

September 29, 2021

Commercial Boiler Controls Tune-Ups Proven Out Through Local CARD Research

Expanded Scope Commercial Boiler Tune-Ups



Russ Landry, PE

This project was funded in part by the Minnesota Department of Commerce, Division of Energy Resources, through the Conservation Applied Research and Development (CARD) program.





•• Presentation Overview

- Project Goal: “Develop and field test an expanded scope commercial boiler tune-up protocol that goes beyond burner adjustments to provide a comprehensive review and adjustment of boiler (temperature & staging) control settings to increase energy savings.”
- Why?...temperature and staging controls
- How & Who?...protocol development & testing
- What?...we learned



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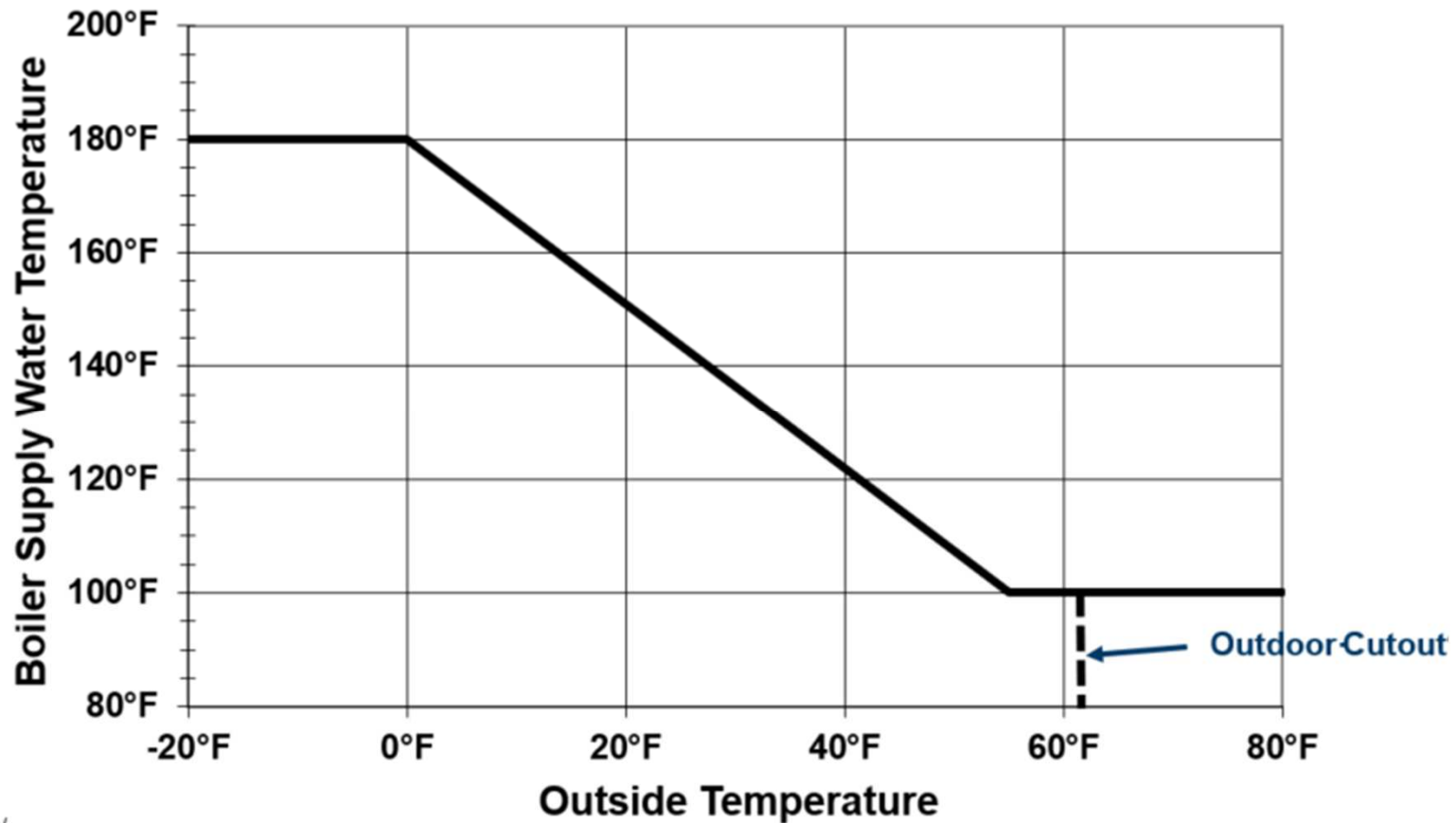
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• Why Boiler Temperature & Staging Control Optimization?

