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DTE and CE C&I Programmable Thermostat Savings Analysis: Preliminary Findings

June 17, 2014

Content of Report

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Navigant's billing analysis of C&I t-stat savings yielded gas savings estimates for three building types, and no clear evidence for electric savings

- Navigant conducted the billing analysis using participants and a matched comparison group to estimate programmable thermostat savings**.**
- This analysis is based on billing data for DTE and CE for 2008 to 2013 covering program participants from 2009 to 2013.
- For gas, estimates of savings are reasonably precise for three categories of fuel/building types:
  - **Gas small retail: 5.0% per building**
  - **Gas small office: 10.2% per building**
  - **Gas all other: 5.0% per building**
- The estimated gas savings are about 13% to 73% of the current MEMD values net and adjusted for current manual operation since the MEMD values had assumed no existing setback at installation.
- Navigant found no evidence for electric savings, even when all participants are combined

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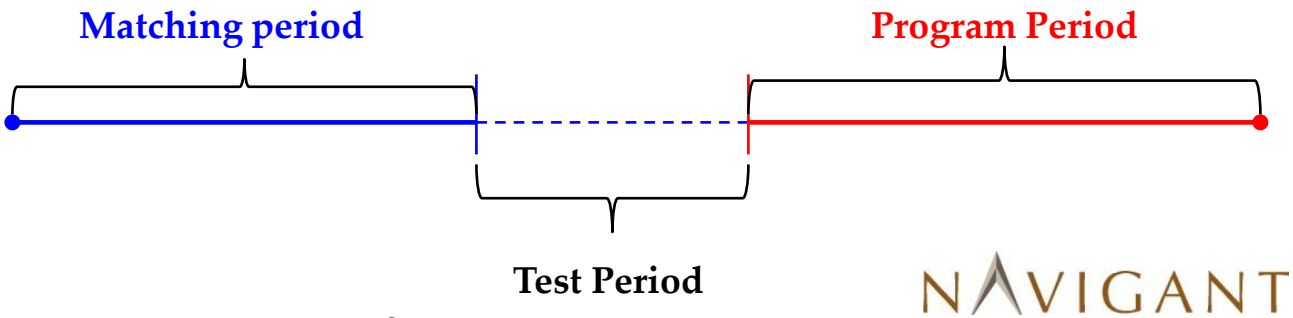
Billing, participant and installation data for C&I thermostat installations cover 2009 to 2013 for both DTE and CE.

- Participants used in the analysis must have 16 months of billing data before enrollment in the program and at least one month of billing data after enrollment
- After data scrubbing, Navigant used over 4,000 electric participants and 5,000 gas participants with post-installation billing data from **each** utility:
  - CE: 8,833 customers for gas; 6,257 customers for electric.
  - DTE: 5,845 customers for gas; 4,034 customers for electric.
- Each utility provided billing data from 2008 to the end of 2013 for both participants and a very large number of potential matches with the requisite billing data (e.g. 150K for DTE gas, 76K for CE gas)

Navigant used Euclidean distance (aka, "nearest neighbor") matching to identify a comparison group.

- Matching is based on past energy use month by month; we match on a 12-month matching period.
- We keep the best and next best matches, and use both in the analysis.
- We include a 4-month test period to detect any evidence of selection bias, and results are consistent with no such bias.
- We use only the ~90% best matches for each building type analyzed
  - 1st screening criterion: use only the best 95% matches
  - 2nd screening criterion: use only customers for whom energy use is within 2 SD of mean energy use for the building type in the matching period.



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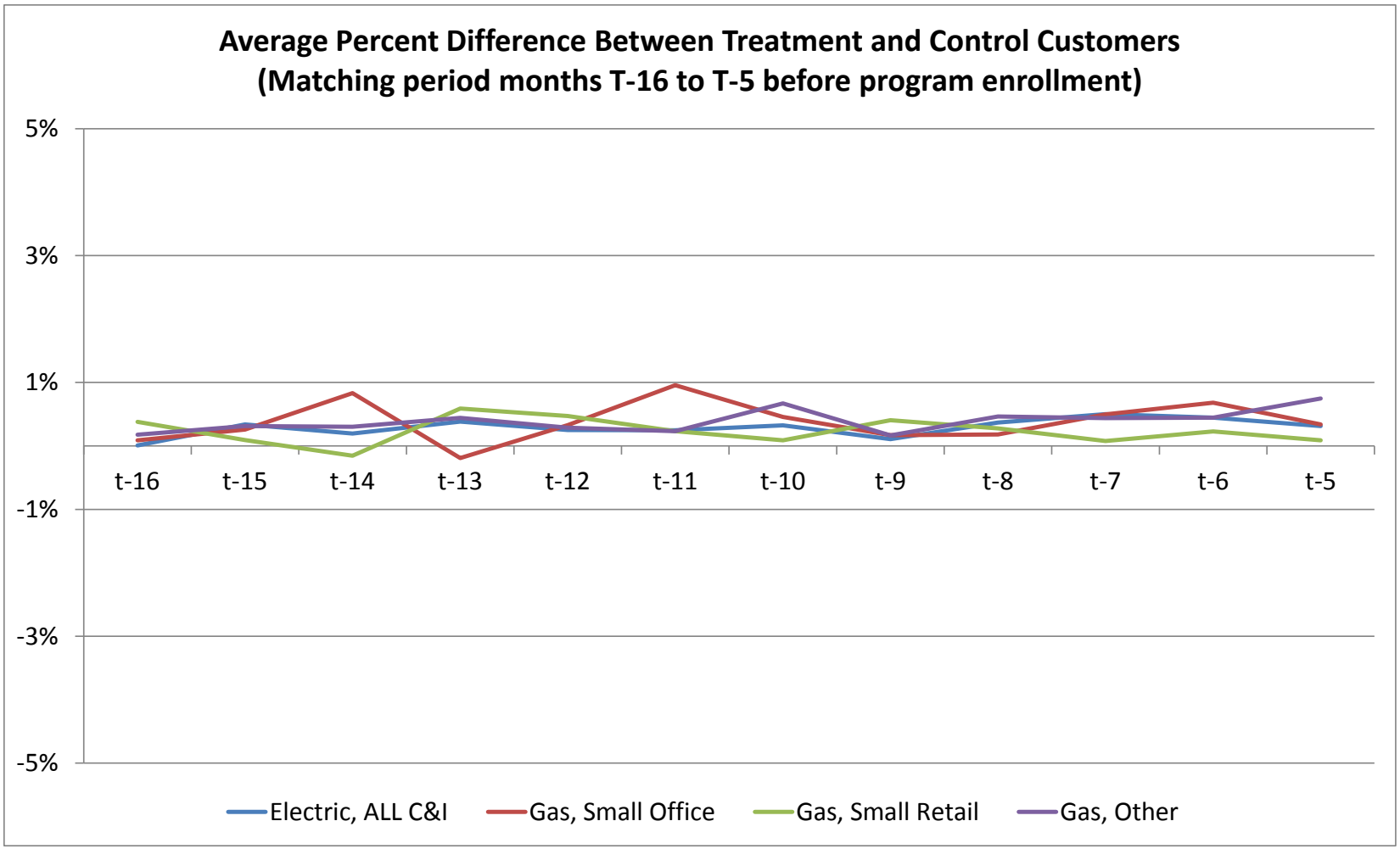
Matches are generally very good, within 1% on average and fairly stable during the matching period.



