FRONTIER energy

Meter Verification vs Deemed Savings

Leveraging AMI to Strengthen Stakeholder Confidence in the Resource Value of Efficiency

Presented at the 2021 EER Conference

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FRONTIER energy

FrontierEnergy.com

500+
distributed energy systems being monitored today

30+ YEARS
of R&D and policy studies/reports

100,000s
of people reached annually

42,400+
low-income residents served

69
organizations using Frontier Energy software

56,600+
hours of training provided

Scope of the Study

Climate Region: South-Central Texas

- Warm & humid, heavy air conditioning load
- 3,500 cooling degree days, 1,700 heating degree days

Population: Residential

- Single-family homes
- 21,380 participants in efficiency program

Study Period: Four Years

- Measures installed between June 1, 2017 – May 31, 2019
- AMI data from May 1, 2016 – June 30, 2020

Scope of the Study

PROGRAM	STRUCTURE	EFFICIENCY MEASURES
Rebate	Cash rebate direct to customer	Attic Insulation
HVAC	Cash rebate direct to customer	Air Conditioners Heat Pumps
Weatherization	No-cost whole-home improvements, Income-based eligibility	Attic Insulation Air Sealing Duct Sealing

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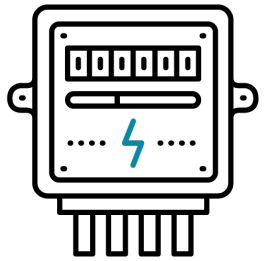
Two Ways to Estimate Savings

Deemed Savings

VS

Meter-Verified



Estimate of **average savings in a portfolio**

Codes-based engineering calculations, **secondary research**

Developed by stakeholder groups

Approved by utility commission/regulatory body

Enable cost-effective, **streamlined programs**

Estimate of savings **at specific project sites**

Requires system-level, **site-specific data** gathering

Analyzed by engineers and statisticians

Verified using statistical tests

Increases confidence in achieved savings

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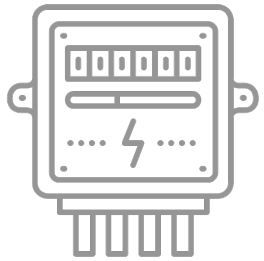

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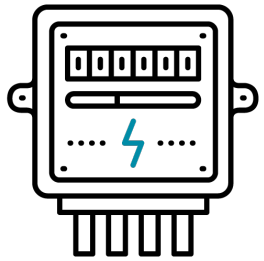

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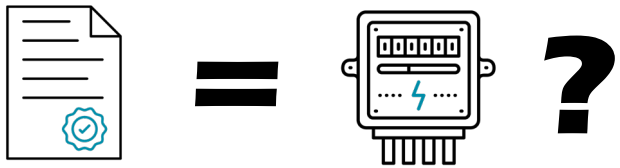
Research Question

Is there a significant difference between deemed vs. meter-verified savings estimates?

Hypothesis

The mean deemed estimate is equal to the meter-verified estimate.

We applied a paired two-sample T-test to see if our hypothesis is true.



Fewer than 50% of the homes remained in the study following data cleaning and model fitting.

Measure Category	Population Census	Sites Remaining After Data Cleaning	Sites Remaining After Model Fitting	% Remaining
Air Conditioner	8,003	4,165	3,787	47%
Heat Pump & Air Conditioner	19	12	12	63%
Heat Pump	4,530	2,065	1,762	39%
Air Sealing	677	446	343	51%
Attic Insulation	1,775	769	606	34%
Attic & Air	5,350	3,818	2,949	55%
Attic Insulation & Duct Sealing	15	9	4	27%
Attic, Duct, & Air	888	607	490	55%
Duct & Air	123	78	64	52%
Total	**21,380**	**11,969**	**10,017**	**47%**

Best-fit Regression Models

We established this model for each home, for both pre- and post-installation periods:

$$kWh_t = \beta_0 + \beta_1 CDH_t + \beta_2 HDH_t + \beta_3 TODeve_t + \beta_4 TODpm_t + \beta_5 COVID_t$$

- t = each hourly interval, and β = the coefficient estimates for each variable
- heating- and cooling-degree hours (HDH and CDH)
- time of day (TOD)
- COVID variable

