To Condense, or not to Condense?

Installation Practices Leave Boiler Savings on the Table

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Condensing boilers are like racehorses

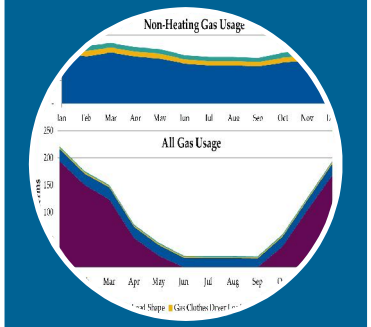
If they're not handled properly, things can go wrong…

Methodology

Long-term metering

Gas consumption spot measurements

Efficiency spot measurements



Billing data disaggregation

Calibrated simulation for weather normalization

On-site Data Collection

Analysis

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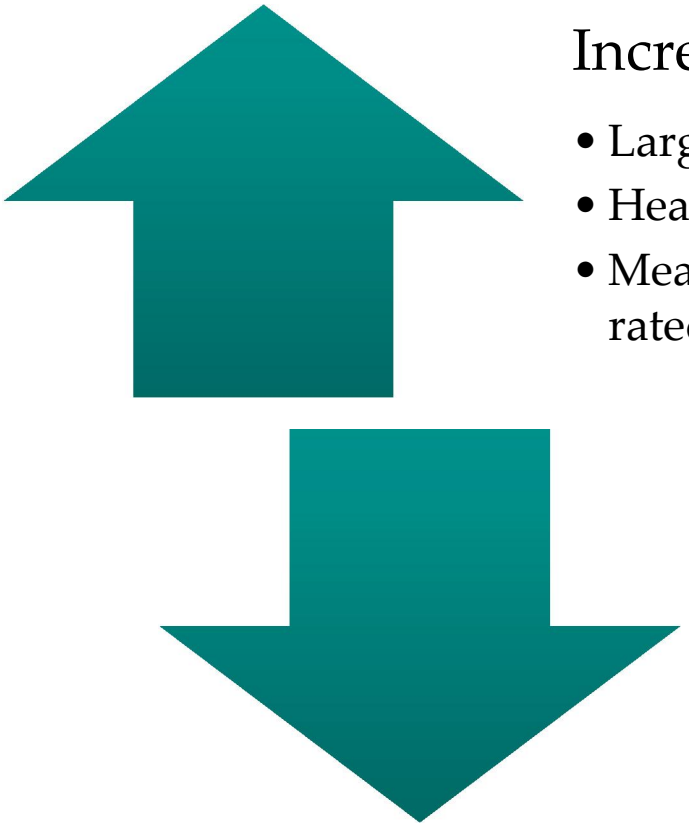
Average rated efficiency for the sample was 94 percent AFUE…

Overall, verified boiler savings exceeded TRM estimates



Increased savings due to…

- Larger heating load
- Heating and hot water loads included
- Measured baseline efficiency below rated

Decreased savings due to…

- High-efficiency units operating well below rated efficiency

Final results were 106% - 113% of TRM values for standard boilers (replace-on-failure measures)