- To fully capitalize on outdoor reset control savings

Boiler System Outdoor Reset Control

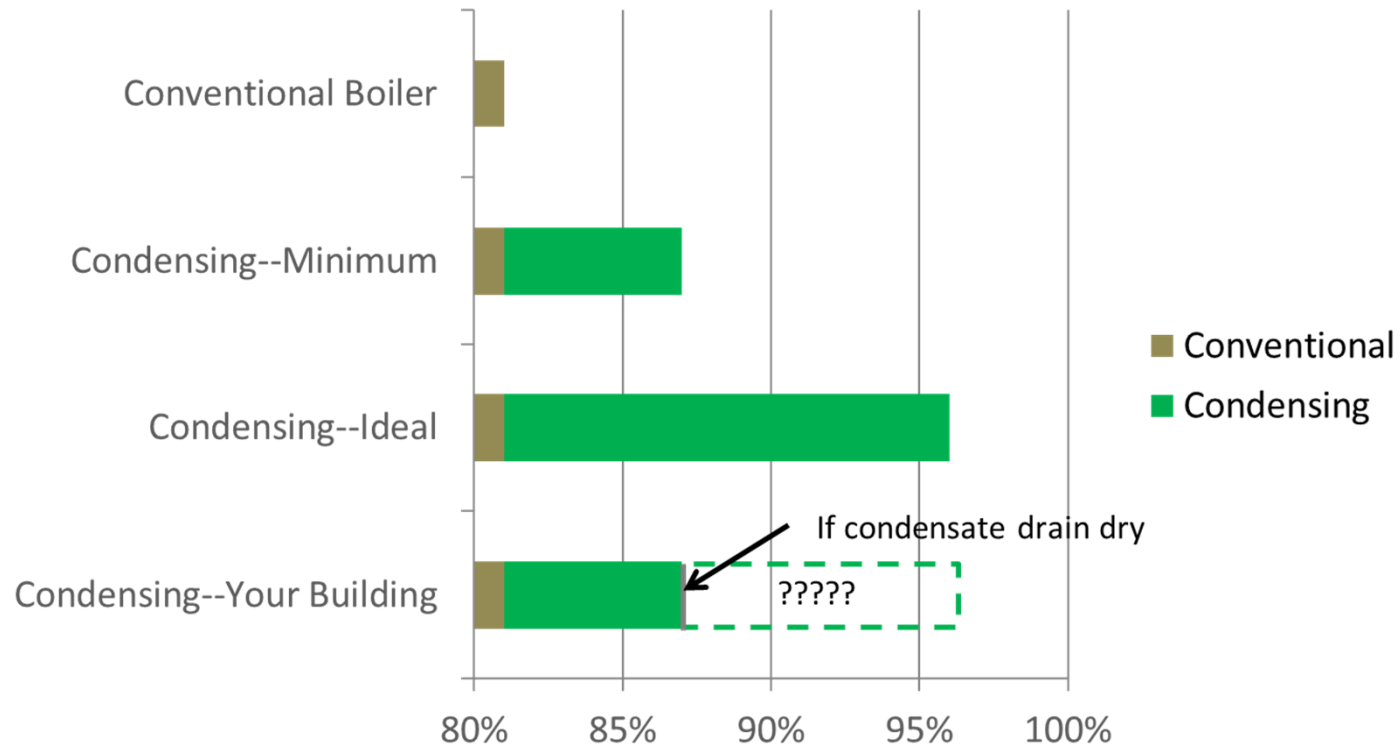




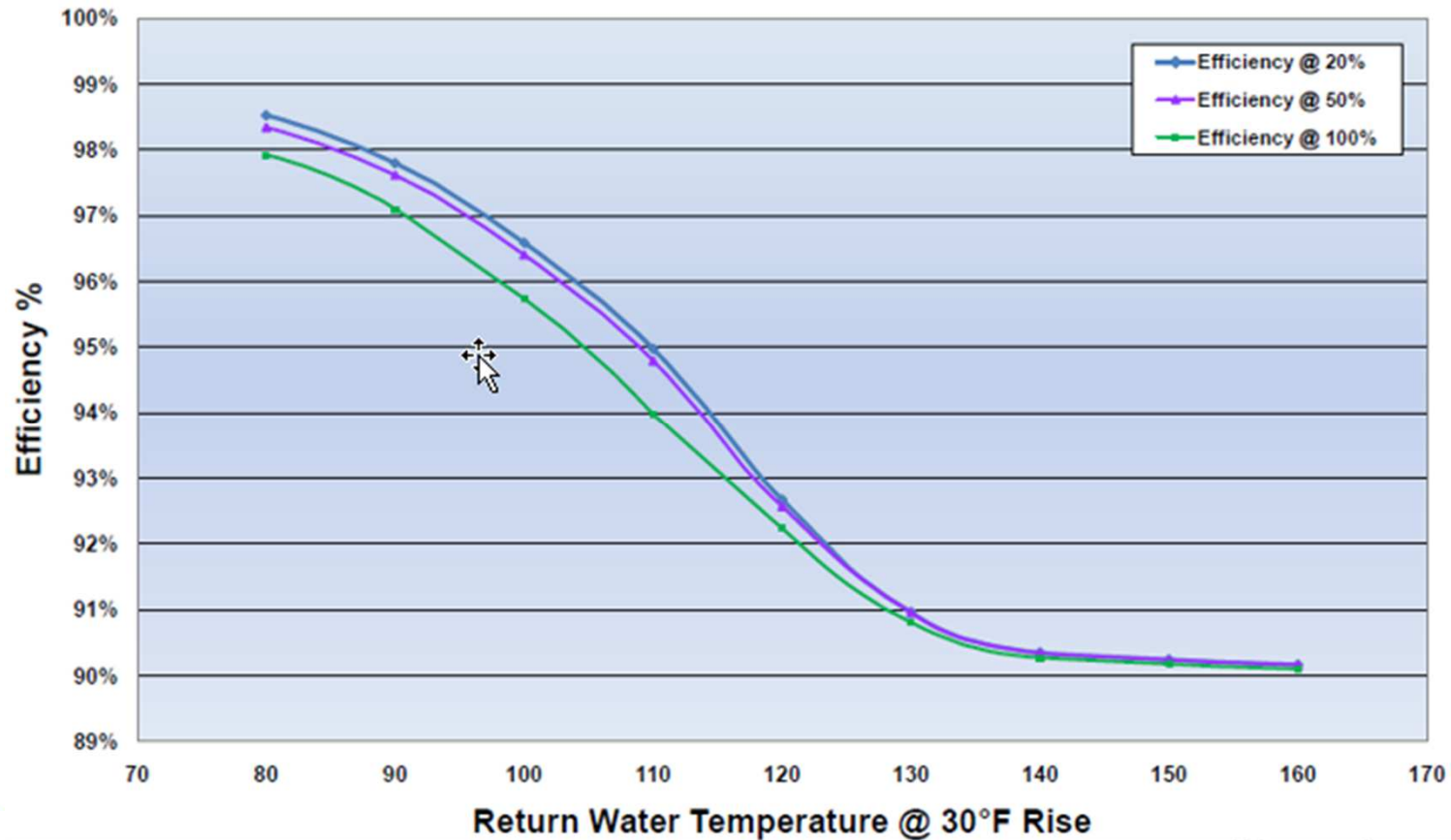
Why Boiler Temperature & Staging Control Optimization?

