Home Energy Report Measure Calibration

Presentation to the Michigan Public Service Commission

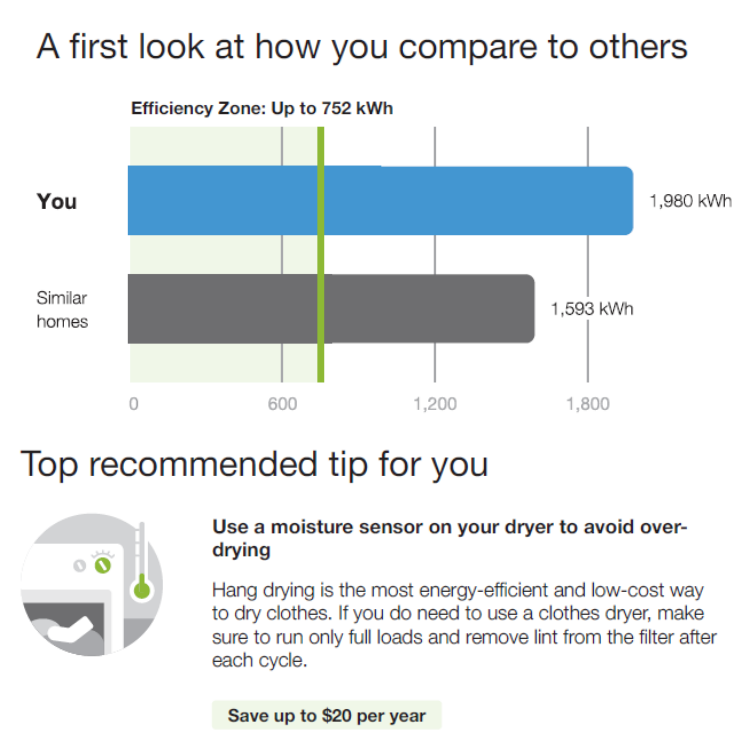
June 2022

Agenda

1. Measure Description

Home Energy Reports (HERs) seek to achieve energy savings by providing households accurate monthly electric and/or gas usage information, motivating a change in energy use behavior.

Figure 1. Sample Home Energy Report



Source: DTE Energy's HER Program Implemented by Oracle

HERs 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.

HERs 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.

2. Motivation for Calibrating

The HER measure in the Behavior Resource Manual (BRM) was last calibrated using data through 2020.

- Following the 2020 Calibration Study, parties agreed that re-calibrating in 2 years was appropriate.
- The 2022 Calibration Study, follows the same methods as 2020 to calibrate energy and demand savings.
- Table 1 shows the current (2022) BRM energy savings values, demand savings can be calculated by multiplying these values by the demand savings factor of 0.78.

Table 1. Current (2022) BRM Energy Savings Values

Fuel Type	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Electric	5k-7k kWh	0.12%	0.59%	0.87%	0.77%	0.89%	0.93%	*	*	*	*
Electric	7k-9k kWh	0.72%	1.27%	1.29%	1.81%	1.64%	1.61%	1.98%	*	1.83%	1.17%
Electric	9k-11k kWh	0.78%	1.36%	1.50%	1.42%	1.24%	1.59%	2.58%	2.02%	*	*
Electric	11-13k kWh	0.90%	1.42%	1.66%	1.84%	1.54%	*	*	*	*	*
Electric	>13k kWh	1.13%	1.88%	2.19%	2.11%	2.19%	1.98%	*	*	*	*
Gas	600-900 Therms	0.27%	0.45%	0.51%	*	0.27%	*	*	*	*	*
Gas	900-1200 Therms	0.47%	0.68%	0.71%	0.74%	0.75%	0.73%	0.89%	*	0.59%	0.88%
Gas	>1200 Therms	0.41%	0.74%	0.73%	0.82%	1.04%	0.69%	0.78%	0.82%	*	*

* The 2020 Workpaper recommended that when a particular usage band/year combination is not in the BRM utilities should claim savings using the last year available in the BRM for that usage band. For example, if a wave in Year 4 was in the 600-900 therm usage band, the utility would claim the Year 3 value as the Year 4 value does not exist.