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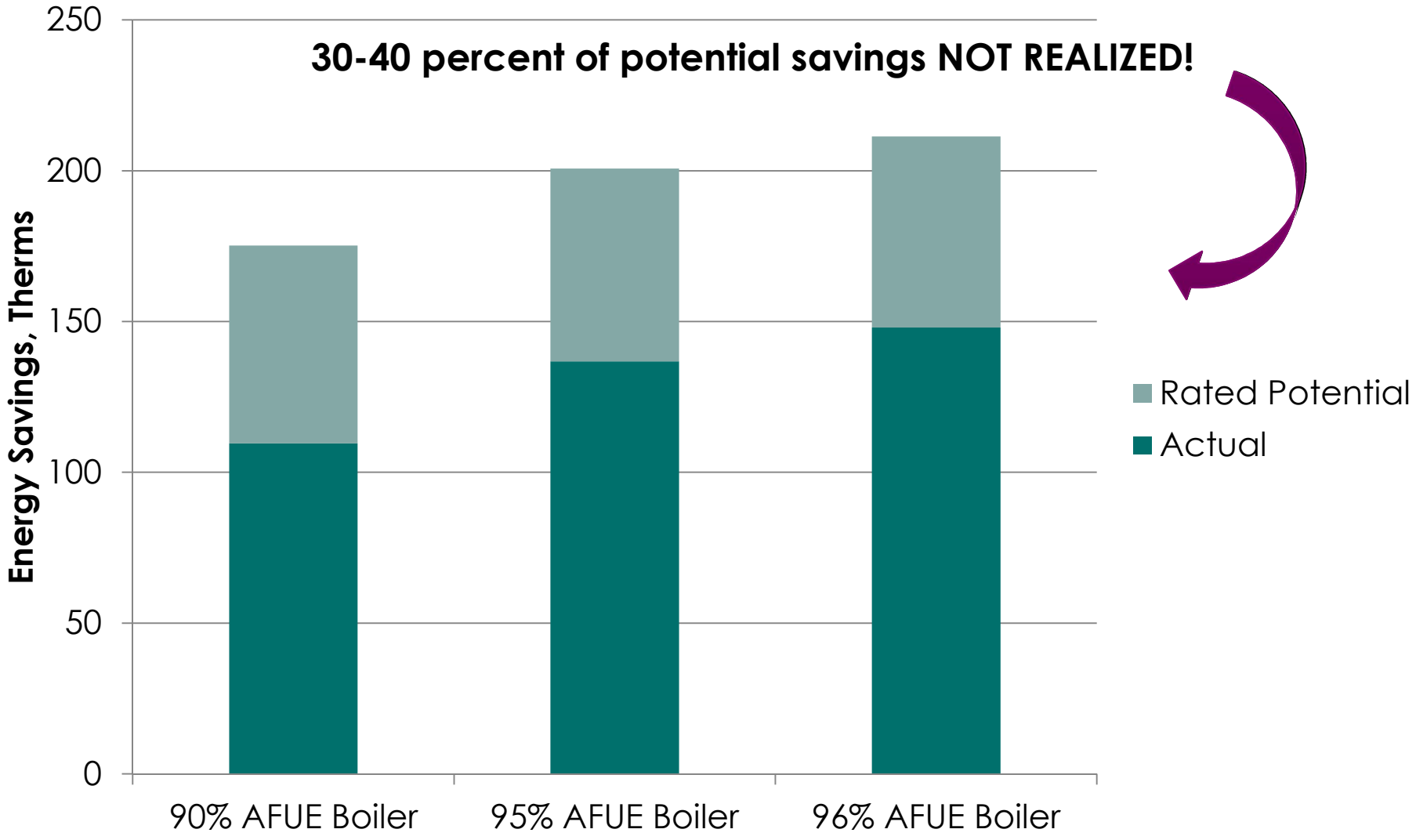
Actual estimated efficiency was only 88 percent