- To fully capitalize on outdoor reset control savings
- • To respond to market shift towards condensing boilers
 - Less burner setting drift
 - Operating efficiency is very sensitive to system return temperature (and firing rate)

•• Condensing Boiler Operating Efficiency Range




Condensing Boiler Operating Efficiency Variation

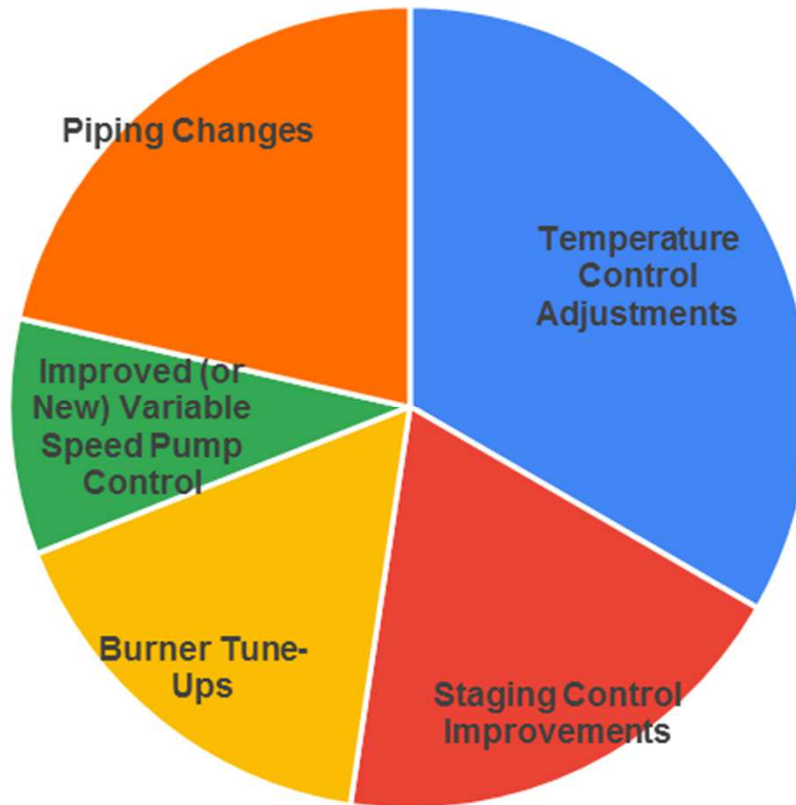




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-  • To follow-up on savings opportunities identified in previous CARD-funded condensing boiler optimization project

Savings Potential In Existing Commercial Condensing Boiler Systems





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-  • To leverage existing program service delivery and sales



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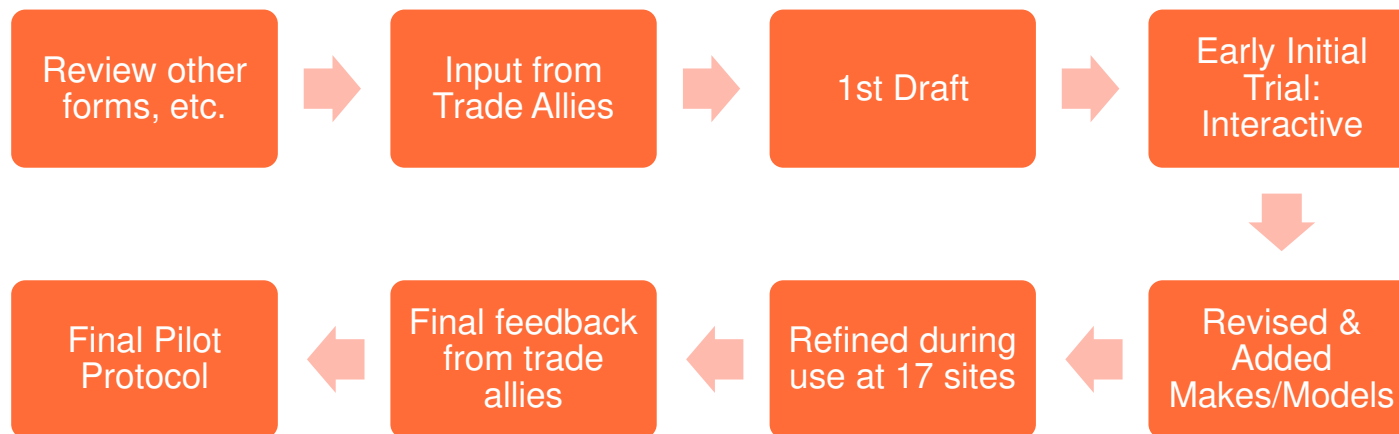
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- Why?...temperature and staging controls
- **How & Who?...protocol development, recruitment & impact**
- What?...we learned