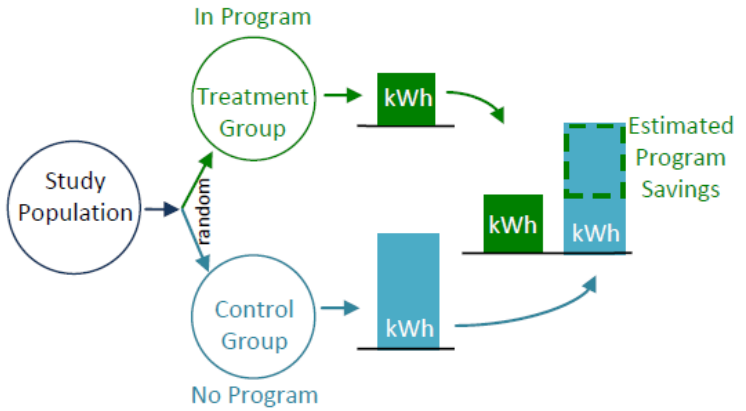
3. Methodology

This calibration study estimates energy savings by usage band and program delivery year (i.e., Year 1, Year 2) using monthly billing data for the DTE (between 2010 and 2021), CE (between 2011 and early 2015),[1] and SEMCO (between 2020 and 2021) programs offering HERs.[2]

DTE, Consumers Energy (CE), and SEMCO implement their HER programs as randomized controlled trials (RCTs), wherein customers are randomly assigned to treatment and control groups (Figure 2). This program design is known to produce unbiased estimate of program impacts.[2]

Because customers are randomly assigned into a treatment group or a control group, they are expected to be equivalent in every way expect program treatment - in this case, receipt of the report. As such, any differences in usage between the treatment group and the control group observed in the program period are necessarily the result of the program.

Figure 2. Illustration of an RCT



Source: SEE Action Report[3]

[1] New data was not incorporated for CE waves due to a gap in the program in 2015 and then changing implementers between 2016 and present. Data from new Consumers waves was not included in this study as Consumers claims custom savings for their current program.

[2] Each HER wave/program year included in the calibration had at least 3 months of post-program data available for the applicable program year. The inclusion of wave/years with fewer than 12 months allowed for retaining years for calibration when a utility chose not to run a wave in a particular calendar year. This applied to 13 out of 103 wave/year combinations, and Guidehouse examined these 13 partial wave/year combinations and found them to have savings consistent with waves with complete years in the same usage band.

[3] 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.
Stewart, J. and A. Todd. *Chapter 17: Residential Behavior Evaluation Protocol*. In NREL's Uniform Methods Project Protocols.
Note: Complete model specifications are shown in Appendix A.

3. Methodology

In this 2022 Calibration Study, Guidehouse used the lagged dependent variable (LDV) model specification agreed to in the 2020 Calibration Study.

Guidehouse estimated a regression model for each program year (i.e., Year 1, Year 2) and usage band for which data are available. The output of the model yields per participant energy savings which we convert into percent savings. These savings represent verified net savings before adjusting for program uplift.

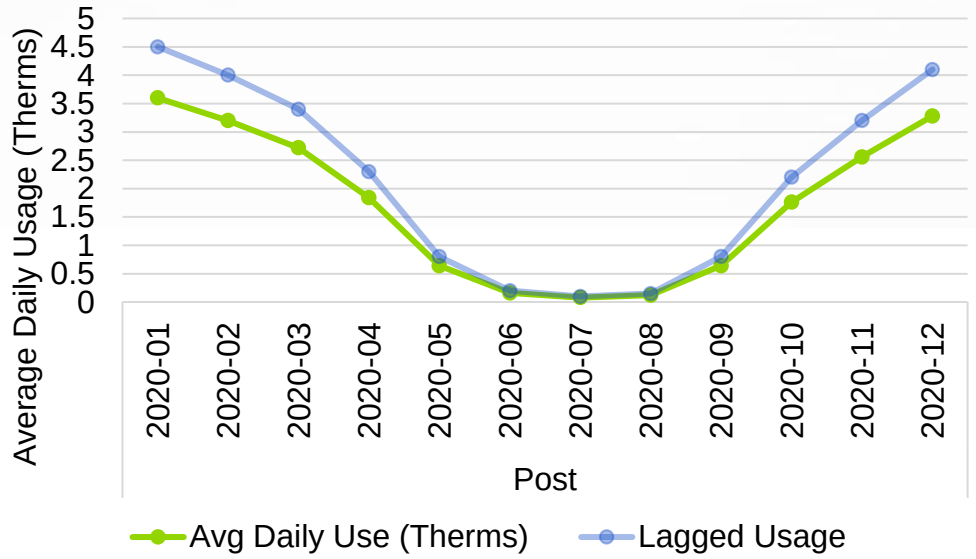
Equation 1. LDV Model Specification[1]