Boiler Savings: Below Expectations



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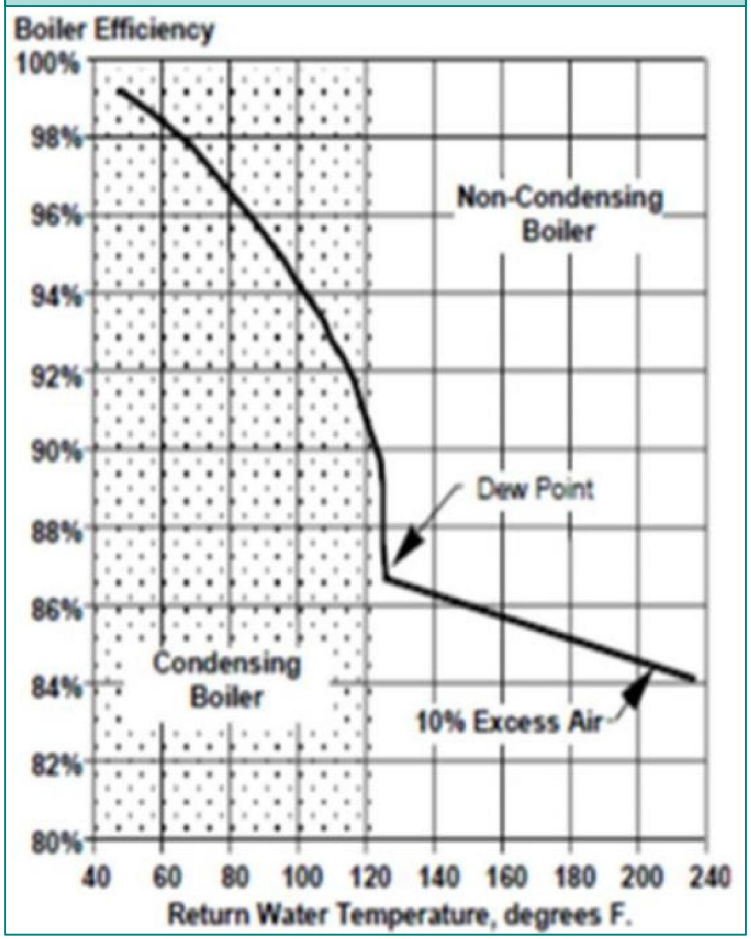
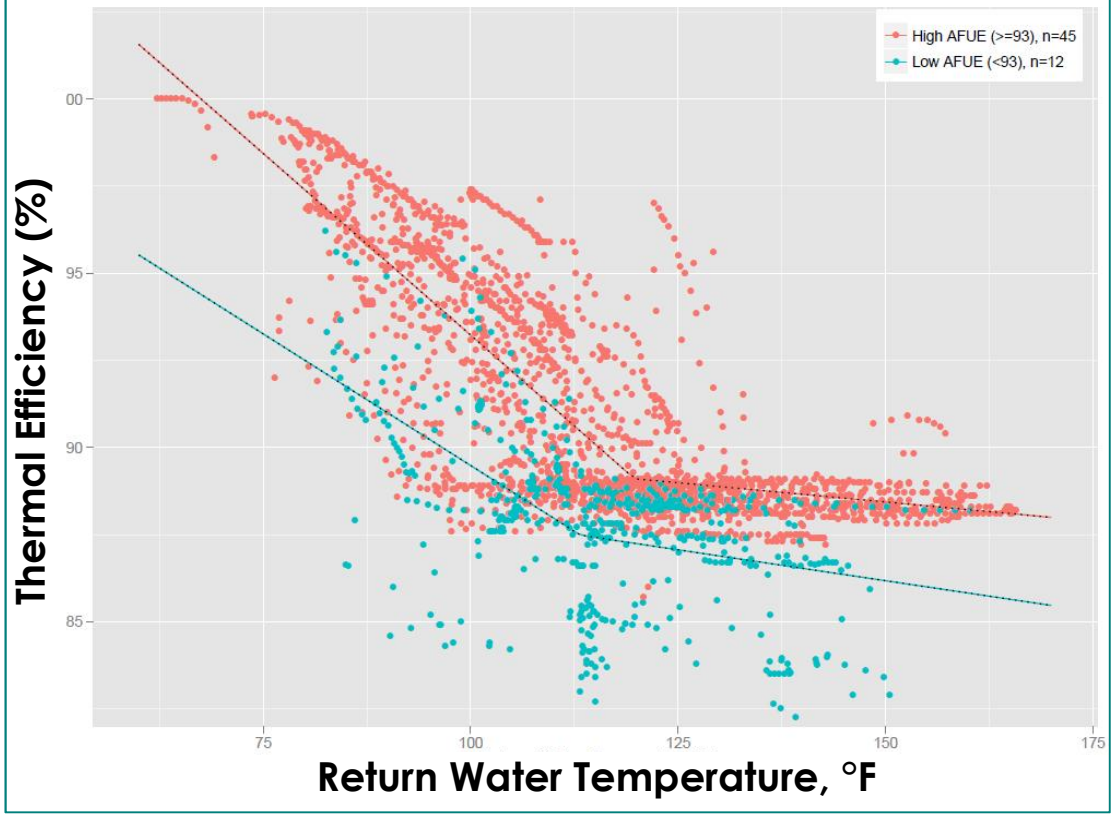
Condensing boiler efficiency is primarily a function of return water temperature

"Textbook"