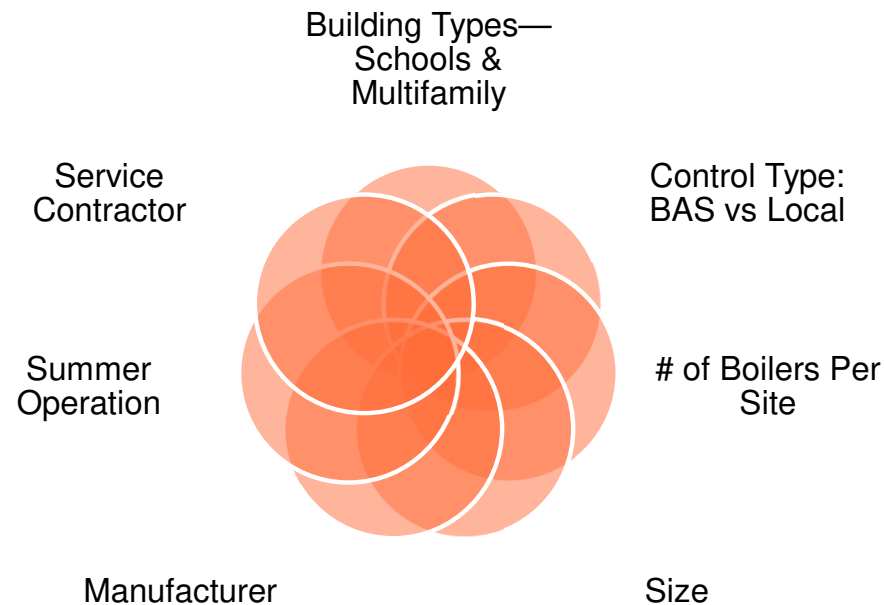
•• How & Who? Protocol Development

- Market Study to Inform Development
 - Interviews with 21 local boiler industry contacts
 - State boiler and pressure vessel database (smaller boiler systems omitted)
- Protocol Development



•• How & Who? Recruitment

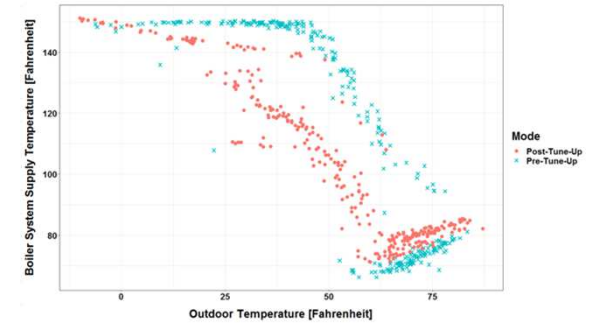
- Targeted #s Within Categories for 7 Different Characteristics



- Recruited contractors, who then recruited end-users
 - 5 contractors, 4 of which recruited 1+ appropriate sites
 - 17 buildings selected from a pool of 32 (5 different building owners)

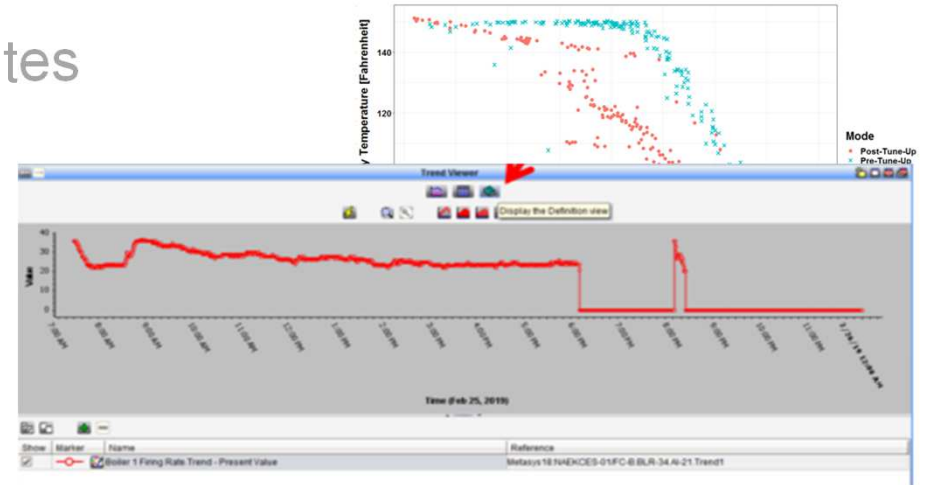
•• How & Who? Impact—Long-Term Monitoring

- Boiler system temperatures—all sites



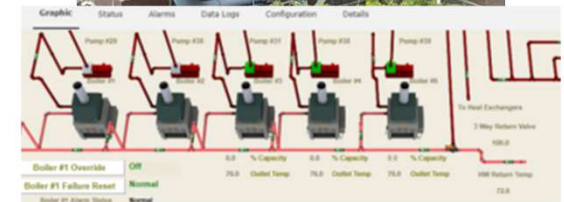
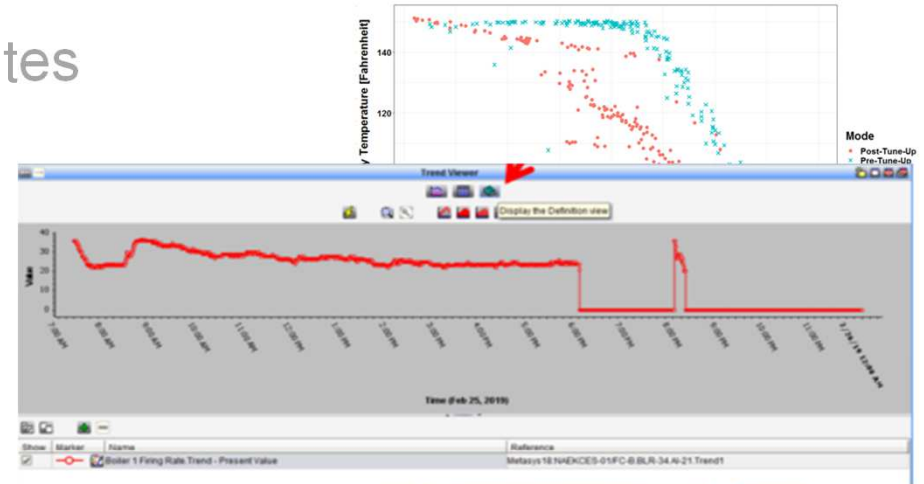
•• How & Who? Impact—Long-Term Monitoring

- Boiler system temperatures—all sites
- Boiler cycling—13 sites
 - On board counters
 - BAS & loggers



•• How & Who? Impact—Long-Term Monitoring

- Boiler system temperatures—all sites
- Boiler cycling—14 sites
 - On board counters
 - BAS & loggers
- Natural Gas Savings
 - Measurement
 - Meters--11 sites
 - BAS firing rates--6 sites
 - Analysis
 - Pre-post regressions
 - Limited Post data (before COVID shutdowns at schools) vs pre-regressions





