BEHAVIOR MODIFICATION REPORT MEASURE CALIBRATION

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The following individuals from Navigant contributed to the development of this report:

Will Sierzchula

Carly Olig

Debbie Brannan

The following individuals from Navigant also provided critical guidance and advice contributing to this report:

Molly Podolefsky

Dan Layton

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Alex Osteen, Cadmus

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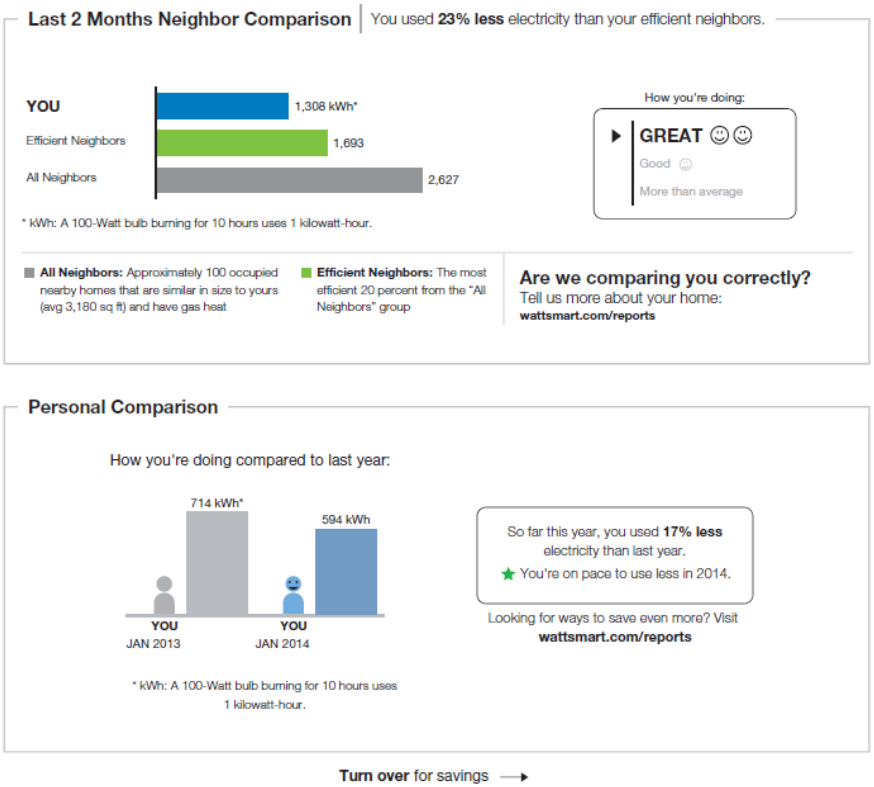
Manish Rukadikar, DTE Energy

Behavior Modification Report Measure Calibration

Behavior Modification Reports seek to achieve energy savings by providing households accurate monthly electricity and/or gas usage information, motivating a change in energy use behavior.

Figure 1. Sample Behavior Modification Report



Source: DTE Energy's Home Energy Report Program Implemented by Oracle

Behavior Modification Reports change energy use behavior[1] through two primary mechanisms:

1. Motivates residential customers through normative messaging to change their behavior. Personalized neighbor comparisons based on home size, location and energy type—among other criteria—give households a motivational benchmark for their energy usage.
2. Provides residential customers with salient, personalized advice to capitalize on this motivation to use less energy and save money.

Behavior Modification Reports are delivered through direct mail and are often supplemented with digital communications such as email, the web, telephones, mobile phones, and social networks. This platform approach ensures all households have access to the information.

[1]Allcott, H. *Social norms and energy conservation.* Journal of Public Economics (2011), Volume 95, Issues 9-10: 1082-1095

The Behavior Modification Report measure has not been calibrated since first introduced to the MEMD. Furthermore, several waves average annual energy consumption falls outside of current MEMD usage bands.