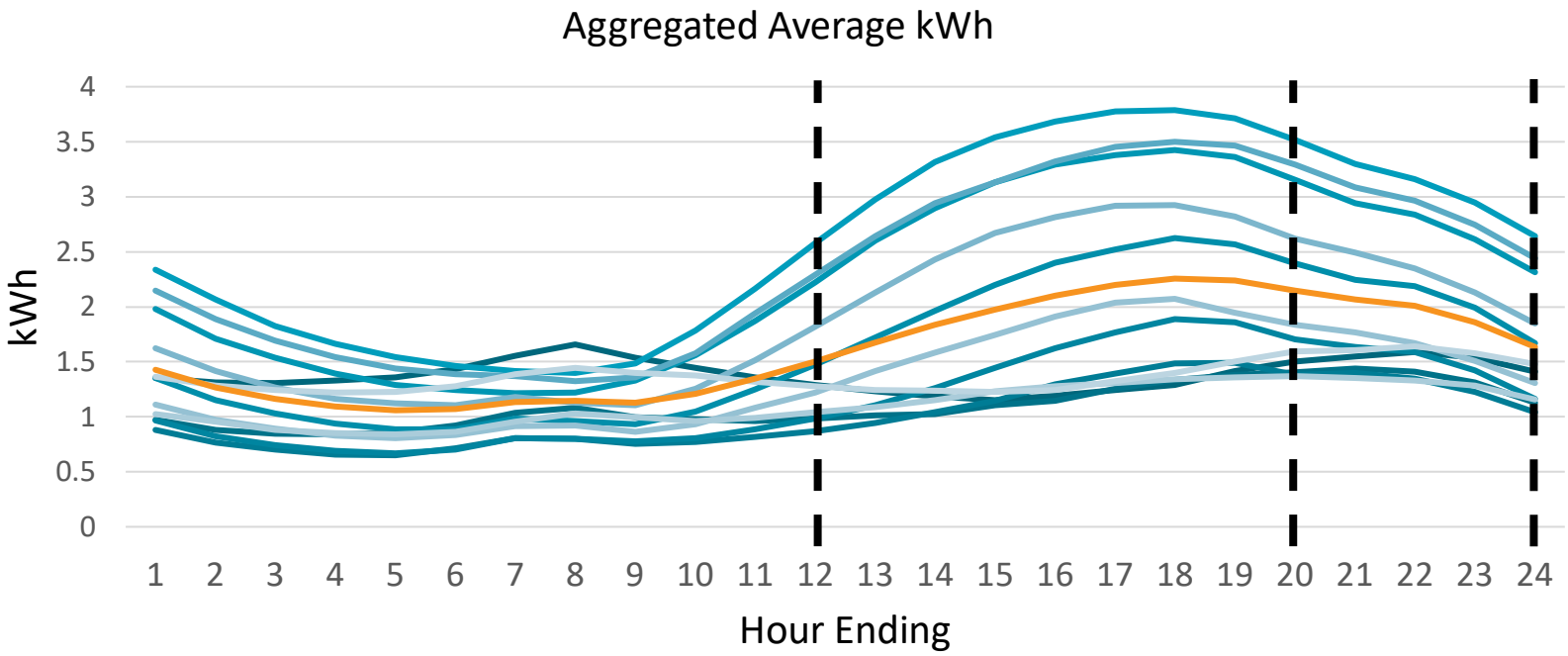
Cooling & Heating Degree Hours

$$kWh_t = \beta_0 + \beta_1 \boldsymbol{CDH}_t + \beta_2 \boldsymbol{HDH}_t + \beta_3 TODeve_t + \beta_4 TODpm_t + \beta_5 COVID_t$$

- Mapped NOAA weather data to align hour-by-hour with energy consumption at each site
- Determined best-fit balance point by **automating a regression that tested increments of 5°F**
- Cooling reference temperatures between 65°F and 80°F
- Heating reference temperatures between 45°F and 65°F
- Output the model coefficients associated with the reference temperatures that produced the best fit, **highest adjusted R^2 and lowest CVRMSE**

Time of Day

$$kWh_t = \beta_0 + \beta_1 CDH_t + \beta_2 HDH_t + \beta_3 \boldsymbol{TODeve_t} + \beta_4 \boldsymbol{TODpm_t} + \beta_5 COVID_t$$