On-site Spot Measurements



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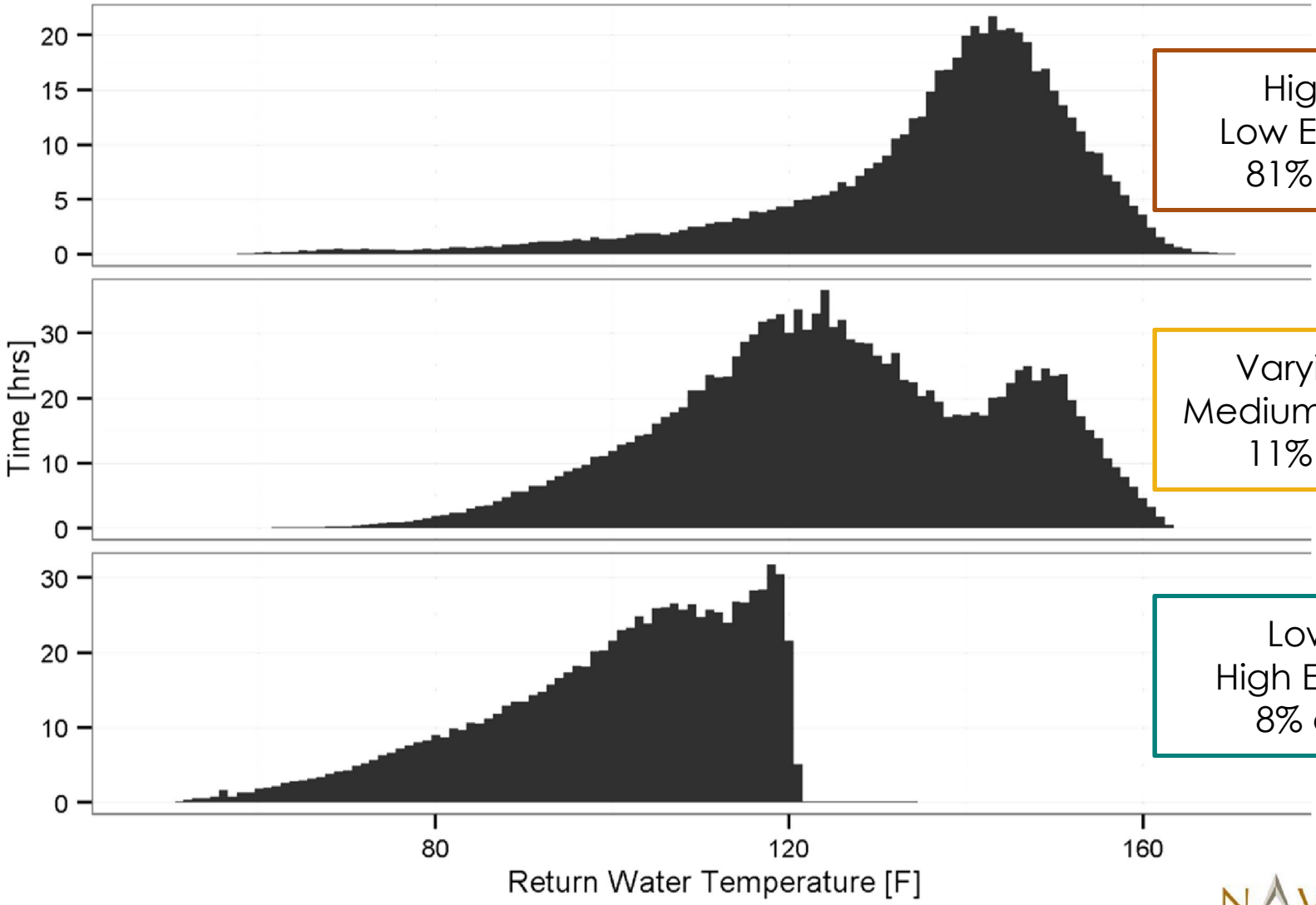
Distribution of hours by return water temperature (RWT)



High RWT
Low Efficiency
81% of sites

Varying RWT
Medium Efficiency
11% of sites

Low RWT
High Efficiency
8% of sites

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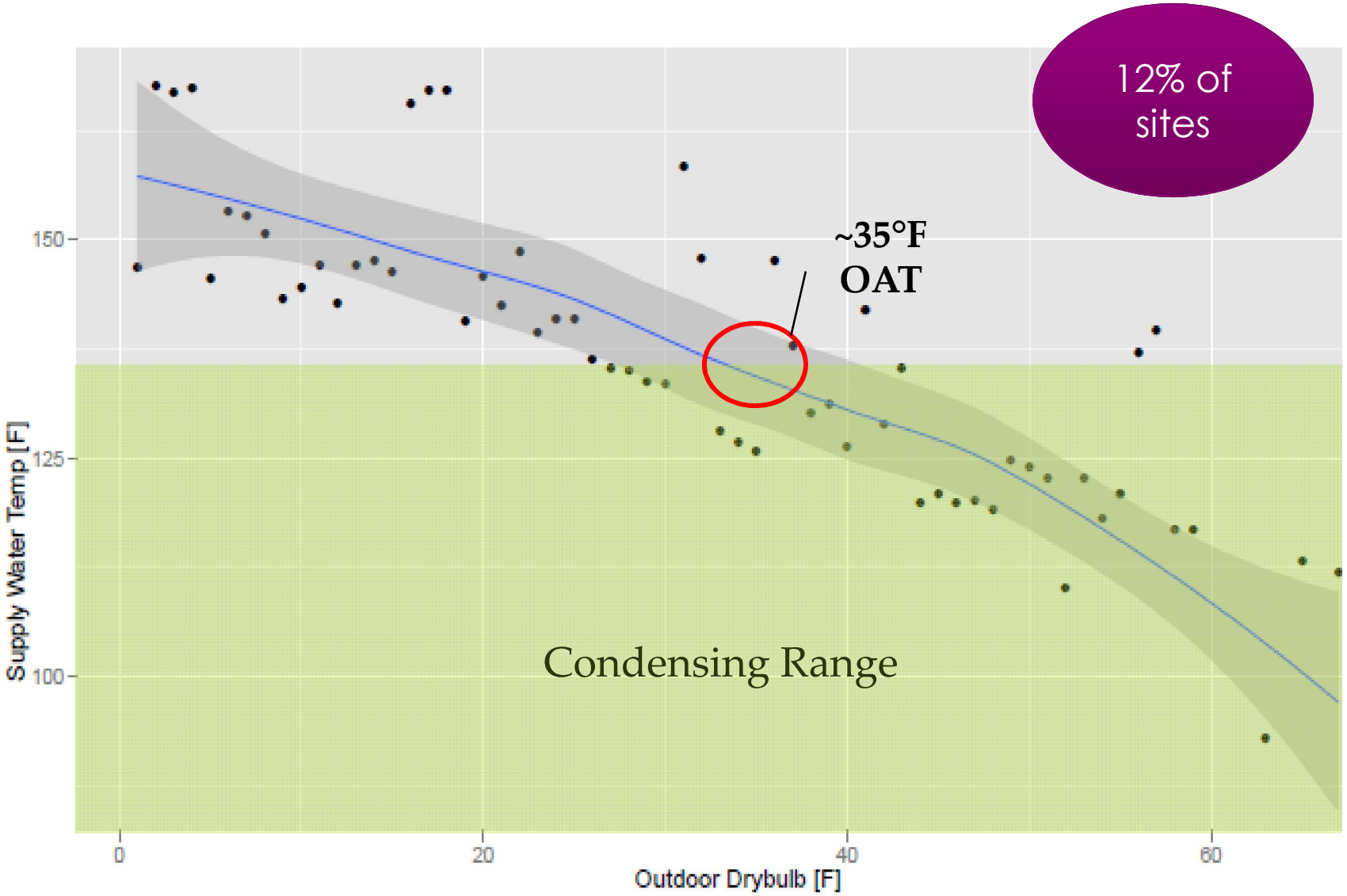
What kind of TLC do boilers need?