•• How & Who? Impact—Program Projections

- Cost-Effectiveness
 - Contractor billed costs
 - Based on \$7.60 per mcf and 2021-2023 CIP filing inputs
- Program Potential
 - Population of existing boilers
 - (Burner) tune-up program participation



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 - Fine-tuning callbacks needed at 4 of 17 sites
 - Backtracking of changes >20°F



•• What We Learned? Detailed Protocol Application

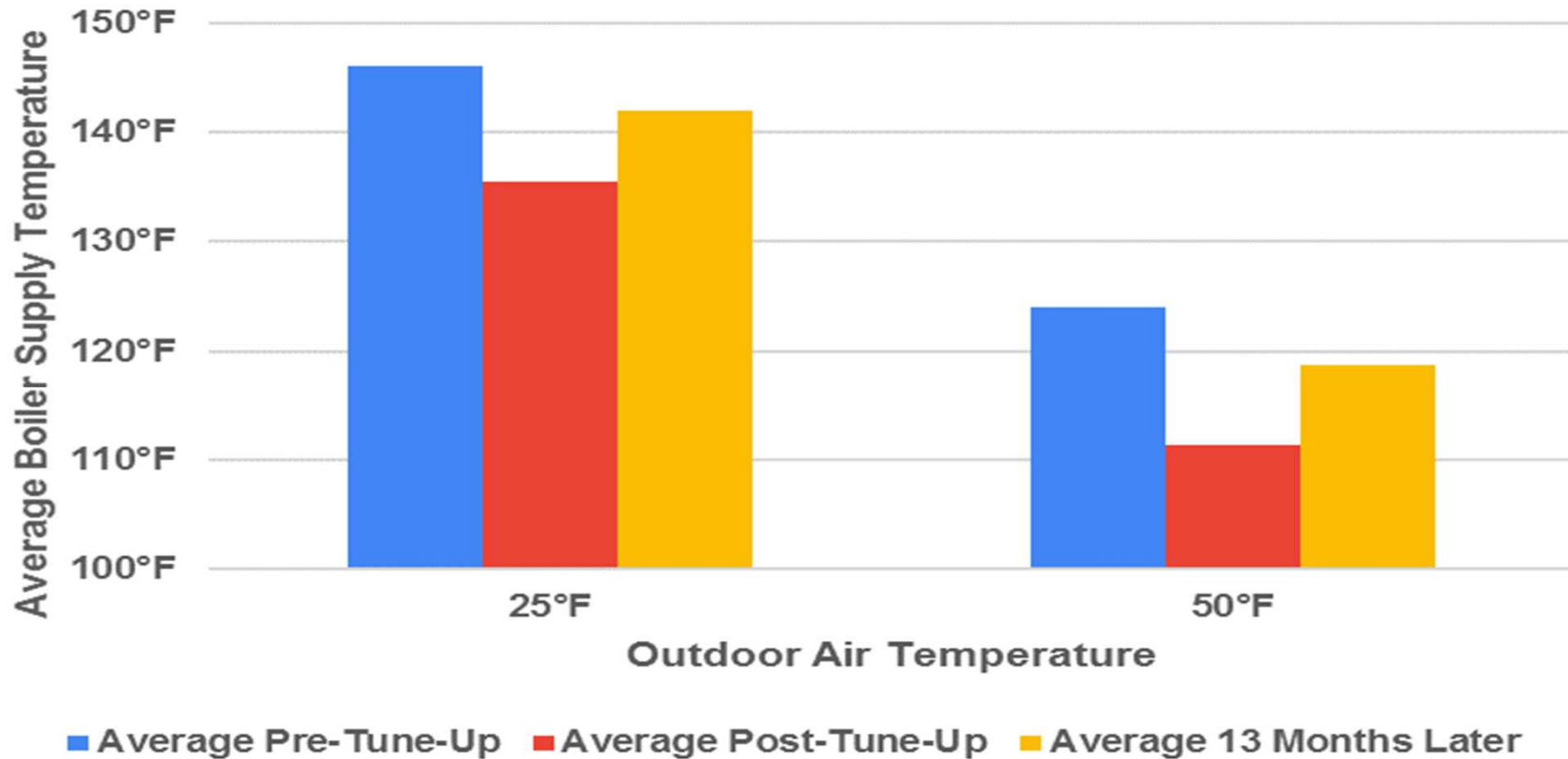
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- Controls problems beyond settings
 - Issues at one-third of sites
 - Most resolved during initial visit