Accounting for Stay-at-Home Orders

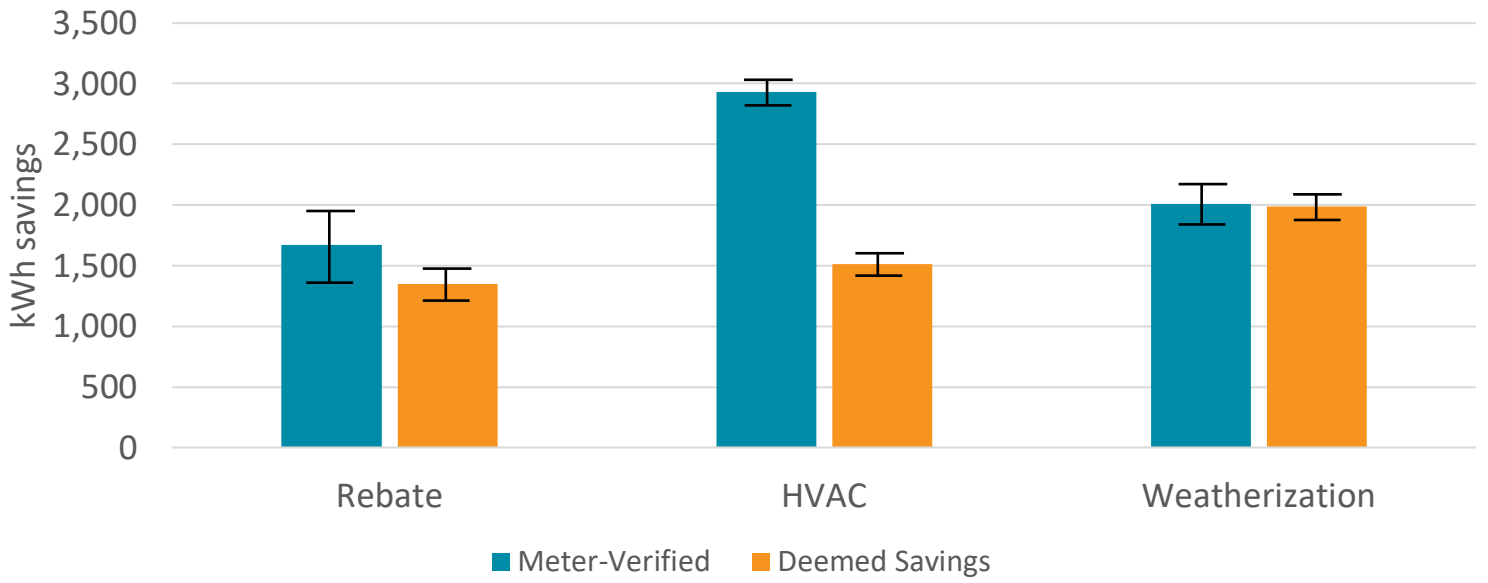
$$kWh_t = \beta_0 + \beta_1 CDH_t + \beta_2 HDH_t + \beta_3 TODeve_t + \beta_4 TODpm_t + \beta_5 \boldsymbol{COVID}_t$$

- Stay-at-home orders were issued in late March of 2020.
- Categorical variable accounts for changes in residential consumption patterns.

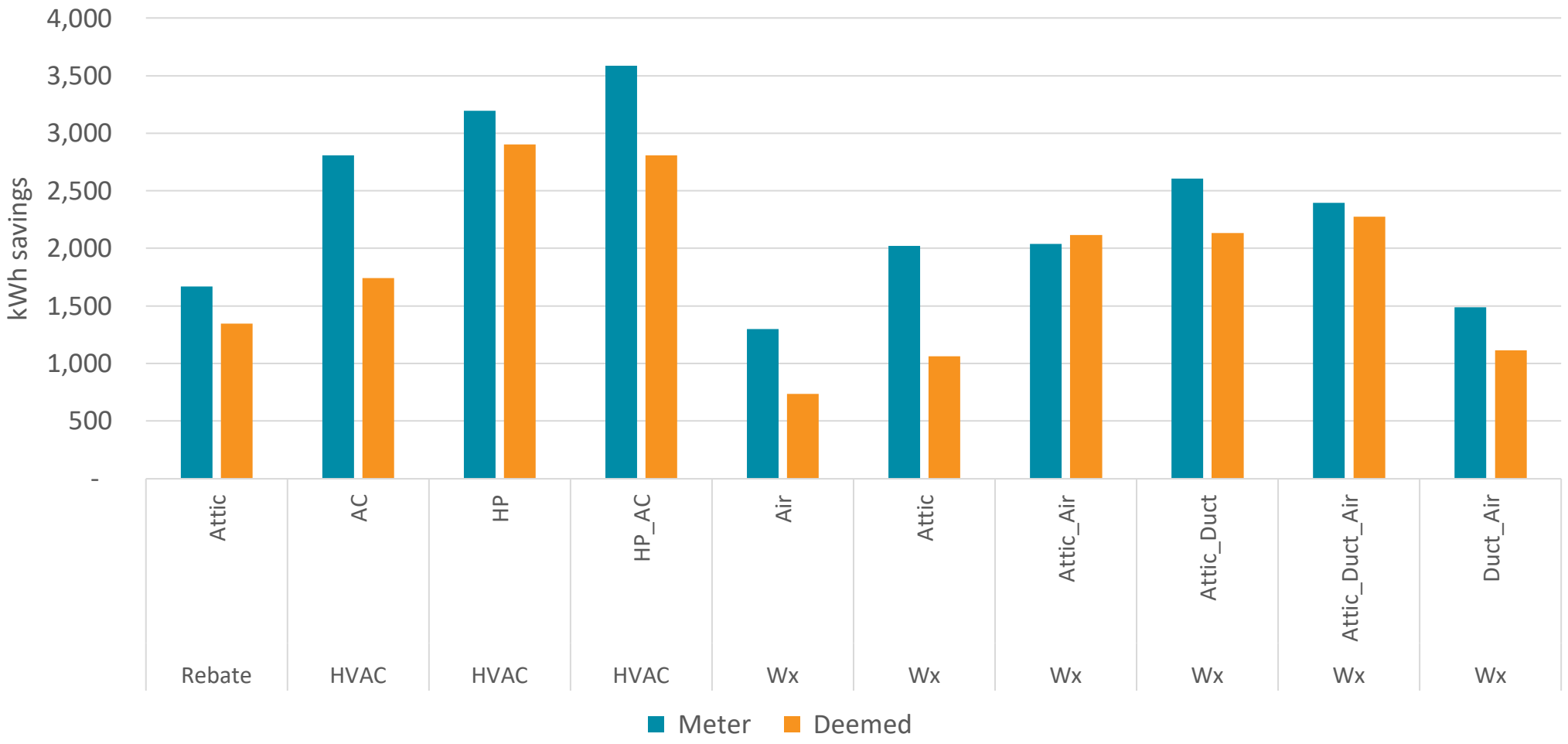
Is there a statistically significant difference between deemed vs. meter-verified savings estimates?