Strong outdoor reset



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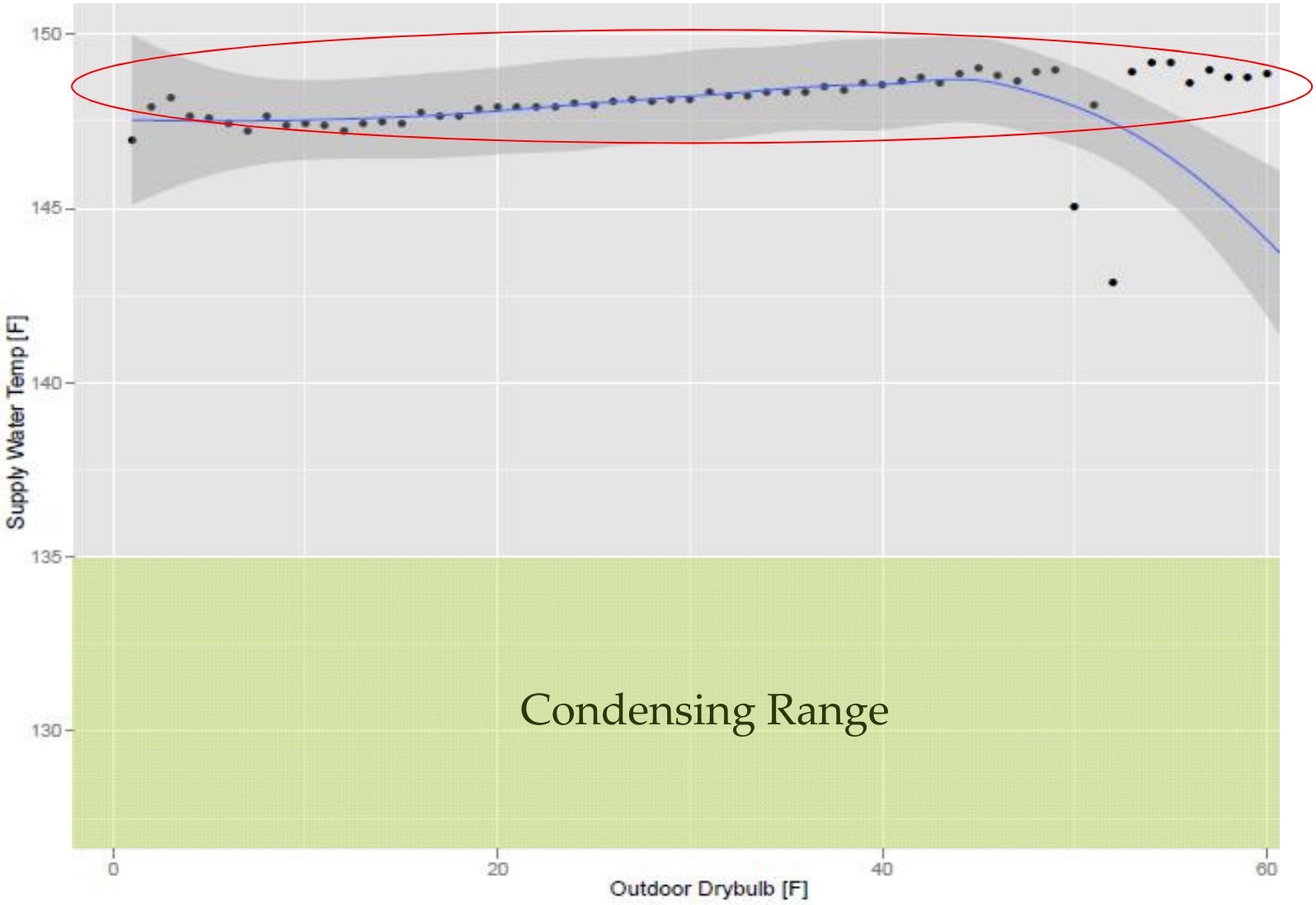
No outdoor reset: 51% of sites