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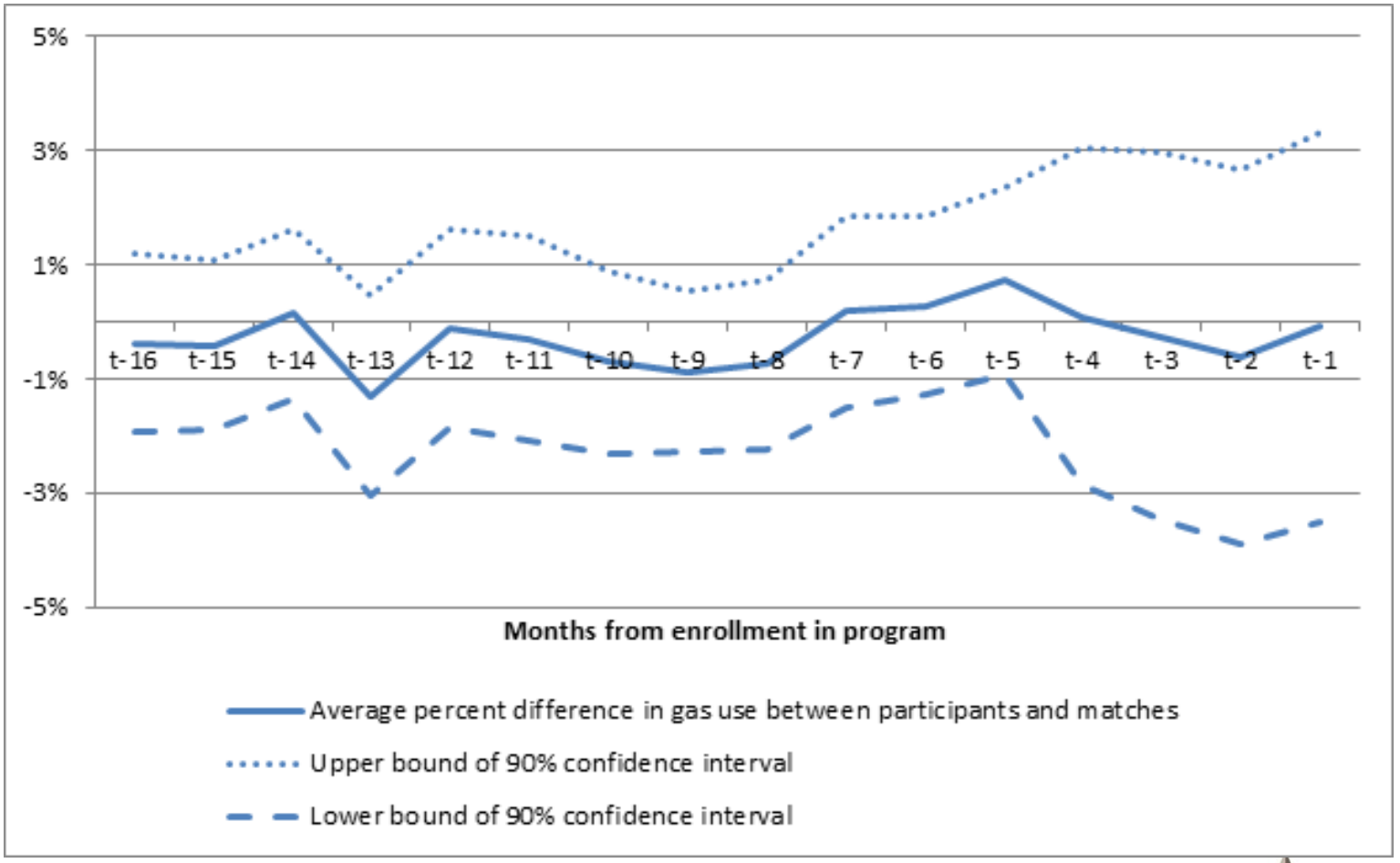
The average difference in the gas use between participants and matches during the test period shows no pattern of deviation



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Matches are used in a regression analysis per Ho et al (2007) to estimate savings.

- Matching is a form of "preprocessing" of the data to assure that participants and nonparticipants used in a regression analysis are "balanced" in the important covariates
  - The most important covariate by far is past energy use
- Regression analysis to account for energy use in the post-enrollment period includes all participants and their matches for the building type, and the following explanatory variables:
  - Energy use in the same calendar month before enrollment

    …The effect differentiated by building type
  - Monthly fixed effect to account for weather and other time-specific factors
  - And, of course, an indicator for participation

Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth Stuart. 2007. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis* 15(3): 199-236.