No significant difference for Weatherization.
Statistically significant difference for Rebate and HVAC programs.

Program	Number of Homes	p-value
Rebate	562	0.0349
HVAC	5,561	0.0000
Weatherization	3,894	0.6710



Measure-level results help drill into differences.



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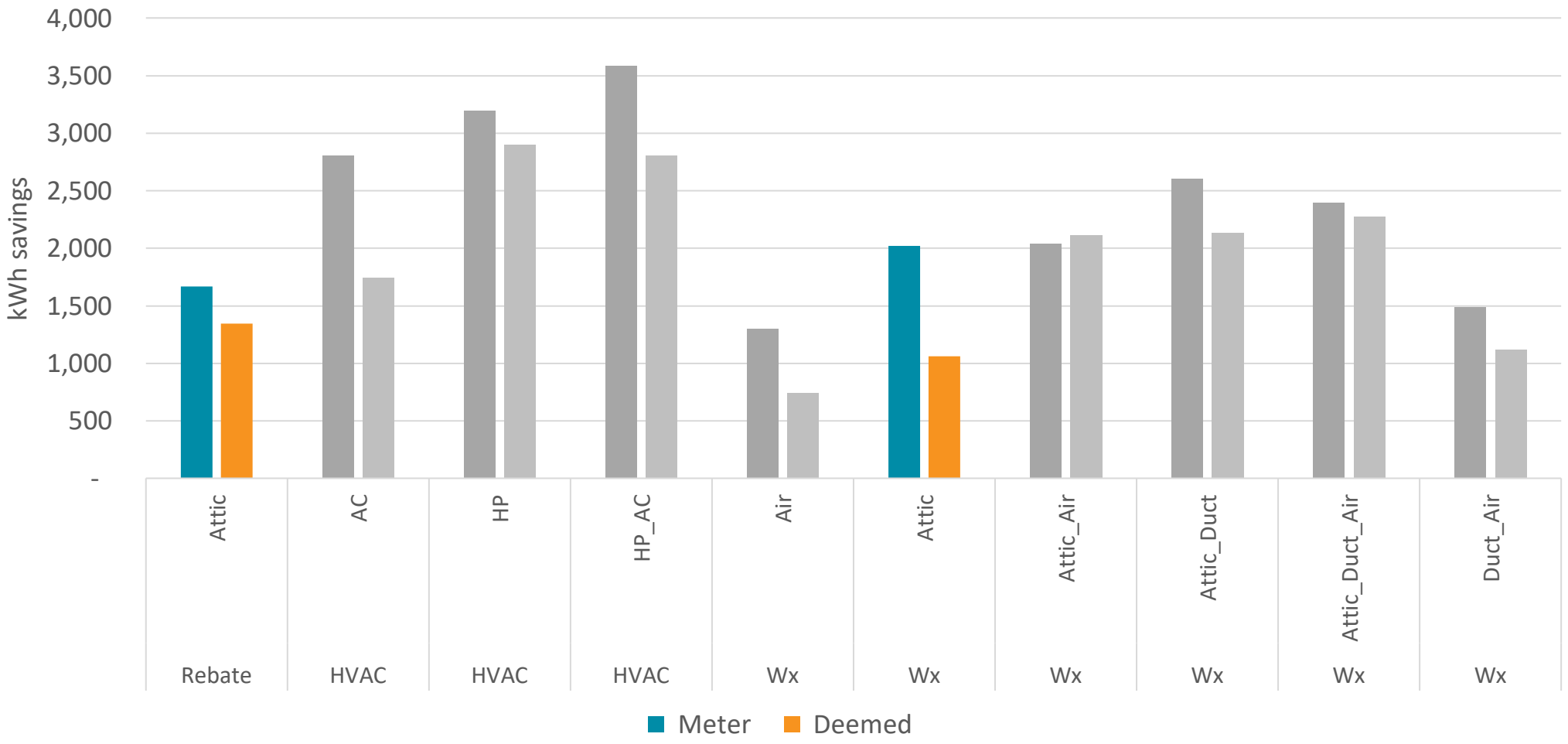
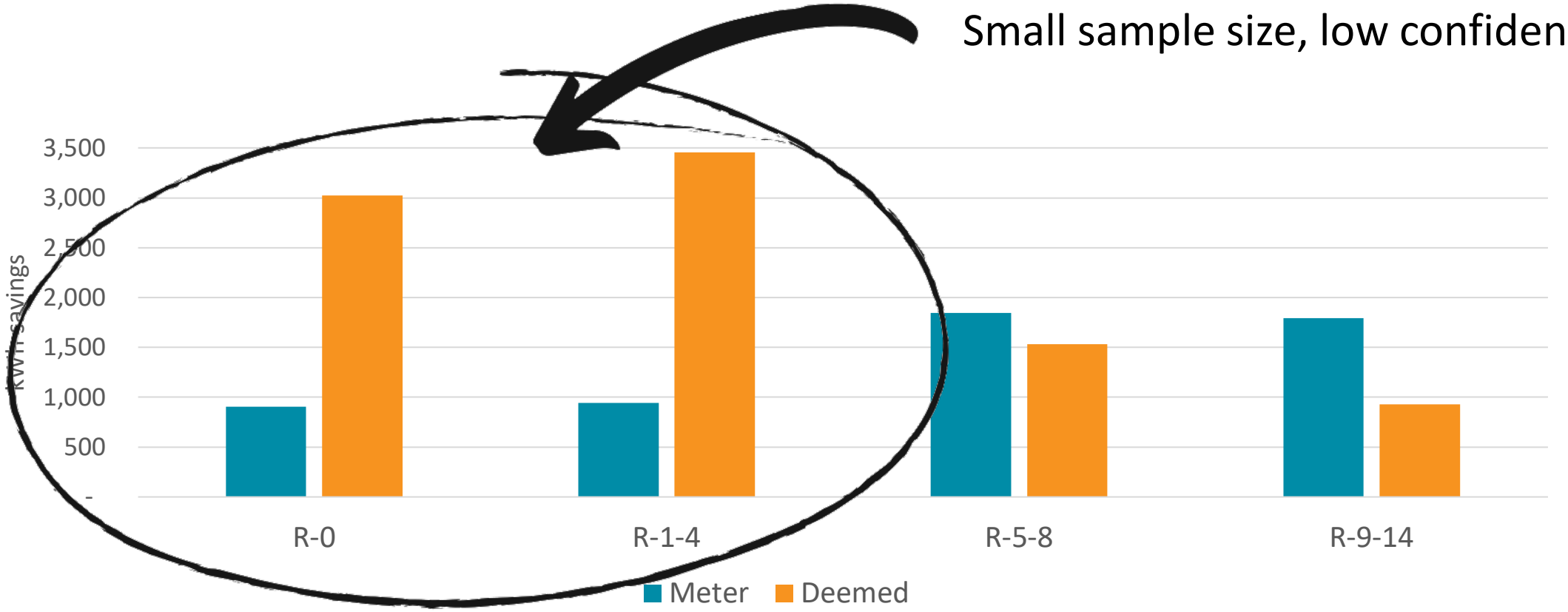