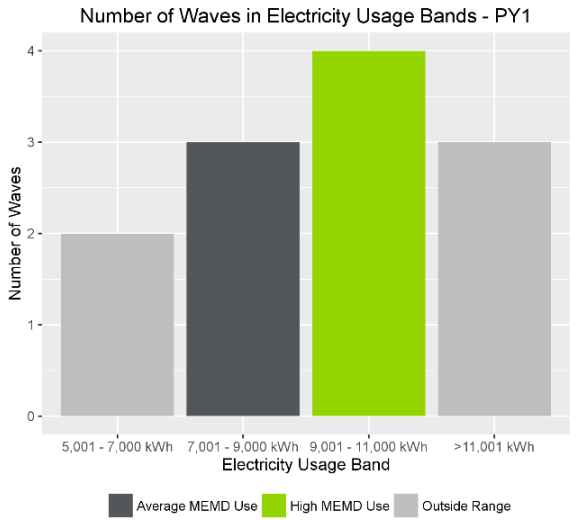
The primary drivers of conducting calibration research on the Behavior Modification Report measure at this time are:

1. The Behavior Modification Report was first introduced to the Michigan Energy Measures Database (MEMD) in 2013 with a Year 1 value. Since then, each year, a new Behavior Modification Report measure has been added to the MEMD representing the savings for each subsequent program year. In the 2017 MEMD, there are Behavior Modification Report measures for Year 1 through Year 5, with a Year 6 value under review for inclusion in the 2018 MEMD. Table 1 presents the savings values as they appear in the 2017 MEMD. To date, the Behavior Modification Report measures have not been calibrated.
2. Several waves have average control usage outside existing MEMD usage bands (see light grey bars in Figure 2). Since energy savings from Behavior Modification Reports vary based on usage levels,[1] current MEMD bands may not provide an accurate representation of energy savings for many customers.

Table 1. 2017 MEMD Usage Bands and Savings Rates

Fuel Type	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Electric	Average (7 to 9 MWh)	1.05%	1.34%	1.45%	1.55%	1.66%
Electric	High (9 to 11 MWh)	1.20%	1.68%	1.82%	1.95%	2.06%
Gas	NA	0.64%	0.71%	0.72%	0.77%	0.69%

Figure 2. Electricity Wave Usage



Source: Navigant analysis of customer billing data

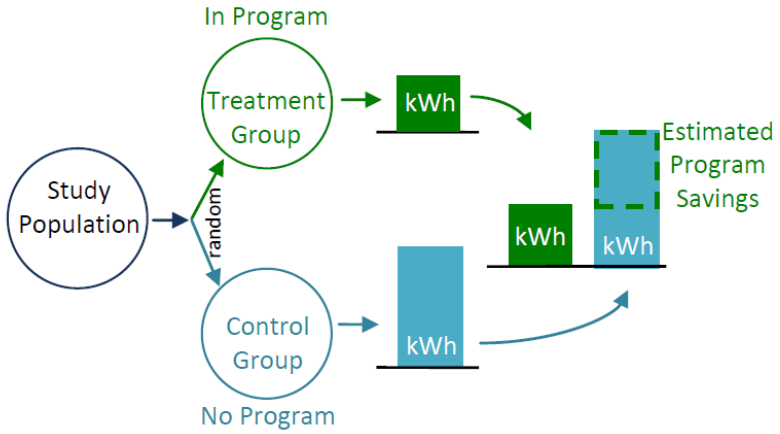
[1]Allcott, H. *Social norms and energy conservation.* Journal of Public Economics (2011), Volume 95, Issues 9-10: 1082-1095

This calibration study uses a linear fixed effects regression model to estimate energy savings by usage band and year using monthly billing data between 2010 and 2016 for the DTE Energy (DTE) and Consumers Energy (CMS) programs offering Behavior Modification Reports.[1]

DTE and CMS run their Behavior Modification Report programs as randomized controlled trials (RCTs), wherein customers are randomly assigned to the treatment and control groups (Figure 3). This program design is known to produce unbiased estimate of program impacts.[2]