$$ADU_{it} = \sum_{J} \beta_{1j} YrMo_{jt} + \sum_{J} \beta_{2j} YrMo_{jt} \cdot \boldsymbol{ADUlag_{it}} + \beta_3 Treatment_i + \beta_4 CDD\_and\_or\_HDD_{it} + \sum_{W} \beta_5 Wave_{iw} + \beta_6 Utility_i + \varepsilon_{it}$$

- LDV controls for differences between the treatment and control groups by including lagged usage (from the pre-period) as an explanatory variable.
- The lagged usage does a good job of controlling for differences in usage over time.
- Time invariant customer characteristics must be explicitly added to the model to be accounted for. With a RCT these characteristics are expected to be well-balanced between the treatment and control groups.

[1] Definitions of all the variables in this model can be found in Appendix A. Control customers in each wave are weighted to make them 1:1 with their respective treatment customers to ensure an unbiased savings estimate when combining multiple waves into the same regression.

Figure 3. LDV Model Illustration

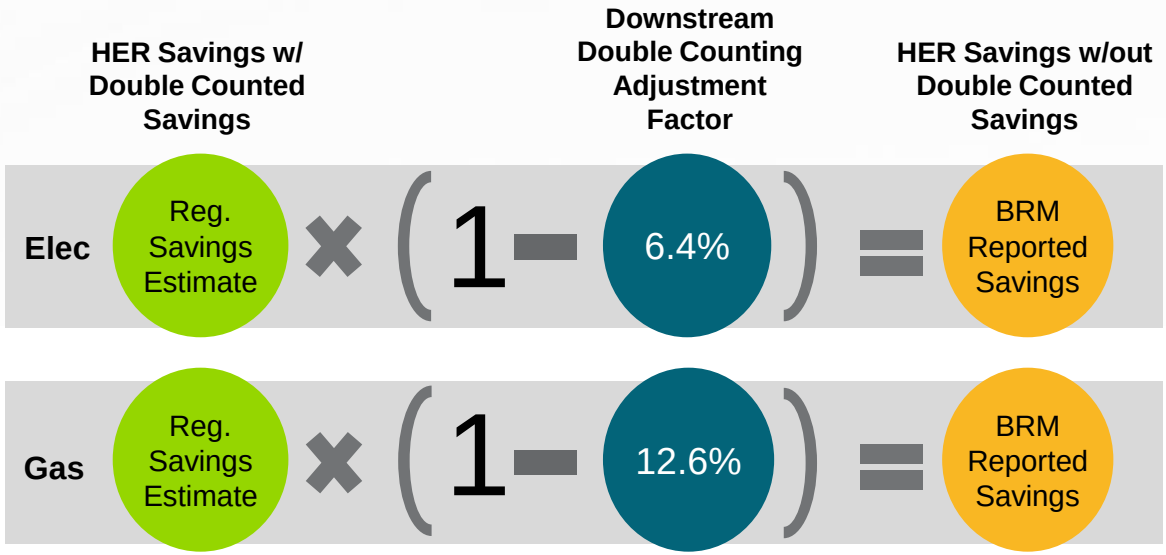


Note, the LDV model only includes unique observations of the dependent variable (average daily usage) for the post period and the pre-period enters as an independent variable (lagged usage). Thus, in estimating one year of savings, the model includes 12 observations.

3. Methodology

HERs 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 HER program and attributed to the lifted program measures.

Figure 4. HER Savings Calculation



Source: Guidehouse

[1] Stewart, J. and A. Todd. *Chapter 17: Residential Behavior Evaluation Protocol*. In NREL's Uniform Methods Project Protocols.