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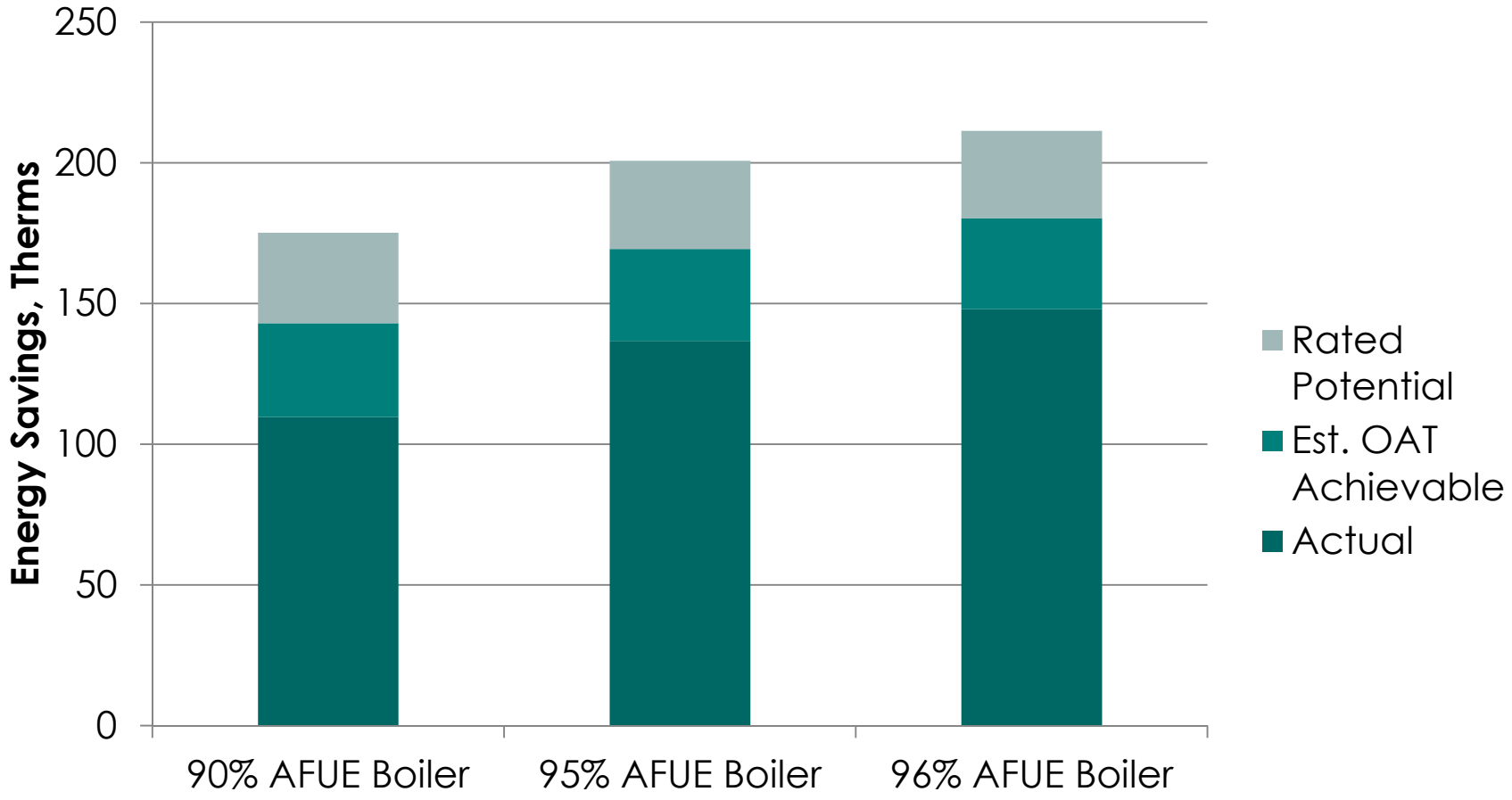
Strategy 1: Improve Outdoor Reset Controls

Preliminary Estimate of Improved OAT Reset Potential



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Strategy 2: Right-size distribution to heating loads

Add Distribution

Reduce Loads

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Strategy 3: Manage Homeowner Expectations

Smaller or no setbacks

Smarter thermostats?