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Regression model specification:

$$\ln NMU_{kt} = \delta_t^m + \sum_{j=1}^{J} \beta^j PreEnergy_{kt} \cdot jSector_k + \alpha_1 Participant_k + \alpha_2 Match1_k + \alpha_3 DTE_k + \varepsilon_{kt}$$

Where,

- $\ln NMU_{kt}$ = natural log of normalized monthly energy use by customer k in month t
- $PreEnergy_{kt}$ = customer k's normalized monthly use in the same calendar month in the pre-enrollment period
- $jSector_k$ = building type of customer k
- $Participant_k$ = participant dummy variable
- $Match1_k$ = dummy variable for whether customer k is a best match (as opposed to 2nd bests match or participant)
- DTE_k = dummy variable for whether customer k is a DTE customer

We conducted a number of robustness checks on the results

- "Simple" specification vs. extended specification
  - Simple: energy use in the pre-enrollment period, monthly fixed effect, participation indicator
  - Extended: adds variables accounting for different effects of pre-enrollment energy use across building types, DTE indicator
- With and without observations with residuals greater than 2 SD from the mean
- Check for whether results are sensitive to the best vs. next best match vs. both matches in a single regression
- Check for differences in savings between CE and DTE (discussed below)

Extensive testing led to the conclusion that with current data we can generate reasonably precise estimates for three building groups for gas, but none for electric.

- Three gas building type savings:
  - Small Office
  - Small Retail
  - All other building types
- Are there differences between CE and DTE?
  - CE and DTE do not differ statistically for Gas Small Retail or Gas Other.
  - As a practical matter, CE and DTE differ for Gas Small Office, but this difference is not statistically significant at 90% confidence level (but it's close).
  - Multiple MEMD values for Gas Small Office are sensible only if the narrative accounting for the possible difference between CE and DTE for Gas Small Office also accounts for no difference for the other two groups.

We report savings in terms of average percent savings per building

- Percentage savings per building reflects current marketing/installation practices
  - Avoid a false "prescriptive" implication; reflects savings as a function of past energy use and "typical" installation practices
- Savings percentages are portable across weather and geographic conditions
  - If actual savings (CCF, kWh) by weather zone are required, Navigant will use the percentages to generate savings by weather zone.

We compared our billing analysis results – savings per building – against the MEMD average annual savings value per building adjusted for the deemed net-to-gross ratio.

MEMD average annual savings per building = MEMD average annual savings value[a] x Assumed square footage of conditioned space per thermostat[b] x Average thermostat installation per building[c] x Part-Use Factor (PUF)[d] x Deemed net-to-gross value[e]

$$\frac{kwh\ (or\ ccf)}{building} = \frac{kwh\ (or\ ccf)}{1{,}000\ sq\ ft} \times \frac{sq\ ft}{1\ thermostat} \times \frac{thermostats}{building} \times 0.89\ PUF \times 0.90\ NTG$$

[a]MEMD estimates reflect weighted average based on *billing analysis participant sample* of available subset of business types with an MEMD value in the Detroit weather zone.
[b]Assumption based on DTE and CE thermostat Direct Install participation data analysis; assumed 1,907 square feet and 2,115 square feet for DTE and CE, respectively.
[c]Based on DTE and CE thermostat installation data analysis.
[d] Part-use factor 0.89 developed in 2013 (PY5) evaluation for the DTE C&I Prescriptive program applied to account for programmable thermostats installed but operating in manual mode.
[e]Net-to-gross value deemed 0.9 0by Michigan Public Service Commission.

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Navigant's billing analysis yielded estimated gas savings for three segments ranging from 5% to 10.2% and no electric savings.

- The estimated gas savings values are about 13% to 73% of the current MEMD values when they are adjusted for those run in manual mode.

	Gas			Electric
	Small Office	Small Retail	Other	Overall
MEMD average annual savings per building (CCF or kWh; DTE/CE avg. participant building)[a]	211	699	1,429[b]	3,684[b]
MEMD average annual savings per building (CCF or kWh; DTE/CE avg. participant building ;part use factor applied) [a,c]	188	622	1,272[b]	3,279[b]
Billing analysis average annual savings per building (CCF or kWh; RPP model)	137	81	172	-230
Billing analysis average percent savings per building (RPP model)	10.2%	5.0%	5.0%	-0.6%
Billing analysis savings as a percent of MEMD savings	**73%**	**13%**	**14%**	**-6%**

[a] *For the MEMD calculation we assume 1,907 square feet per thermostat for DTE and 2,115 square feet per thermostat for CE based on 2013 Direct Install program tracking data.*

[b] *MEMD estimates reflect weighted average based on billing analysis participant sample of available subset of business types with an MEMD value in the Detroit weather zone.*

[c] *Part-use factor 0.89 developed in 2013 (PY5) evaluation for the DTE C&I Prescriptive program applied to account for programmable thermostats installed but operating in manual mode.*

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Estimated gas savings relative to consumption are below the modeled savings percentages - ranging from 5% to 10% of annual gas consumption compared to the modeled annual savings of 14% to 24%.

- Participants appear to be considerably smaller in size than the average C&I customer in Michigan, leading to lower ccf and kWh savings than estimated in the MEMD.