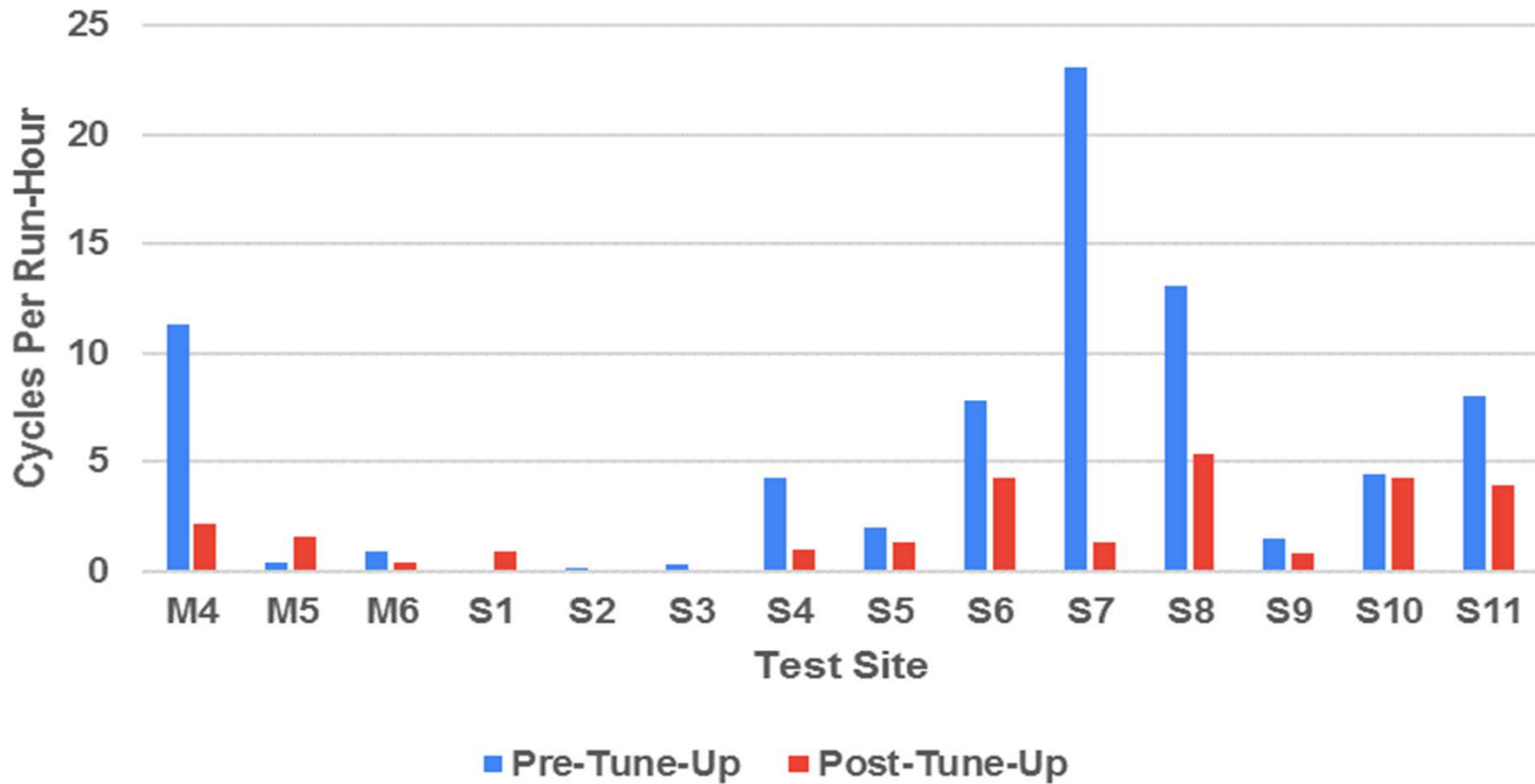
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 - Most resolved during initial visit
- BAS changes made without controls contractor
- Mechanical plans very helpful for buildings with newer HVAC
- Cost ~\$750 per site or ~\$250 per boiler

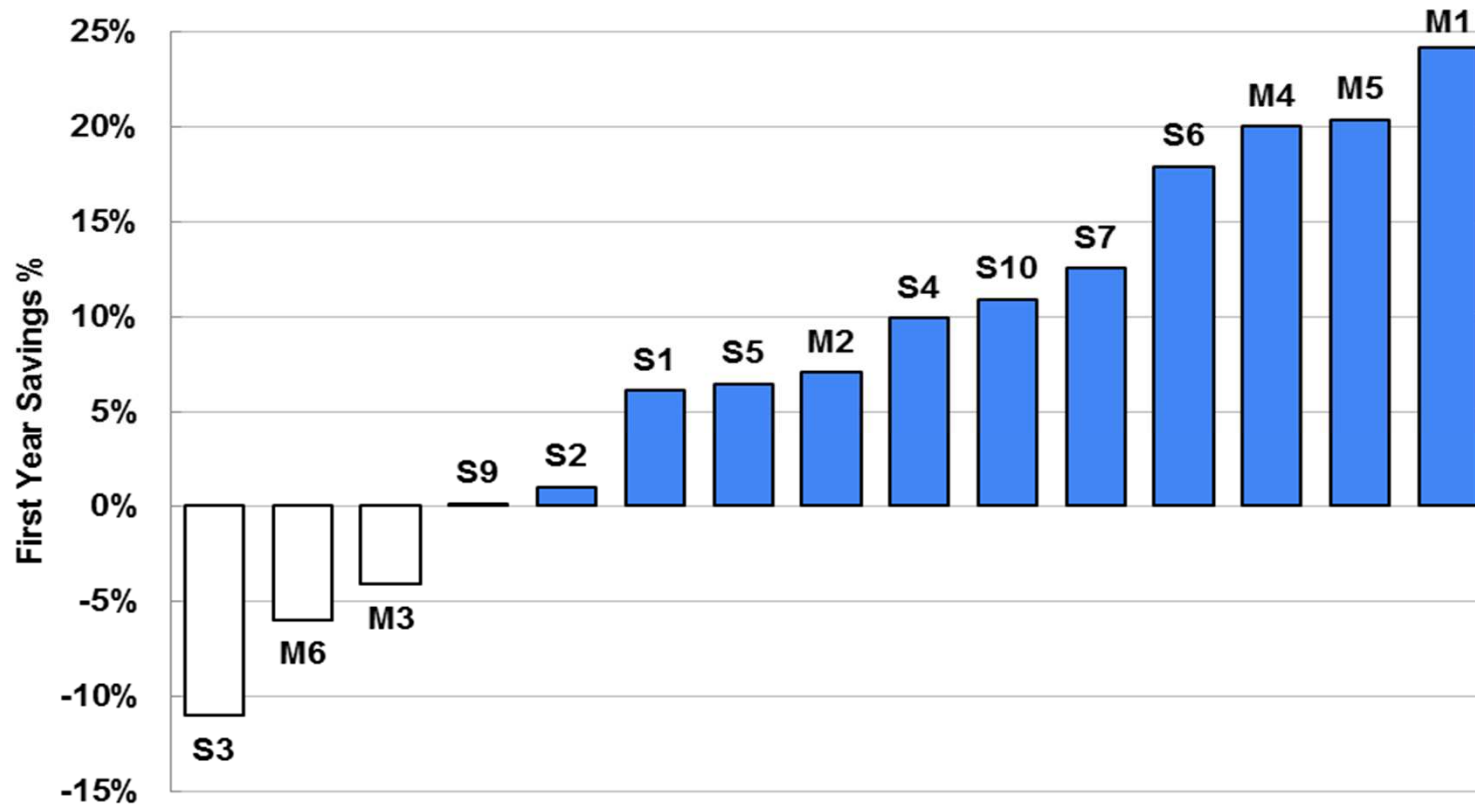
What We Learned? Control Tune-Up Impact on Temperatures