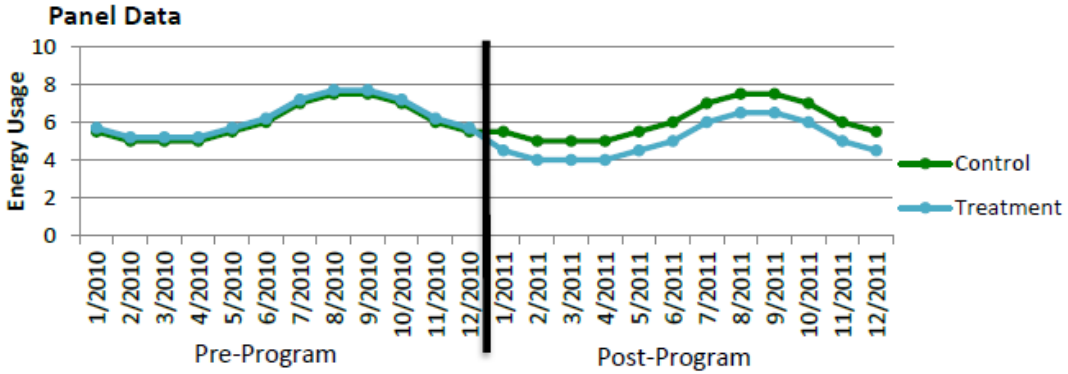
The regression model utilizes pre and post program data in a panel dataset to estimate the savings caused by the program (Figure 4). Because the treatment and control groups are equivalent is every way expect receipt of the report (because customers were randomly assigned to the two groups), the report must drive any differences in usage in the post program period. The regression specification is included in Appendix A.

Figure 3. Illustration of an RCT



Source: SEE Action Report[2]

Figure 4. Panel Dataset Illustration



Source: SEE Action Report[2]

[1] Each HER wave/program year included in the calibration analysis had 12 months of data.

[2] State and Local Energy Efficiency (SEE) Action Network. 2012. *Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations*. Prepared by A. Todd, E. Stuart, S. Schiller, and C. Goldman, Lawrence Berkeley National Laboratory. http://behavioranalytics.lbl.gov.

In addition to calibrating savings based on existing MEMD usage bands, this study also introduces usage bands of 5 to 7 MWh and greater than 11 MWh, and developing usage bands of 900 to 1,200 Therms and greater than 1,200 Therms. Not all deemed savings values will be calibrated.

Table 2. Existing and Proposed Usage Bands

Existing MEMD Usage Bands

Fuel Type	Usage Band
Electric	7 to 9 MWh
Electric	9 to 11 MWh

Fuel Type	Usage Band
Gas	NA

Proposed MEMD Usage Bands

Fuel	Usage Band
Electric	5 to 7 MWh
Electric	7 to 9 MWh
Electric	9 to 11 MWh
Electric	> 11 MWh
Gas	900-1200 Therms
Gas	>1200 Therms