	Gas			Electric
	Small Office	Small Retail	Other	Overall
Billing analysis average *energy use* per year per building (CCF or kWh)[a]	1,347	1,622	3,444	34,365
Billing analysis average percent savings per building (RPP model)	**10.2%**	**5.0%**	**5.0%**	**-0.7%**
MEMD average annual savings per building (CCF or kWh; MEMD building model square footage)[b]	696	1,443	15,096[c]	37,415[c]
MEMD average *energy use* per year per MEMD building (CCF or kWh; MEMD building model)	4,864	6,166	62,093[c]	475,076[c]
MEMD average percent savings per building (MEMD building model)	**14.3%**	**23.4%**	**24.3%**	**7.9%**
Average thermostat installations per building	1.5	1.6	2.7	2.2

[a] *Based on average energy use during the matching period.*
[b] *For the MEMD calculation we assume square feet per building based on the MEMD building simulation model.*
[c] *MEMD estimates reflect weighted average based on billing analysis participant sample of available subset of business types with an MEMD value in the Detroit weather zone.*

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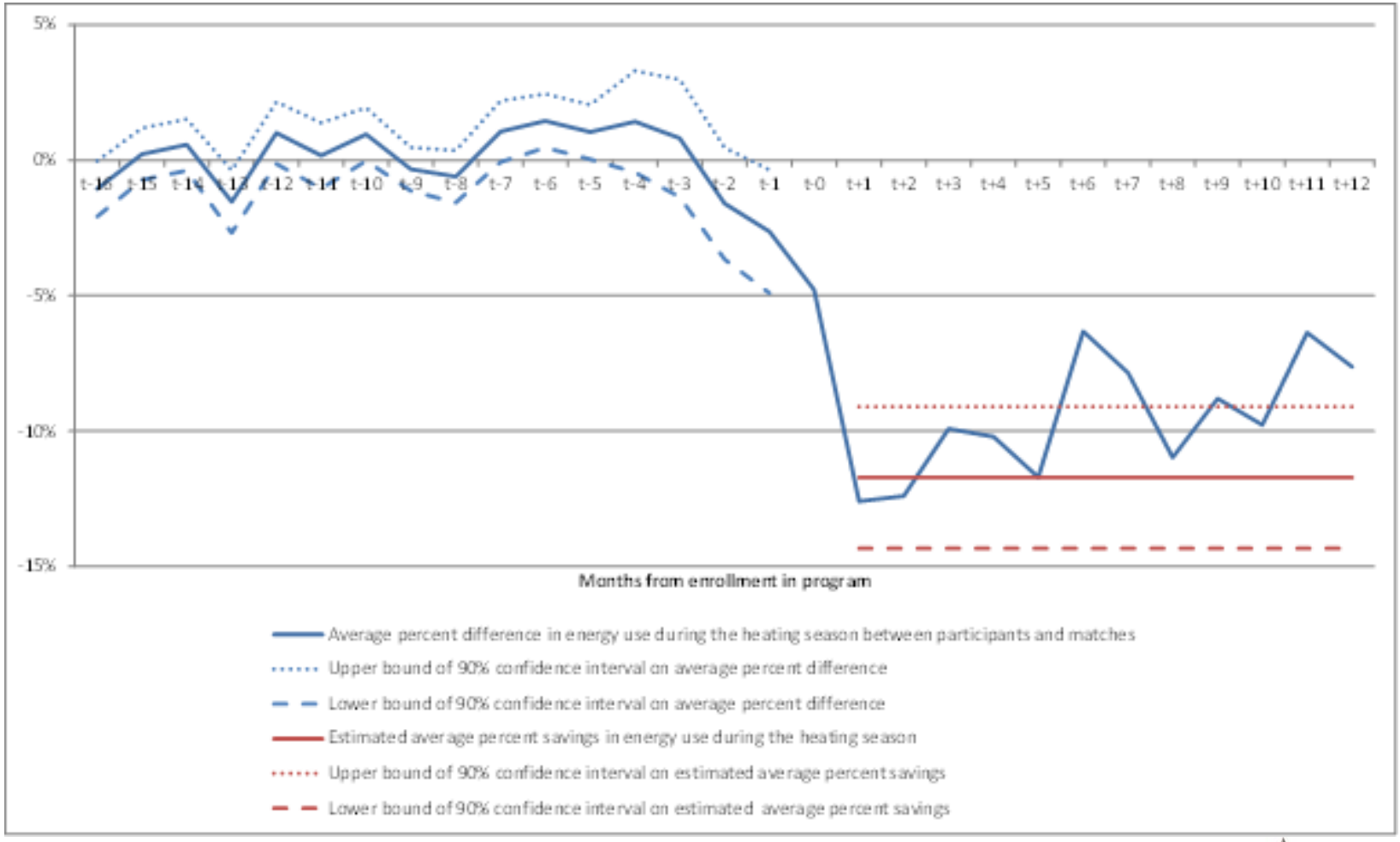
For small office, the average gas savings percentage per building during the heating season is 11.7%. On an annual basis this is 10.2%, with a 90% confidence interval bounded by 7.9% and 12.5%.