What We Learned? Control Tune-Up Impact on Cycling



What We Learned? Control Tune-Up Impact on Gas Use






What We Learned? Control Tune-Up Impact on Gas Use

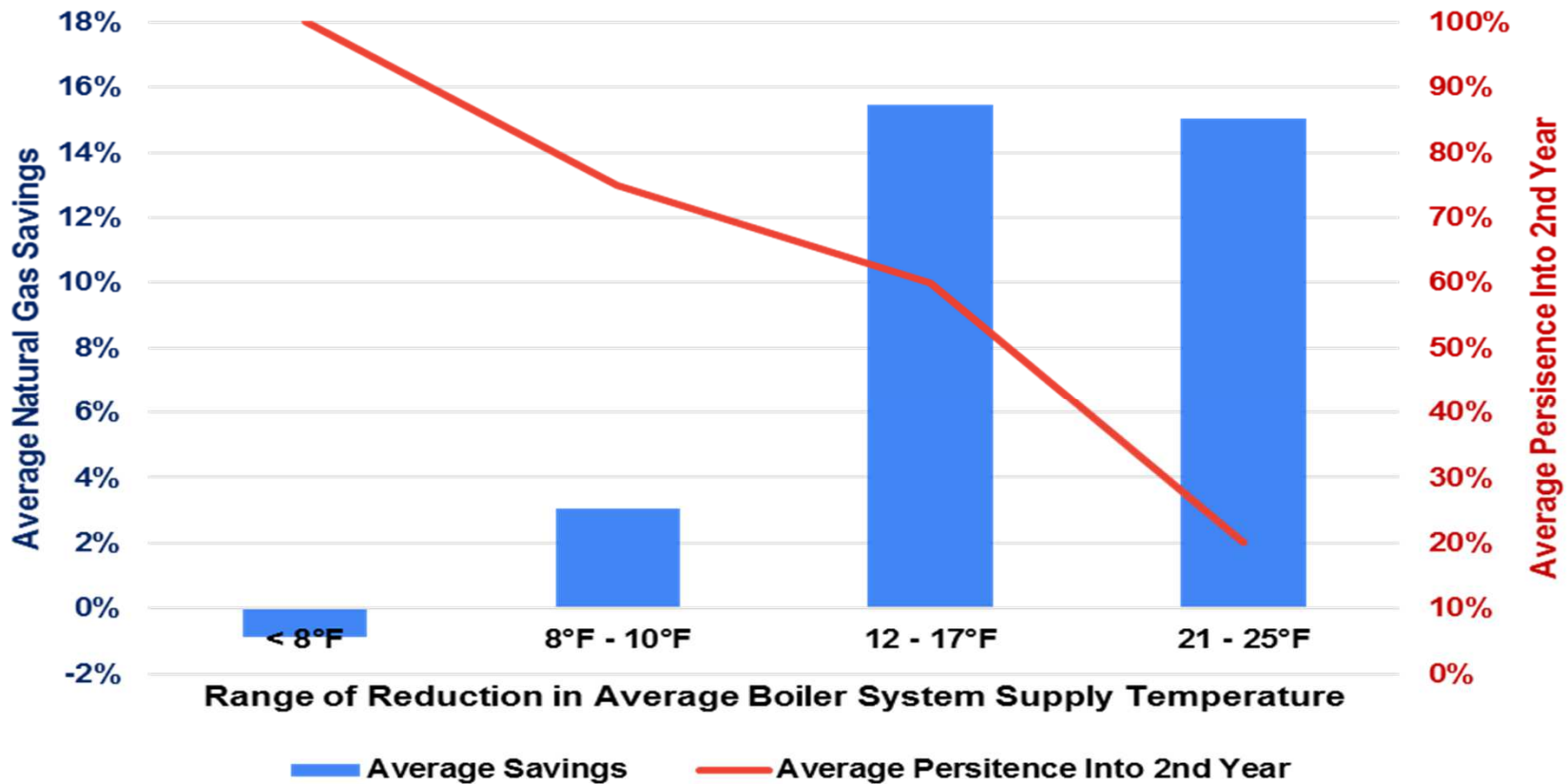
Sample	Mean Percent	Median Percent	Mean Gas	Median Gas
Multifamily Buildings (N=6)	10.3%	13.6%	152 Dth	67 Dth
School Buildings (N=9)	6.0%	6.5%	187 Dth	148 Dth
Both Building Types (N=15)	7.7%	7.1%	173 Dth	137 Dth

•• What We Learned? Savings Persistence

- Average of 66% into the 2nd year
- Persistence into 2nd year varied greatly by site
 - Most at 100%
 - Significant minority <20%