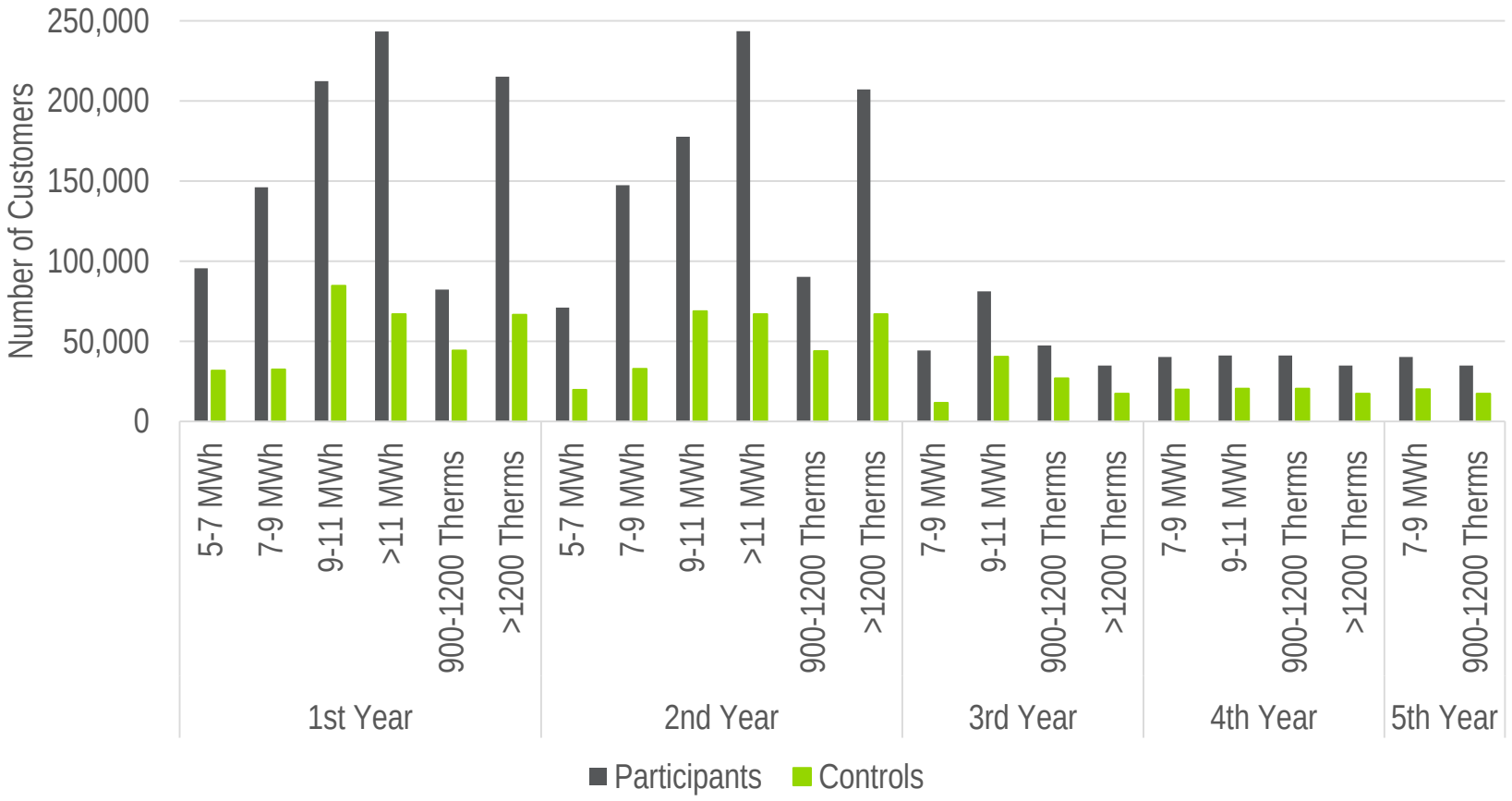
Table 3. Number of Waves per Usage Band by Year[1]

Fuel	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Electric	5 to 7 MWh	2	1	-	-	-
Electric	7 to 9 MWh	3	3	2	1	1
Electric	9 to 11 MWh	4	3	2	1	-*
Electric	> 11 MWh	3	3	-	-	-
Gas	900 – 1200 Therms	3	3	2	1	1
Gas	> 1200 Therms	3	3	1	1	-*

* These are deemed in the MEMD but there is not enough data to calibrate them.

[1]Refer to Appendix B for additional information on specific DTE Energy and Consumers Energy cohorts included in the calibration study.