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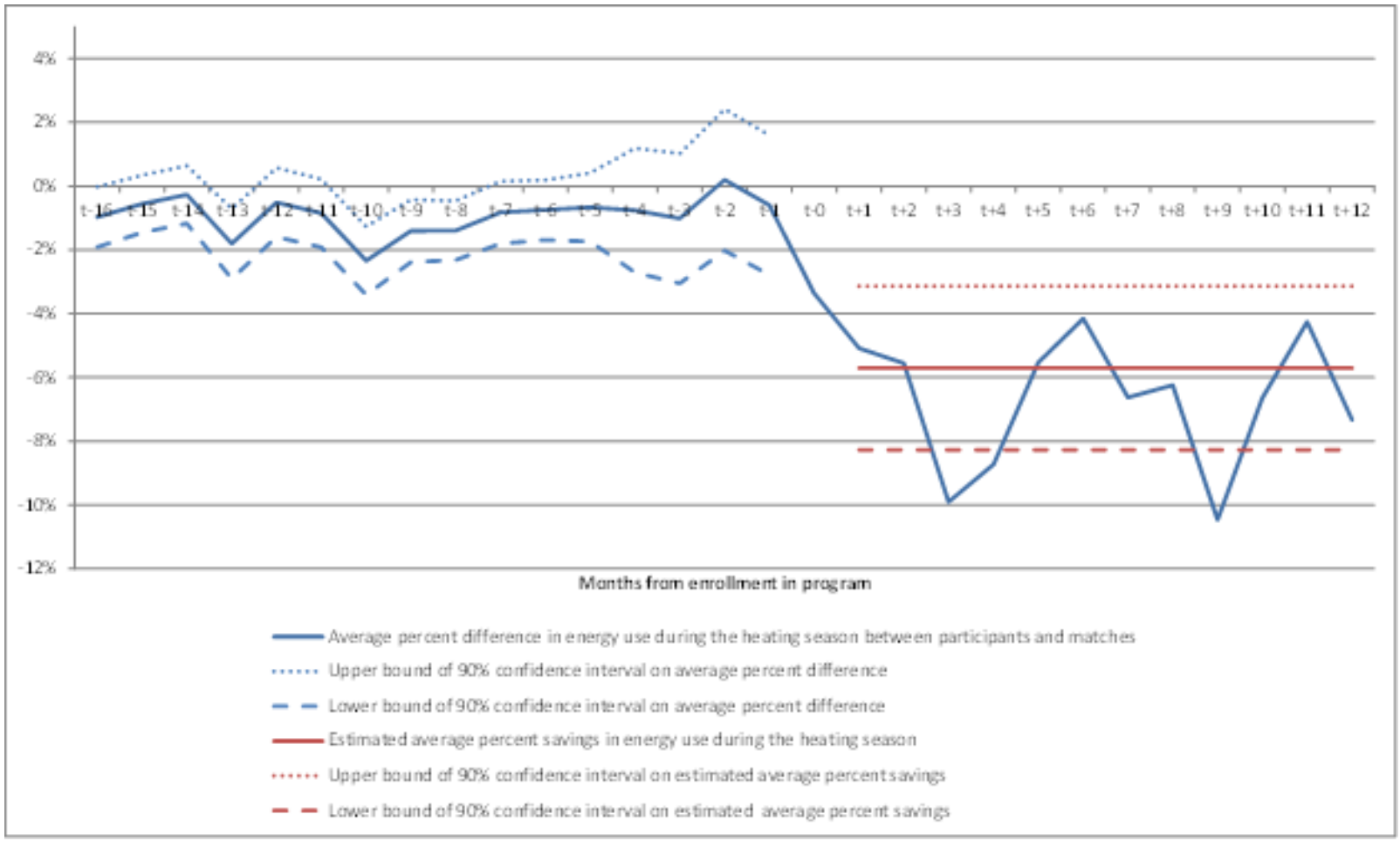
For small retail, average gas savings percentage per building during the heating season is 5.7%. On an annual basis this is 5.0%, with a 90% confidence interval bounded by 2.7%, and 7.3%.



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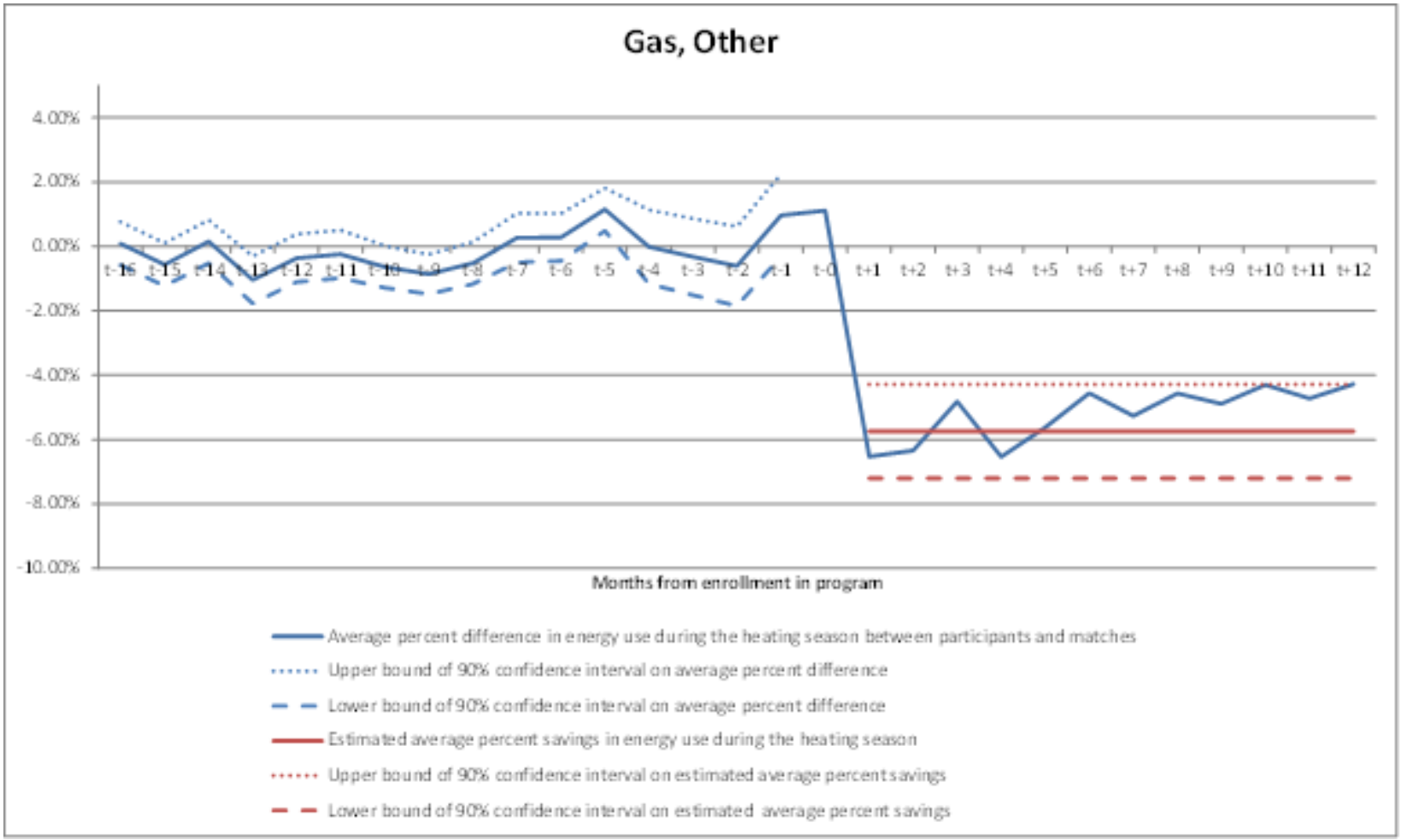
For other building types, the average gas savings percentage per building during the heating season is 5.7%. On an annual basis this is 5.0%, with a 90% confidence interval ranging from 3.7% to 6.3%