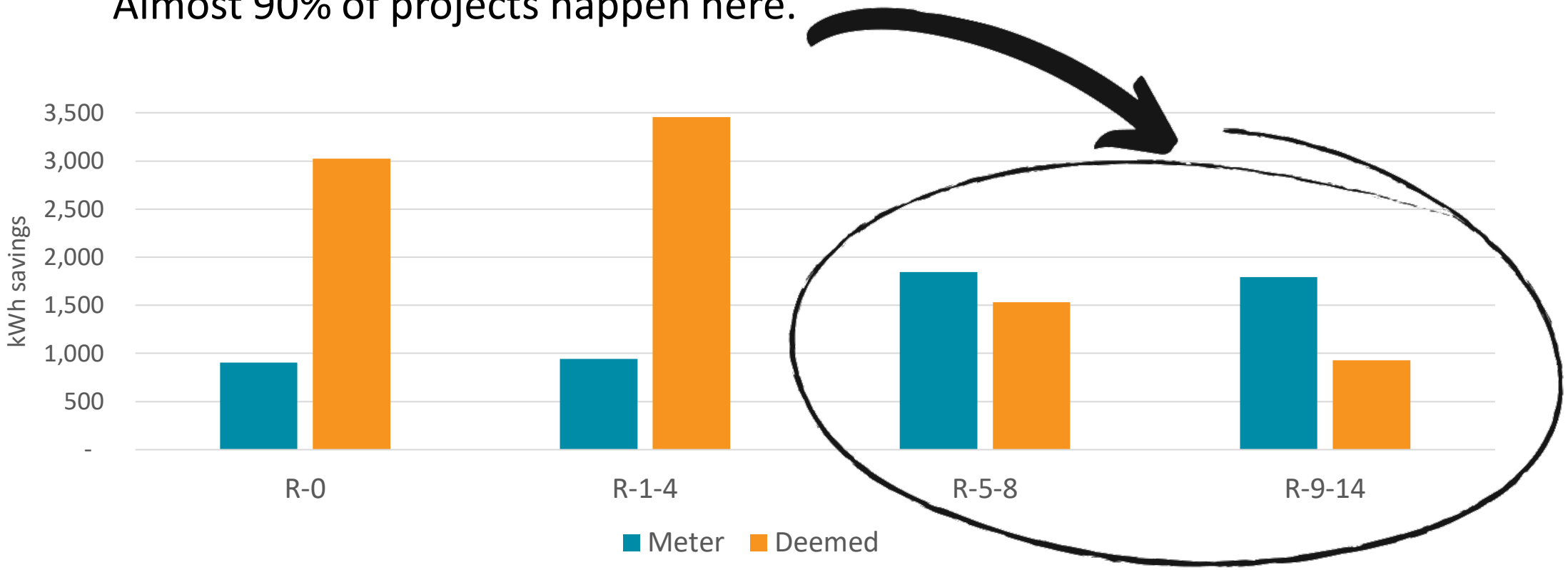
The differences in the rebate program are primarily driven by the higher baseline categories.

Small sample size, low confidence.



The differences in the rebate program are primarily driven by the higher baseline categories.

Almost 90% of projects happen here.