•• What We Learned? Savings & Persistence



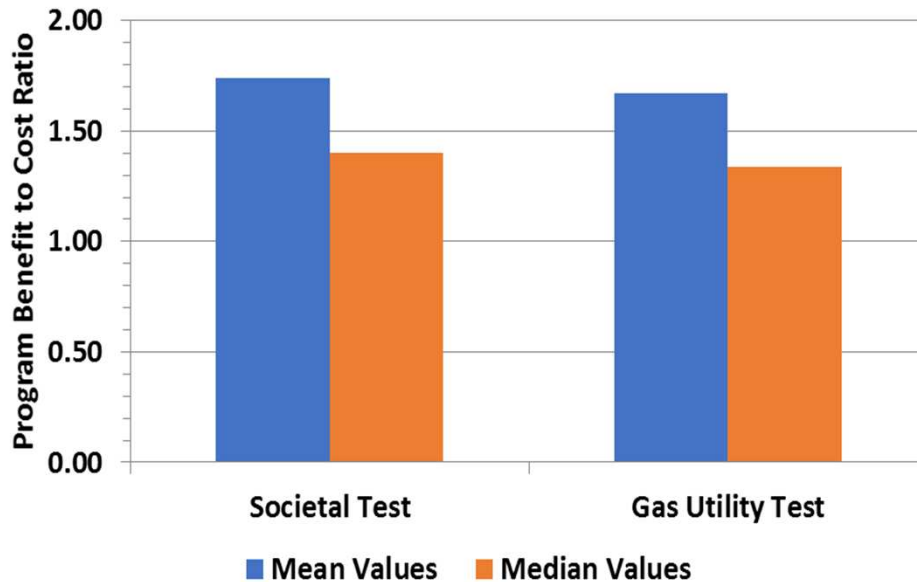
•• What We Learned? Cost-Effectiveness & Impact

- Simple Payback
 - Median 0.73 years
 - 10 of 17 sites < 1 year
- Achievable Potential
 - 196,500 Dth (10% of C&I portfolio)



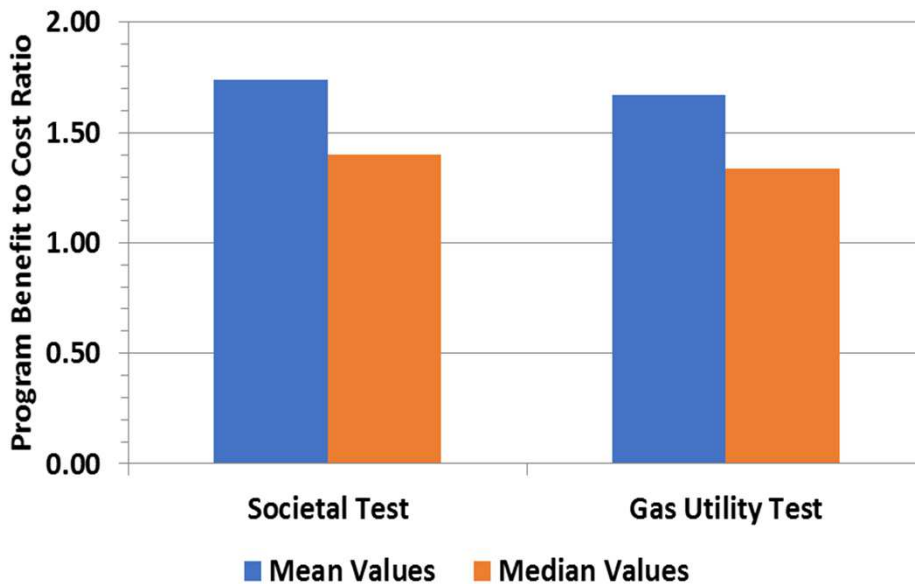
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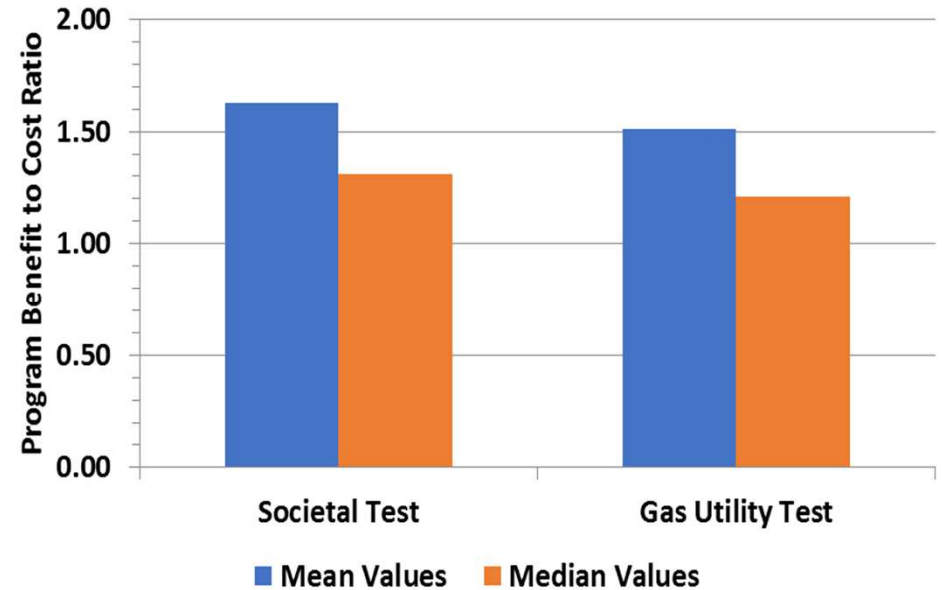


•• What We Learned? Cost-Effectiveness & Impact

- Existing Program Costs



- 25% Larger Program Costs





What We Learned? Recommendations: CIP Program Development & Marketing

- End user market research.
- Budget and timeline should allow for extensive contractor training, on-demand technical support, and quality control.
- Work with trade allies during program planning.
- Leverage boiler service contractors to promote the service.
- Test approaches to increase persistence.



What We Learned? Recommendations for CIP Program Implementation

- Provide extensive contractor training and on-demand technical support.
- Institute a robust quality control program.
- Provide clear customer expectations: BAS access & mechanical plans.
- Match technician make/model familiarity with each site.



•• Key Takeaways

- 7-8% Average Savings Achieved from Low-Cost Boiler Temperature and Staging Control Optimization
- Many Factors Can Impact Initial Savings & Long-Term Savings Persistence




Questions?

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Thank You