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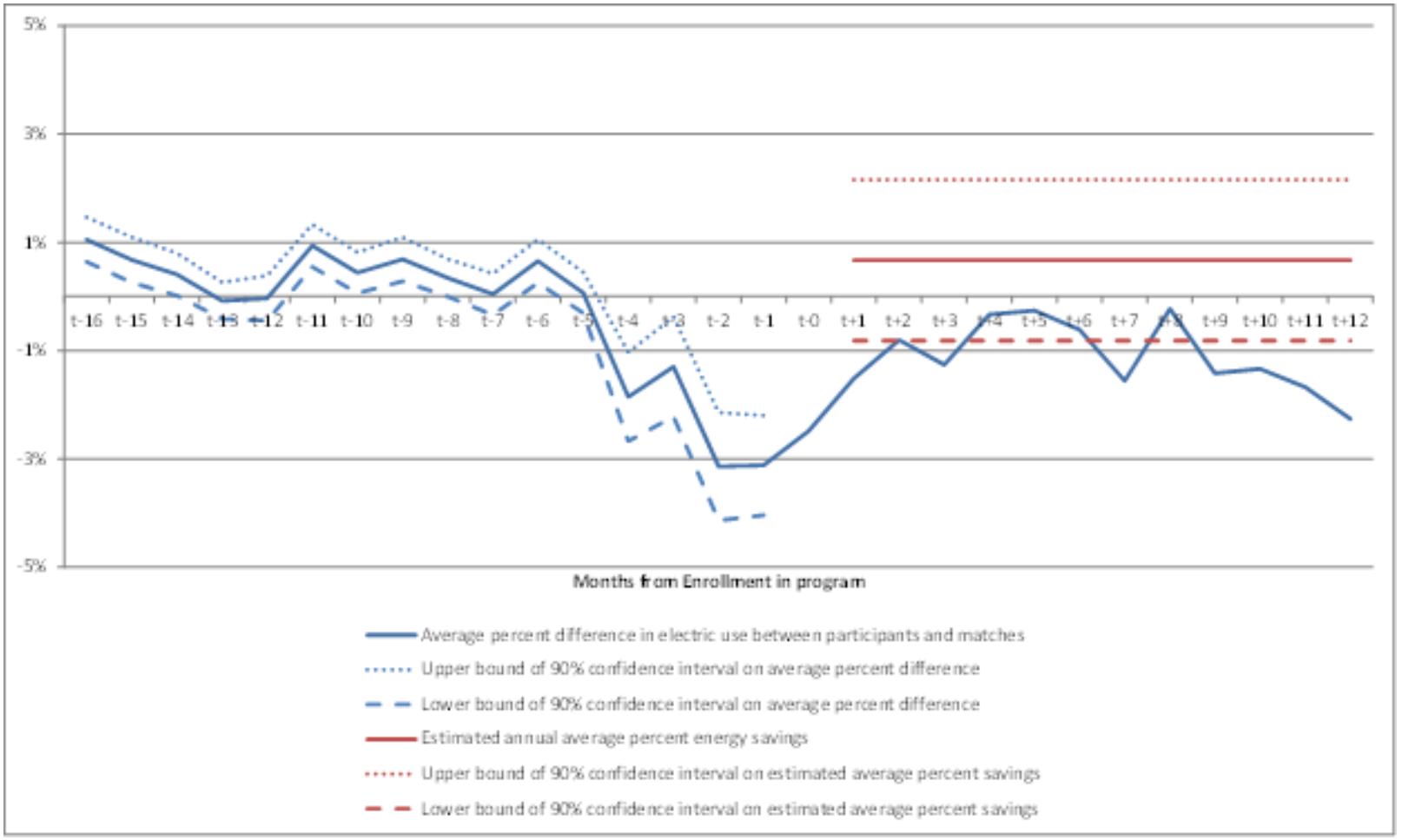
Annual electric savings per building for all C&I installations averaged -0.6% per building annually, with a 90% confidence interval of -1.9% to 0.7%.



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Navigant's billing analysis yielded robust results for three fuel/buildings types

- Savings as a percent of annual consumption for the three types were:
  - Gas/small office: 10.2%
  - Gas/small retail: 5.0%
  - Gas/other: 5.0%
- We recommend proposing two values for the MEMD revision, replacing all weather zone and building type values:
  - Gas/small office: 10.2%
  - Gas/other: 5.0%
- Expectations in December 2013 that additional data would generate reliable savings estimates for gas for other building types have not been borne out
- The available evidence indicates little/no electric savings

Navigant recommends using a percentage of annual consumption savings value.

- One advantage of using a percentage of consumption savings value (adjusted for percentage of conditioned space retrofitted) is that differences in participant conditioned square footage are taken into account in the savings estimates, making the values more accurate.

	CE Participants*	DTE Participants**	DTE C&I Customers (Excluding primary metered)
Average Building Square Feet	4,104	3,632	6,151

**Based on participants in the Consumers Small Business Direct Intall program, does not include participants in the Business Solutions program. Based on 2013 program tracking data.*

***Based on participants in the DTE Direct Intall program, does not include participants in the Standard Prescriptive Program. Based on 2013 program tracking data.*

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Questions?