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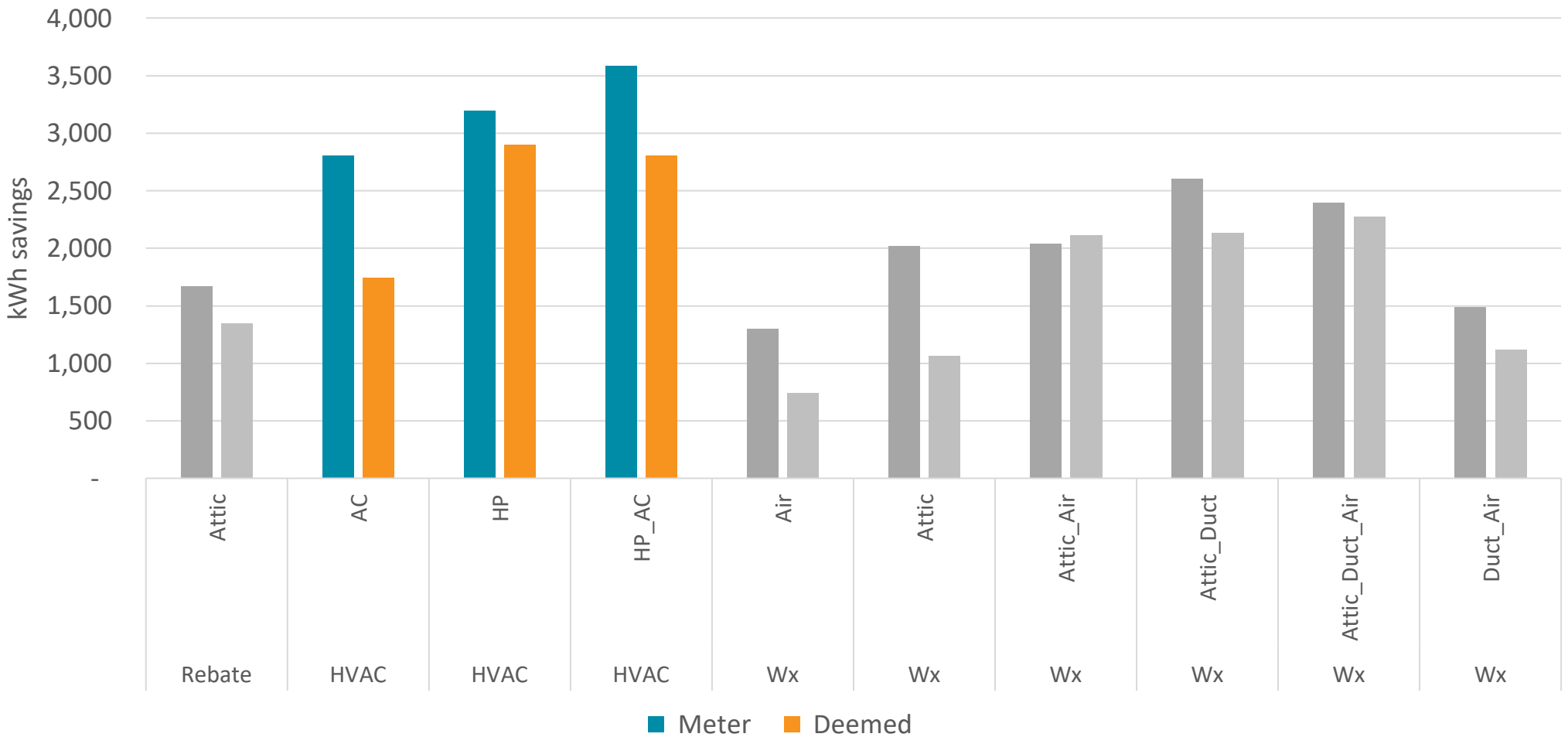
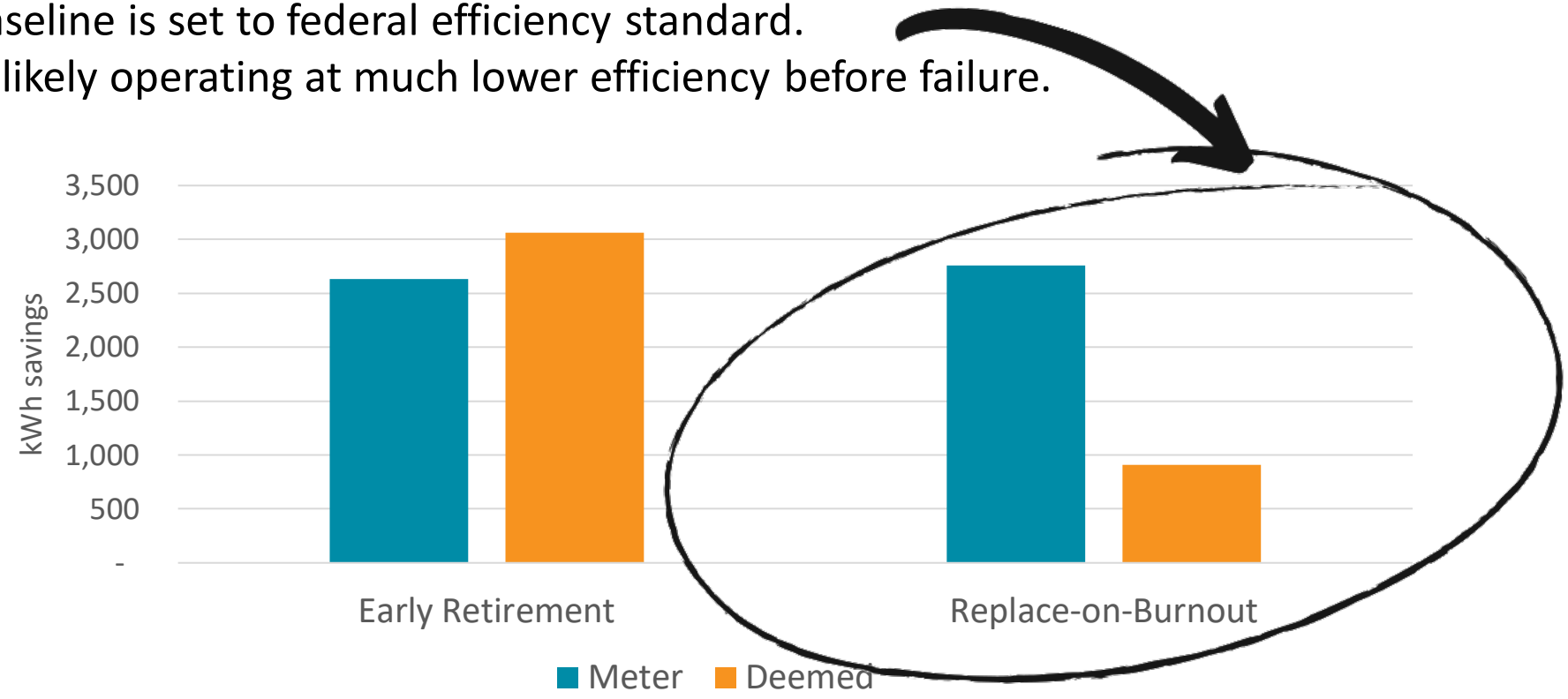