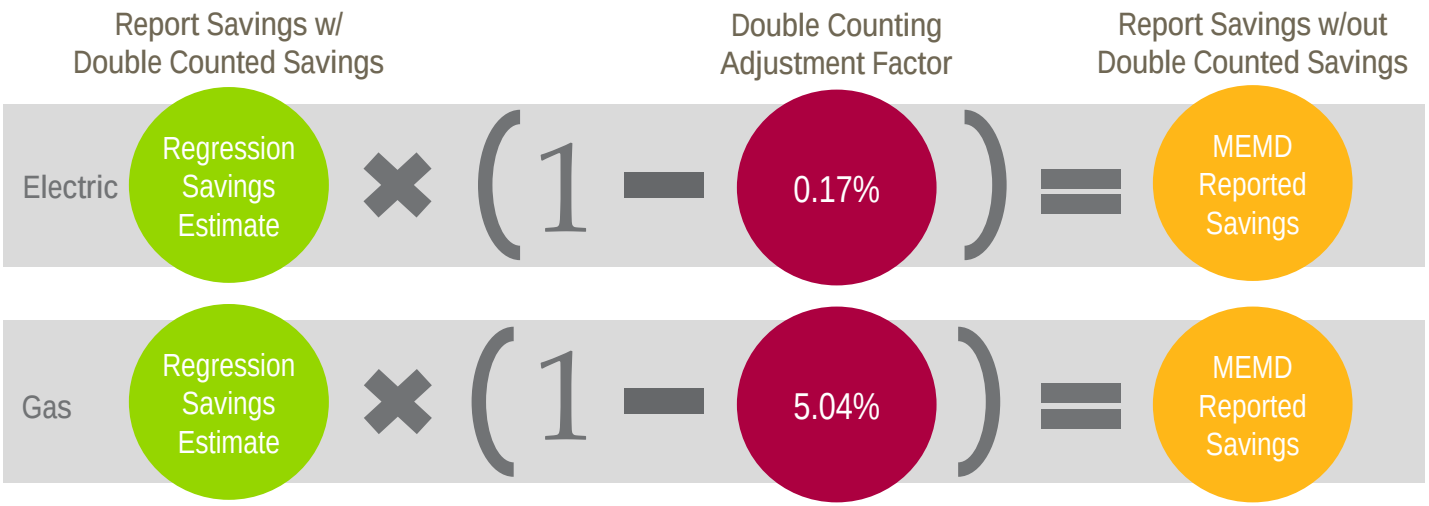
The earlier years have more customers in the calibration than the later years. The savings estimates for program year/band combinations with fewer customers are less precise.



Behavior Modification Reports may increase participation in other energy efficiency programs (also referred to as program uplift). To avoid double-counting, the savings associated with program uplift are subtracted from the Behavior Modification Report and attributed to the lifted program measures.

- This calibration study did not determine program uplift for each wave. Instead, it combined average program uplift estimates for DTE and CMS across all study waves, weighted by the proportion of participants from each utility.
    - DTE program uplift estimates use a difference-in-difference (DID) statistic. This value is defined as the program's participation rate change between program and pre-program years for the control group subtracted from the same change for the treatment group.
    - CMS program uplift estimates use a simple difference between treatment and control participation rates during the program year.
- Reported savings values were calculated using the following formula:

Regression Savings Rate x (1 – Weighted Average of Difference Statistics) = Reported Savings Rate



The evaluation team calibrated electricity and gas savings, introducing two additional electric usage bands and developing gas usage bands. Saving values have been adjusted to account for uplift.

Table 4. Calibrated MEMD Usage Bands[1]

Fuel	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Electric	5 to 7 MWh	0.48%	0.77%	-	-	-
Electric	7 to 9 MWh	0.84%	1.50%	1.82%	2.27%	2.01%
Electric	9 to 11 MWh	1.08%	1.52%	1.77%	1.25%	2.18%*
Electric	> 11 MWh	1.20%	1.78%	-	-	-
Gas	900-1200 Therms	0.34%	0.53%	0.91%	0.86%	0.66%
Gas	>1200 Therms	0.43%	0.60%	0.57%	0.66%	1.09%*

* These savings values have not changed from the deemed value as there was not enough data to calibrate them.

Table 5. Difference between MEMD and Calibrated Savings Rates

Fuel Type	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Electric	5 to 7 MWh	n/a	n/a	n/a	n/a	n/a
Electric	7 to 9 MWh	-0.21%	0.16%	0.37%	0.72%	0.35%
Electric	9 to 11 MWh	-0.12%	-0.16%	-0.05%	-0.70%	0.00%
Electric	> 11 MWh	n/a	n/a	n/a	n/a	n/a
Gas	NA	-0.30%	-0.18%	0.19%	0.09%	-0.03%
Gas	NA	-0.21%	-0.11%	-0.15%	-0.11%	0.00%

[1]Refer to Appendix C for more detailed discussion of changes in savings over time and across bands.