Future Research

Which strategies are most cost effective?

Which can we realistically implement?

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Link to Evaluation Report:
http://ma-eeac.org/wordpress/wp-content/uploads/High-Efficiency-Heating-Equipment-Impact-Evaluation-Final-Report.pdf

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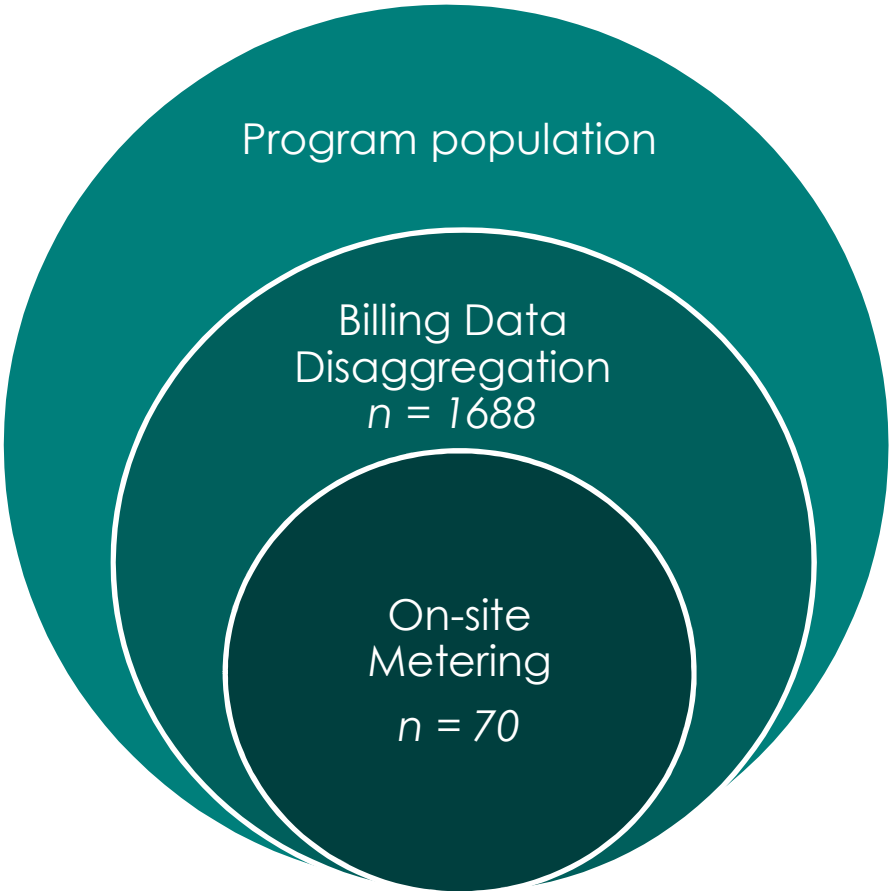
Nested Sampling Approach for Boilers



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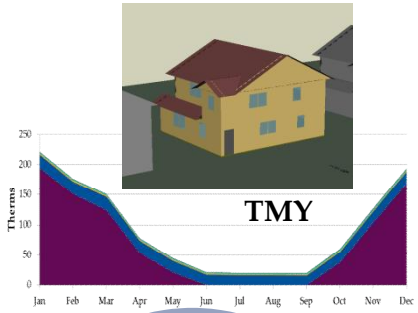
Methodology: Calculating Final Annual Gas Consumption

Calculated ratio of metered therms to estimated heating therms billed *for metered sites during the metering period*



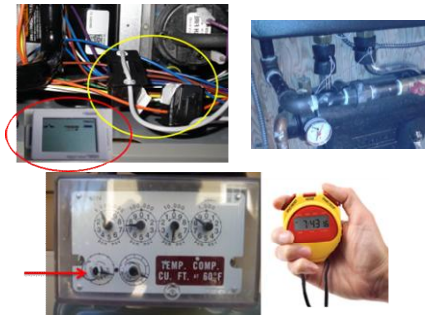
Final Gas Heating Use

=

Ratio of Metered to Billed Heating Use

×

Calibrated Model Heating Use



Building model based on site characteristics calibrated to billing data for *entire disaggregation sample*

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Boiler Sample Dispositions

Group	Target	Achieved	Limitations
Long Term Metering: Gas Consumption	70	42	Unusable metered data (16) Unusable spot measurements (12)
Long Term Metering: Efficiency	70	54	Unusable metered data (16)
Billing Data Disaggregation	1,000	1,688	n/a
Standard New Efficiency Spot Measurements	30 *(36 visited)*	28	Efficiency >=90% AFUE (6)* Unable to take measurements (3)* Unable to verify nameplate (1)