[2] Uplift for DTE was calculated on a calendar year basis and compared to calendar year HER savings. Savings were pro-rated for both HER and the other EE programs when an HER wave launched partway through the calendar year. In all other cases, annualized savings were used.

- Uplift followed the same methodology as the 2020 Calibration Study which is consistent with the UMP chapter 17.[1]
- The calibration study calculated uplift for all DTE and SEMCO waves using a difference-in-difference (DID) statistic based on pre-period and post-period average savings from other energy efficiency programs. These estimates were combined with uplift estimates from the prior CE evaluations and weighted by the proportion of participants from each utility.[2]
- Compared to the prior calibration study, uplift increased from 5.7% for electric and 9.4% for gas.
- The team did not make any adjustment for upstream programs in line with the review conducted in the 2020 Calibration Study which did not find evidence of lift in upstream lighting.

3. Methodology

The 2022 Calibration Study estimated a demand savings factor using the same method as the 2020 Calibration Study.

- Due to AMI data limitations, calibration of demand savings only included DTE waves launched in 2016 or later.
  - Uplift for DTE's demand response programs was accounted for in these estimates by excluding customers in the demand response programs.
- Guidehouse estimated a demand savings regression model for all waves with available AMI data and an analogous energy savings regression model for the same waves. These regression specifications are included in Appendix A.
  - The demand savings model only includes data for 3-6pm on the three hottest, consecutive, non-holiday weekdays in July.
- We calculated a demand savings factor by comparing the demand savings to the energy savings using the following equation:

$$\text{Demand Savings Factor} = \frac{\%\ Demand\ Savings}{\%\ Energy\ Savings}$$

- The resulting demand savings factor can replace the current 0.78 demand savings factor used for all waves. The waves used for demand calibration cover all the usage bands.

Note: Due to data limitations the calibration study is unable to determine whether the demand savings factor varies by usage band. As a result, we assume a single demand savings factor for all waves.

4. Data

Guidehouse included data from approximately 2 million treatment customer and 650k control customers across 26 program waves for DTE (spanning 2010-2021), CE (spanning 2011-early 2015), and SEMCO (spanning 2020-2021).

- The 2022 Calibration utilized data from all waves implemented by DTE (spanning 2010-2021) and Consumers waves implemented prior to 2017 (spanning 2011-early 2015). We also included a SEMCO wave newly launched in 2020.
  - Data from new Consumers waves were not included in this study as Consumers claims custom savings for their current program.
  - No weighting of the service areas is necessary as the entire program population for each utility is used in the calibration.

[1] Appendix B has more information about the included waves including customer counts and program years included. This appendix also includes information about which waves were excluded and why.

Table 2. Waves Included in Calibration[1]

Waves Included in 2017 Calibration Study	Additional Waves in 2020 Calibration Study	Additional Waves in 2022 Calibration Study
CMS_201105_D	DTE_201602_D*	
CMS_201203_D	DTE_201602_E*	
CMS_201204_E_MUSK	DTE_201602_G	
CMS_201303_E	DTE_201606_D*	
CMS_201305_D	DTE_201606_E*	
DTE_201107_D**	DTE_201610_G	DTE_202004_E*
DTE_201309_D	DTE_201710_D*	SECG_202011_G
DTE_201309_E	DTE_201710_G	
DTE_201401_D	DTE_201711_G	
DTE_201401_E	DTE_201803_D*	
DTE_201504_D	DTE_201803_G	
DTE_201504_E	DTE_201901_D*	

* Wave included in demand savings factor calibration. Due to AMI data availability, only DTE electric customers in waves starting after 2016 were included.
** Data for this wave was imputed during the pre-period per the 2020 Calibration Study.

4. Data

Guidehouse included 26 waves across 10 program years between DTE, CE, and SEMCO in the calibration study.