Navigant recommends calibrating the Behavior Modification Report measure on a regular basis (e.g., every 2 - 3 years) as the composition of waves included will change as waves become more mature.

- Year 3 values were based on at most two waves, while Year 4 and Year 5 values were based on a single wave or could not be calibrated.
- Calibrated savings results are particularly sensitive when based on a small sample.

Questions?

Appendices

A Linear Fixed-Effects Regression model used to calculate energy savings.

Formally, the model is:[1]

$$ADU_{it} = \alpha_i + \beta_{1b}(Post_{it} \cdot Treatment_i \cdot Wave_{ib}) + \beta_{2b}(Post_{it} \cdot Wave_{ib}) + \beta_{3b}(CDD_{it} \cdot Wave_{ib}) + \beta_{4b}(HDD_{it} \cdot Wave_{ib}) + \varepsilon_{it}$$

Where,

- ADU_{it} is the average daily usage for household *i* during month *t*
- α_i is a household-specific fixed effect that captures factors which do not change over time
- $Post_{it}$ is a binary variable taking value of 0 if month *t* for household *i* is in the pre-period, or 1 in the program period
- $Treatment_i$ is a binary variable identifying if a household is in the treatment (1) or control (0) group
- $Wave_{ib}$ is a factor variable identifying whether household *i* is in wave *b*
- CDD_{it} is the number of cooling degree days for household *i* during month *t*
- HDD_{it} is the number of heating degree days for household *i* during month *t*
- ε_{it} is the cluster-robust error term for household *i* in time *t*

[1] This methodology is consistent with the methodology used by DTE Energy and Oracle when submitting savings rates to the MEMD for the Behavior Modification Report measure. Further, this is the methodology the EWR Collaborative approved resulting from the Behavior Modification Report Savings Model Calibration Study completed in 2015.

Table A1. Waves included in the Calibration Study

Wave	Utility	Fuel	Start Date	PY1	PY2	PY3	PY4	PY5	Participants	Controls
DTE_2011_07_d	DTE	Dual	7/1/2011	Y	Y	Y	Y	Y	50,665	25,305
DTE_2013_09_d	DTE	Dual	10/1/2013	Y	Y				108,966	32,056
DTE_2013_09_e	DTE	Elec	10/1/2013	Y	Y				121,936	32,089
DTE_2014_01_d	DTE	Dual	1/1/2014	Y	Y				79,113	21,983
DTE_2014_01_e	DTE	Elec	1/1/2014	Y	Y				95,661	21,993
DTE_2015_04_d	DTE	Elec	4/1/2015	Y					31,418	15,697
DTE_2015_04_e	DTE	Elec	6/1/2015	Y					38,217	17,450
CMS_201105_d	CMS	Dual	5/1/2011	Y	Y	Y	Y		50,131	24,852
CMS_201203_d	CMS	Dual	2/1/2012	Y	Y	Y			8,620	8,623
CMS_201204_e_Musk	CMS	Elec	4/1/2012	Y	Y	Y			50,575	7,000
CMS_201303_e	CMS	Elec	3/1/2013	Y	Y				128,079	26,197
CMS_201305_d	CMS	Dual	7/1/2013	Y	Y				52,489	20,999

Source: Navigant analysis of customer billing data

Table A2. Waves excluded in the Calibration Study

Wave	Utility	Fuel	Start Date	Participants	Controls	Reason
DTE_2015_04_d	DTE	Gas	4/1/2015	31,418	15,697	Usage was below 900 Therm cutoff
CMS_201204_e_bc	CMS	Elec	4/1/2012	20,584	15,168	No zip codes for CDD/HDD
CMS_201203_g	CMS	Gas	3/1/2012	100,615	40,825	No zip codes for CDD/HDD
CMS_201403_d	CMS	Gas	3/1/2012	34,992	9,999	No zip codes for CDD/HDD

Source: Navigant analysis of customer billing data

The large drop in savings from Year 3 to Year 4 in the 9 to 11 MWh band and the increase in savings from Year 2 to Year 3 and Year 3 to Year 4 in the 7 to 9 MWh band are explained by waves falling out of the sample or shifting from one band to another between years.