**Two of the units without spot measurements were also high efficiency. 36 total sites visited.*

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Boiler Savings: Standard Boilers, Heating & Hot Water

Measure	AFUE Type	Efficient AFUE	Baseline AFUE	Verified ROF Therm Savings	2013 Report TRM ROF Therm Savings	Rel. Precision at 90% Confidence
90% AFUE Boiler ROF Baseline	Rated	92.7%	Rated: 82.0 % Verified: 79.3%	96	104	9.9%
	Verified	86.2%				
95% AFUE Boiler ROF Baseline	Rated	95.0%		123	123	
	Verified	88.4%				
96% AFUE Boiler ROF Baseline	Rated	96.0%		135	131	
	Verified	89.3%				

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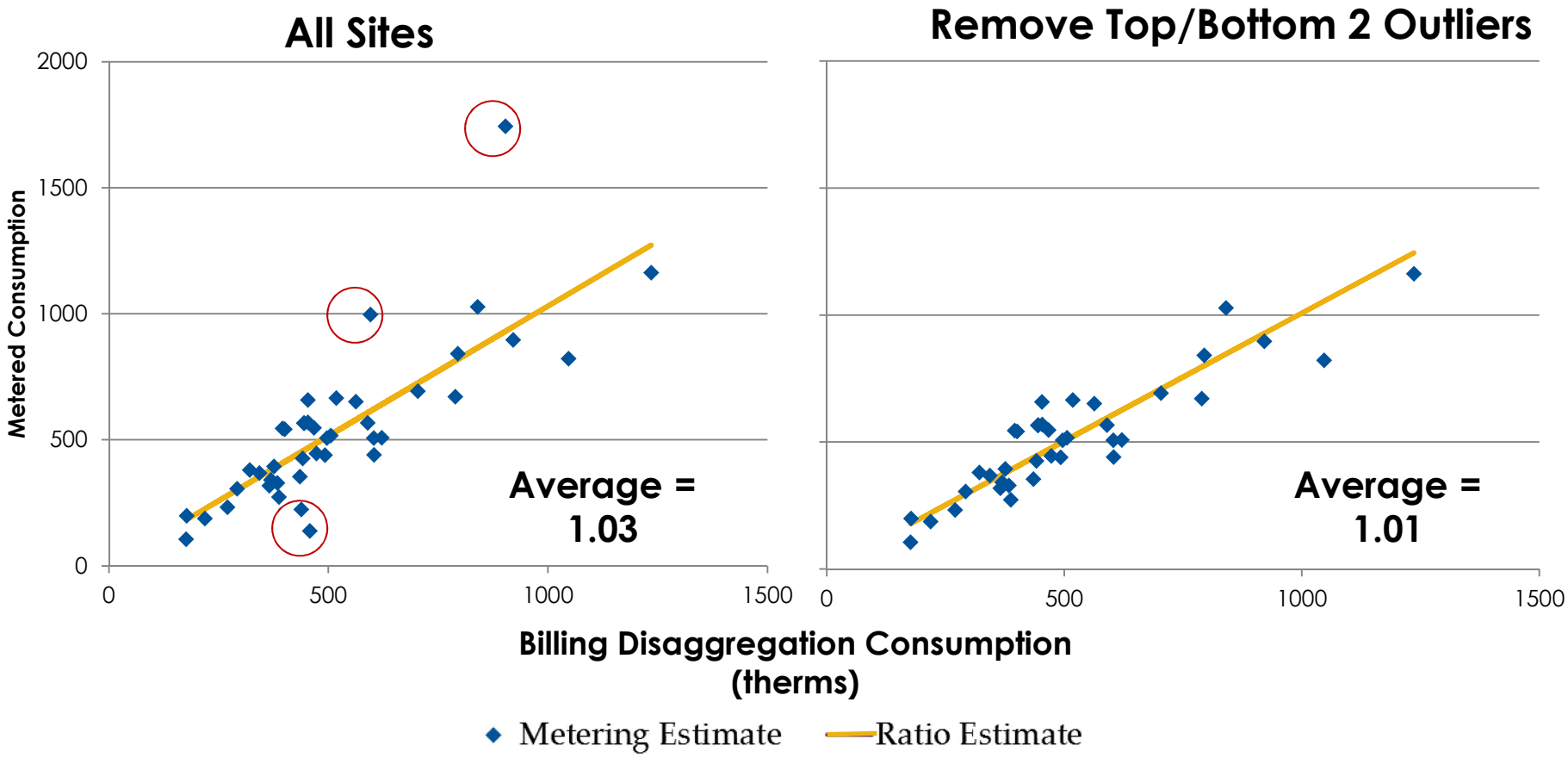
Comparison of Metered and Billing Data: With and Without Outliers



Includes both heating and hot water loads: 83% of final metered boilers served hot water and heating.

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