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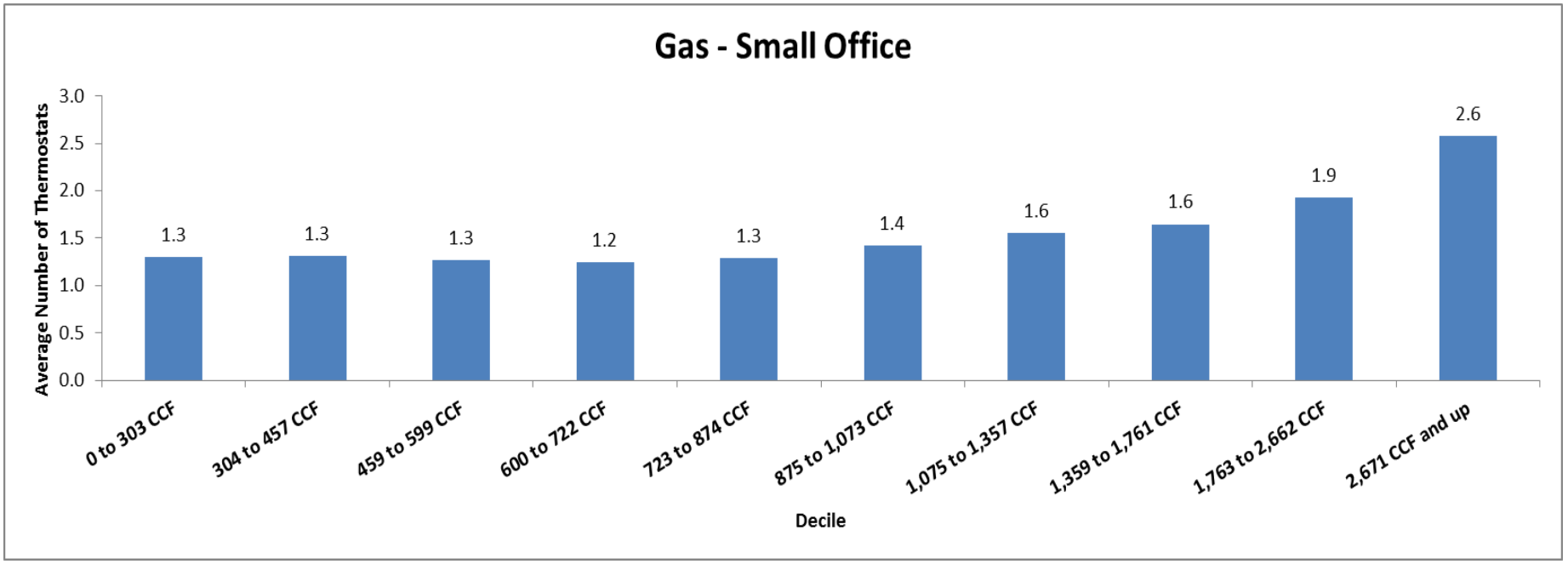

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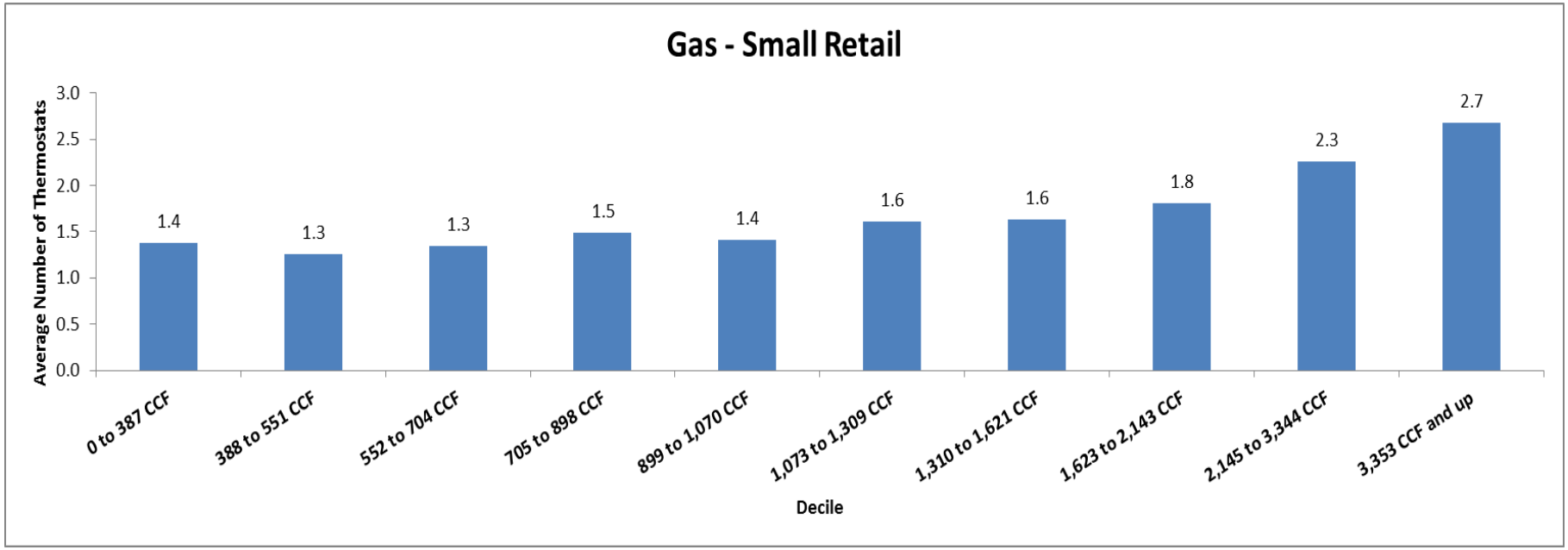