The drop in savings from Year 3 to Year 4 in the 9 to 11 MWh band is explained by a wave shifting from the 9 to 11 MWh band to the 7 to 9 MWh band (see the pink arrow in Figure C1).

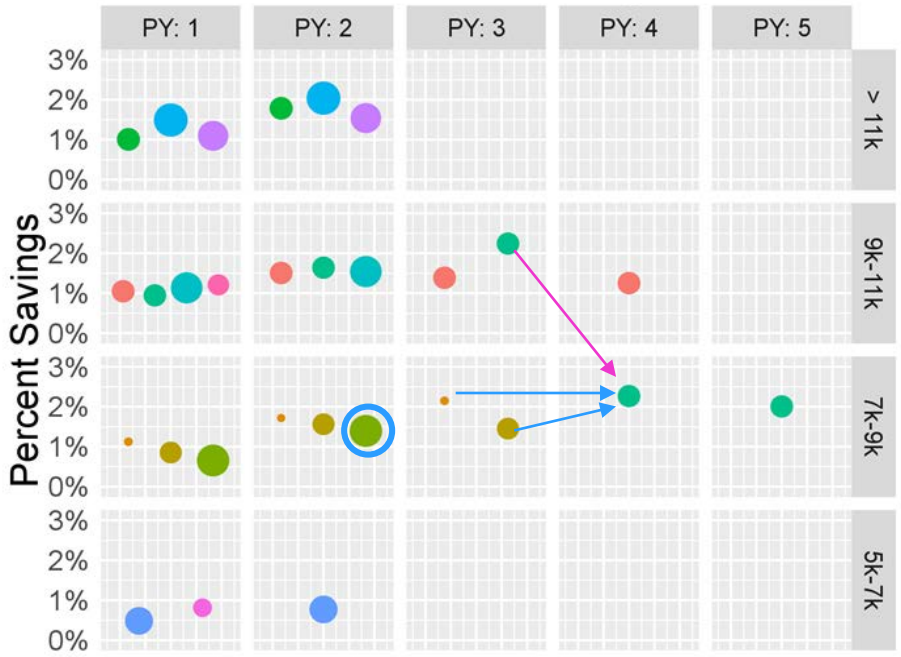
The increase in savings from Year 2 to Year 3 in the 7 to 9 MWh band is explained by a relatively large wave dropping from the analysis in Year 3 (i.e., this wave had not been in the program for three full years). See the wave circled in blue in Figure C1.

The increase in savings from Year 3 to Year 4 in the 7 to 9 MWh band is explained by the two waves in Year 3 falling out of the sample and being replaced by a wave with slightly higher savings in Year 4 (see the blue arrows in Figure C1).

Table C1. Electric Wave Savings

Fuel	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Electric	> 11 MWh	1.20%	1.78%	-	-	-
Electric	9 to 11 MWh	1.08%	1.52%	1.77%	1.25%	2.18%*
Electric	7 to 9 MWh	0.84%	1.50%	1.82%	2.27%	2.01%
Electric	5 to 7 MWh	0.48%	0.77%	-	-	-

Figure C1. Electric Wave Savings



The large increase in savings from Year 2 to Year 3 in the 900 to 1200 therm band and the decrease from Year 4 to Year 5 is explained by waves falling out of the sample or shifting from one band to another between years.

The increase in savings from Year 2 to Year 3 in the 900 to 1200 Therm band is explained by a relatively large wave dropping from the analysis in Year 3 (i.e., this wave had not been in the program for three full years). See the wave circled in pink in Figure C2.

The decrease in savings from Year 4 to Year 5 in the 900 to 1200 Therm band is explained by the one wave in Year 4 falling out of the sample and being replaced by a wave with slightly lower savings in Year 5 (see the blue arrow and blue circled wave in Figure C2).

Table C2. Gas Wave Savings

Fuel	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5
Gas	>1200 Therms	0.43%	0.60%	0.57%	0.66%	1.09%*
Gas	900-1200 Therms	0.34%	0.53%	0.91%	0.86%	0.66%

Figure C2. Gas Wave Savings