Table 3. Number of Waves per Usage Band by Year[1,2]

Fuel Type	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Electric	5k-7k kWh	3	2	2	1	1	1	1	1		
Electric	7k-9k kWh	4	7	4	4	2	1	1		1	
Electric	9k-11k kWh	5	5	5	4	4	4	1	2	*	1
Electric	11-13k kWh	5	2	2	2	1	1	1	1		
Electric	>13k kWh	3	3	1	1	2	2	1	1		
Gas	600-900 Therms	3	2	3	1	1	1				
Gas	900-1200 Therms	9	8	7	6	3	3	2	2	1	1
Gas	>1200 Therms	5	6	4	5	3	2	1	1		

* These are deemed in the BRM (or have been proposed by DTE/Oracle) but there is not enough data to calibrate them in this study.

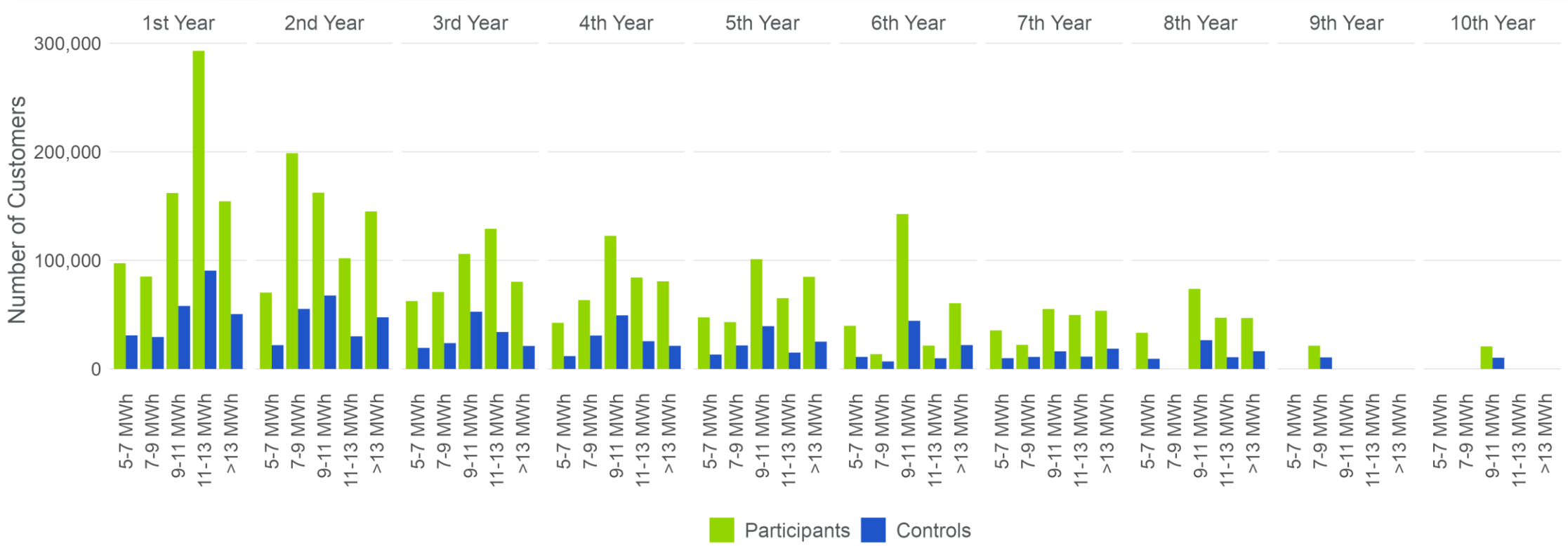
Source: Guidehouse analysis

[1]Refer to Appendix B for additional information on specific DTE, CE, and SEMCO cohorts included in the calibration study.
[2]Guidehouse received updated data from Oracle for the 2022 Calibration Study which affected some earlier years. Therefore, in a couple cases waves changed a band/year assignment compared to the 2020 Calibration Study.