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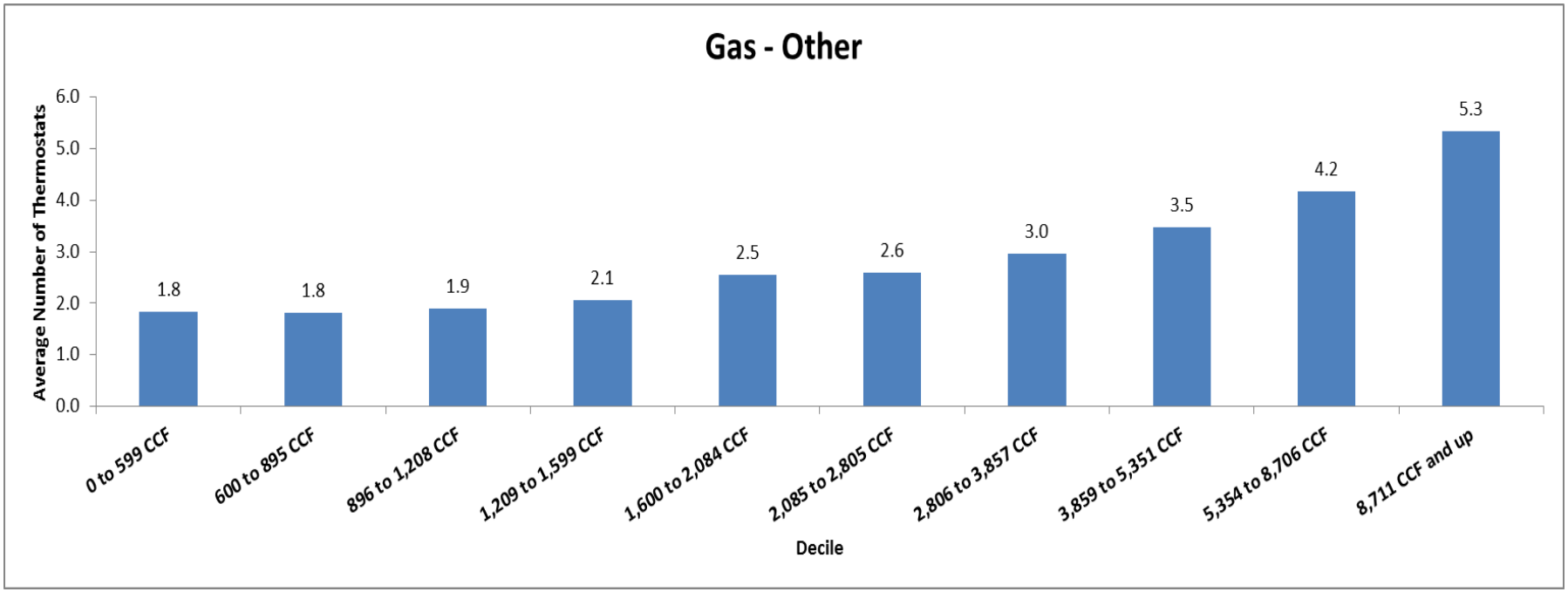

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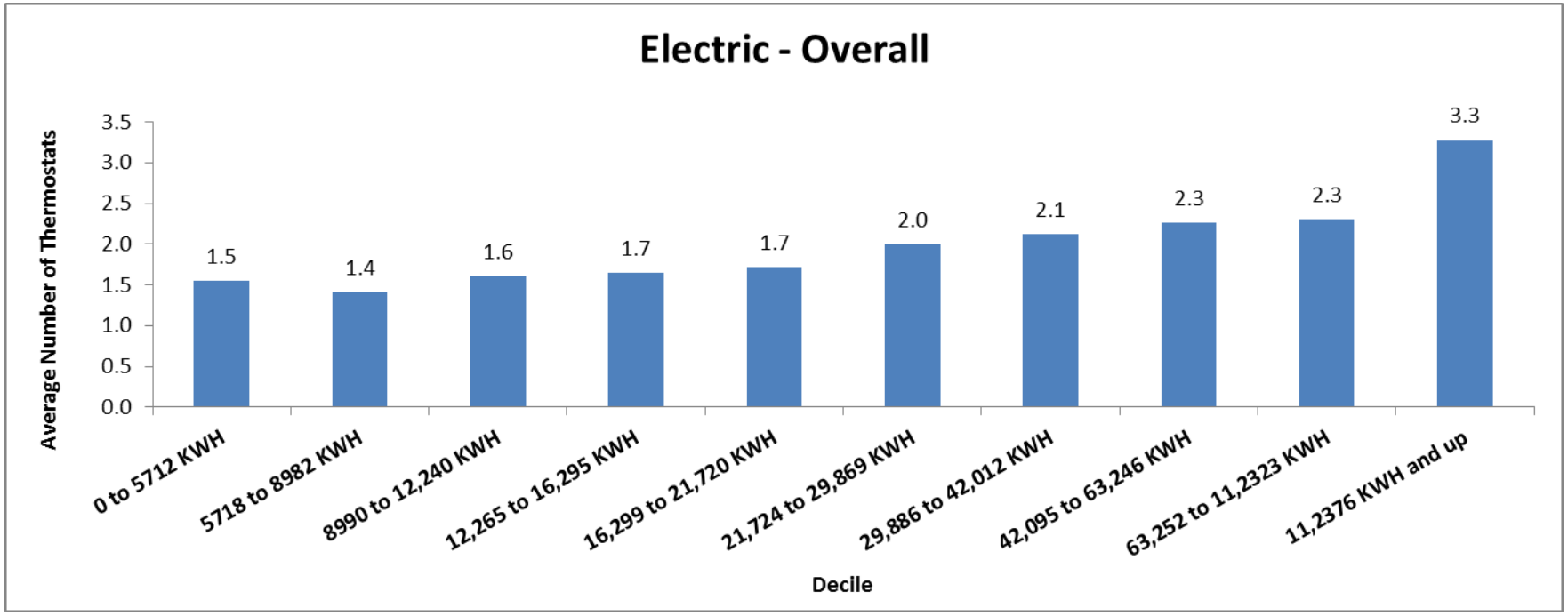

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