual CSD-1 (controls and safety devices) testing.

- Annual boiler tune-ups impacts the assumed baseline for efficiency gains.
- Caveat: These data represent contractors that have participated in the program (and not a random sample of the market).



> *Most [of our] customers would do [boiler tune-ups] regardless, as part of the regular maintenance. They have the CSD testing laws to get tested annually. We always do the combustion tuning together with the CSD-1 testing.*

CONTRACTOR INTERVIEWS: STATE REQUIREMENTS

Interviewees suggest that tune-ups do not happen as frequently outside of the program, indicating program influence.

"Sometimes we lose work to a cheaper contractor who doesn't do tune-ups and takes short-cuts on CSD-1 testing…We get called back when the boiler has issues, and find the boiler hasn't even been opened or cleaned"

"[Enforcement of CSD-1 requirements] depends on municipality. Certain jurisdictions are more strict. All jurisdictions do require testing."

DETAILED PHASE II FINDINGS

LOW VS. HIGH FIRE BOILER EFFICIENCY IMPROVEMENTS

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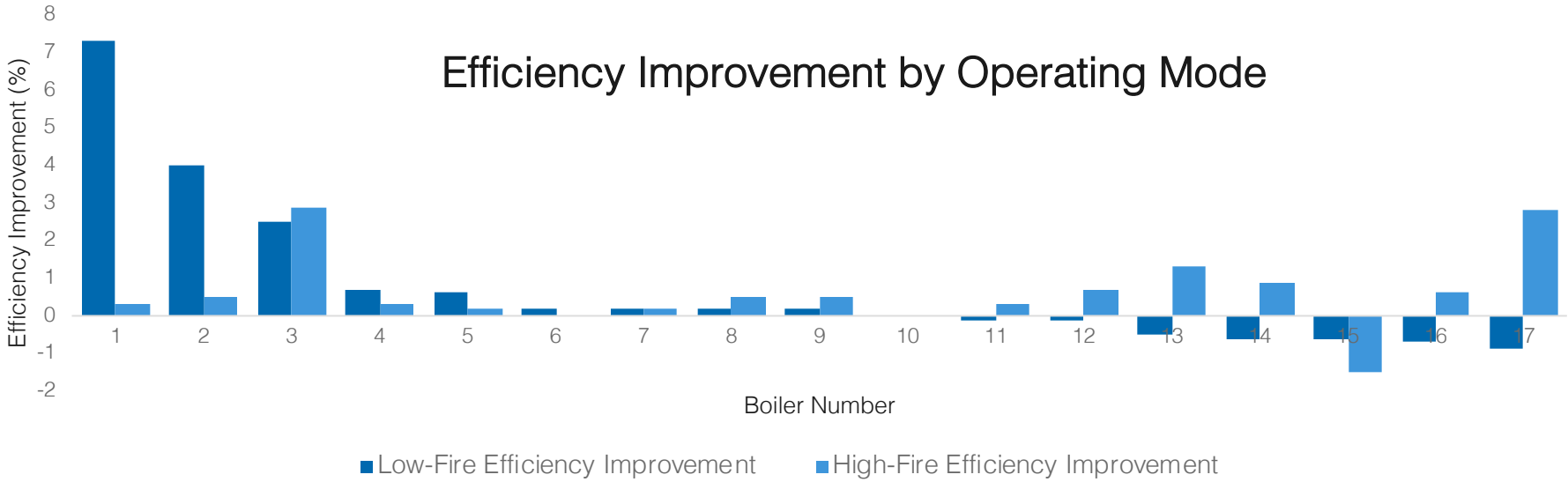
LOW vs. HIGH FIRE EFFICIENCY IMPROVEMENTS

No statistical difference in efficiency gains between high and low fire operating modes.

→ High fire is representative of the true tune-up savings, even though most boilers spend most of their operating hours in low fire modes.



DETAILED PHASE II FINDINGS

CONTRACTOR FEEDBACK

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CONTRACTOR INTERVIEWS: PROGRAM DOCUMENTATION

There is an opportunity to engage additional contractors. Some avoid the programs due to paperwork, so streamlining applications could encourage participation.

- → DTE has a spreadsheet version which several contractors mentioned was very helpful.
- → 2 of 7 contractors said they had some difficulty determining which boilers were eligible for rebate and keeping track was a bit challenging, particularly for new customers.
- → 3 of the 7 contractors mentioned frustration with the amount of duplicate information required both between the same customers with multiple boilers/buildings as well as year-over-year.
  - → Opportunity for data stored in a system to avoid redundant data entry?

WHAT IT MEANS:

RECOMMENDATIONS AND DISCUSSION

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RECOMMENDATION: ENERGY SAVINGS

Our collection of additional program data confirmed Phase I finding. HVAC boiler tune ups have an average efficiency gain of 1.34%, compared to the current assumption of 2.0%, based on program data.

★ **Recommendation: During the update cycle for the 2022 MEMD, consider:**

→ Changing the assumed 2.0% efficiency increase for HVAC boilers to a **1.34% increase**

RECOMMENDATION: PROGRAM IMPROVEMENTS

There is an opportunity to engage additional contractors by streamlining program documentation requirements.

★ **Recommendation: Consider ways to simplify the program application and possibly store and pre-populate required data.**

→ DTE's spreadsheet application was considered helpful at reducing redundant data entry.

RECOMMENDATION: MONITOR CONDENSING BOILERS

Some contractors suggested new condensing boilers may have less room for improvement. The data collected was not conclusive, but the prevalence of this equipment in the market may limit the potential for tune-ups.

★ Recommendation: Continue to monitor condensing boiler market saturation and consider that as a factor in future MEMD updates.

→ Currently, condensing boilers account for 26% of the program in our sample.

thank you

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