4. Data

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

Figure 5. Customer Counts by Usage Band and Program Year, Electric

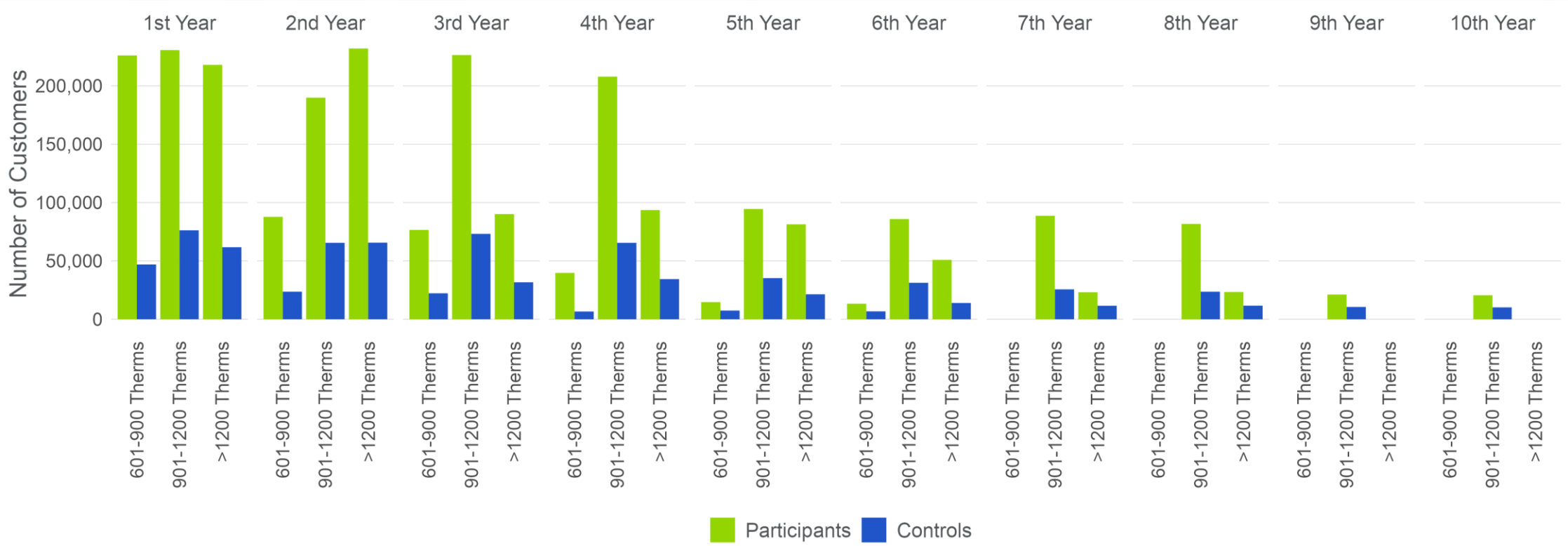


Source: Guidehouse analysis

4. Data

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

Figure 6. Customer Counts by Usage Band and Program Year, Gas



Source: Guidehouse analysis

5. Calibrated BRM Savings Values

Calibrated BRM values, accounting for uplift, are shown below.

In general, savings for each usage band increase and then level off over time and are generally higher for higher usage bands than lower usage bands. These results are consistent with evaluated results across many jurisdictions reflecting program ramp-up and the larger savings opportunities among higher users.

The new demand savings factor is 0.62, compared to 0.78 in the current BRM.

Table 4. Calibrated BRM Usage Bands[1,2,3]

Fuel Type	Usage Band	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Electric	5k-7k kWh	0.13%	0.63%	0.71%	0.76%	0.91%	0.85%	0.86%	1.00%		
Electric	7k-9k kWh	0.75%	1.22%	1.23%	1.51%	1.65%	1.43%	1.98%		1.58%	*
Electric	9k-11k kWh	0.76%	1.36%	1.52%	1.44%	1.25%	1.51%	1.67%	1.27%		0.95%
Electric	11-13k kWh	0.75%	1.41%	1.63%	1.80%	1.52%	1.36%	1.87%	2.07%		
Electric	>13k kWh	1.11%	1.89%	2.11%	2.05%	2.10%	2.06%	2.03%	1.68%		
Gas	600-900 Therms	0.27%	0.35%	0.49%	0.47%	0.35%	0.42%				
Gas	900-1200 Therms	0.36%	0.54%	0.75%	0.79%	0.70%	0.74%	0.78%	0.59%	0.79%	0.89%
Gas	>1200 Therms	0.41%	0.70%	0.66%	0.73%	0.72%	0.71%	0.93%	0.85%		

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

[1] Guidehouse received updated data from Oracle for the 2022 Calibration Study which affected some earlier years. Therefore, some values changed slightly (before accounting for uplift) even though no new waves were added to that year/usage band combination.