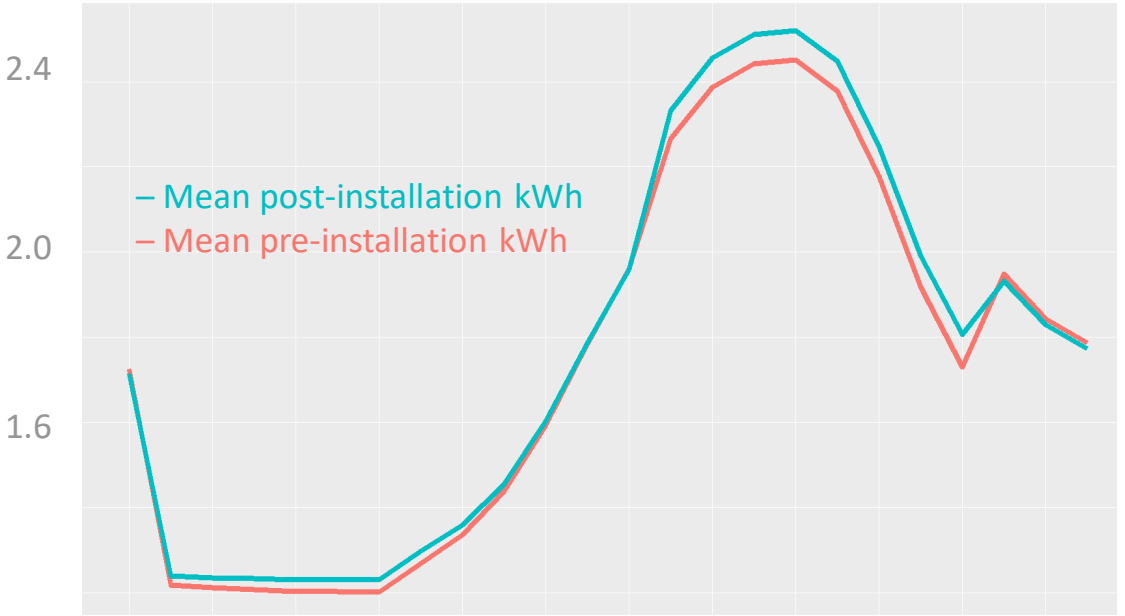
The differences in the HVAC program are driven by code baseline for replace-on-burnout projects.

Almost 70% of projects are replaced-on-burnout.
The deemed baseline is set to federal efficiency standard.
Actual systems likely operating at much lower efficiency before failure.



Control Group

- **Limited data availability** impacted robustness of control group.
- Average weather-normalized consumption for the control group was slightly higher in the post-period than the pre.
- This indicates that our analysis in the participant homes is likely somewhat conservative, and **a full accounting for exogenous effects is likely to increase savings.**



Insights & Lessons Learned

Program-level results indicate that the deemed estimates are generally a good measure of energy savings at the meter, though may be somewhat conservative.

Insights & Lessons Learned

The differences are explainable and expected.

Insights & Lessons Learned

Stratifying by sub-category can inform input assumptions to improve deemed estimates and identify implementation issues.

Insights & Lessons Learned

Consider potential data attrition early-on during sample design. Missing and poor-quality data may impact your confidence.

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Thank you from the project team!

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