[2] Values have been proposed by DTE/Oracle for Year 11 9k-11k kWh and 900-1200 Therms but are not included here as they are not part of the calibration. The currently proposed DTE/Oracle values use the uplift adjustment and demand savings factor from the 2020 Calibration Study.

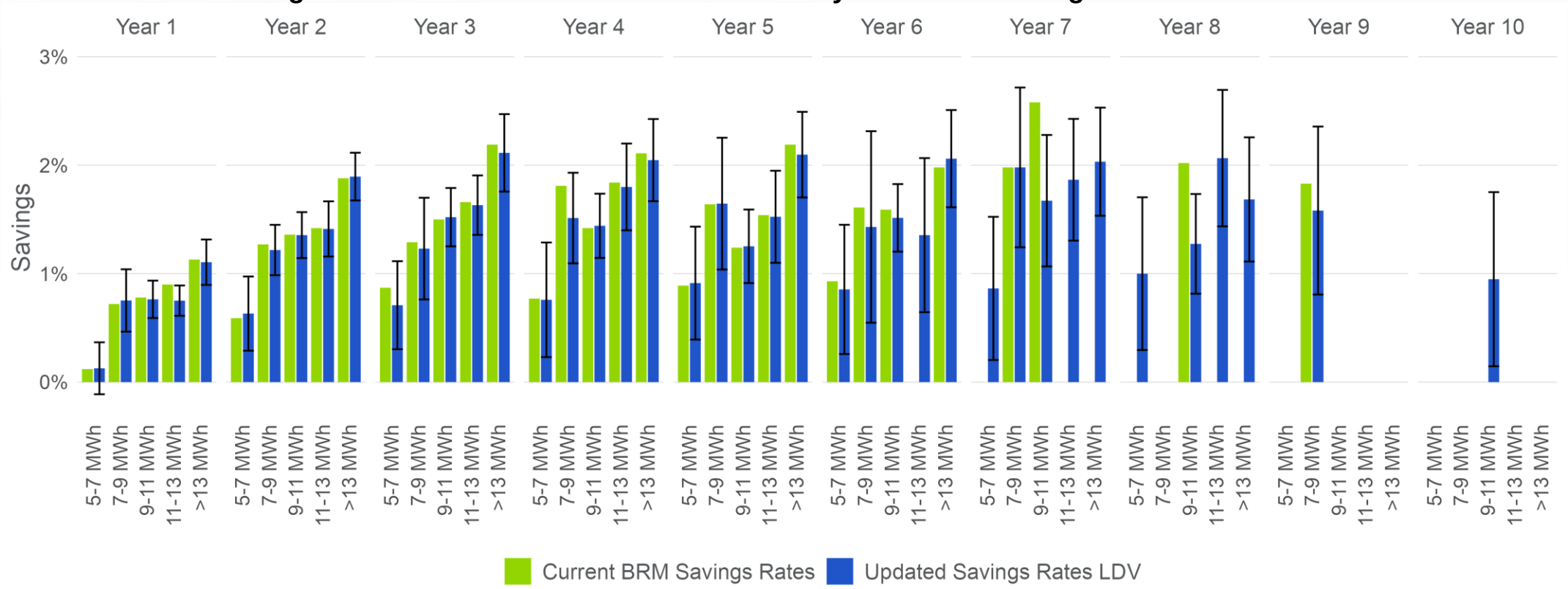
[3] Note, when a usage band/year combination does not exist in the BRM for a wave for which savings are being claimed, the BRM recommends the utility claim the last year available in the BRM for that usage band. For example, if a utility would like to claim savings for a wave in Year 8 in the 7k-9k kWh band, we recommend using the Year 7 value, 1.98%.

Source: Guidehouse analysis

5. Comparison of Calibrated Savings Values to the BRM

Comparisons of calibrated values to the current BRM values for *electric waves* are shown below. Generally, the newly calibrated values are generally similar to the current BRM with later years more likely to see larger changes because of the smaller amount of data.

Figure 7. Difference between BRM and Newly Calibrated Savings Rates - Electric



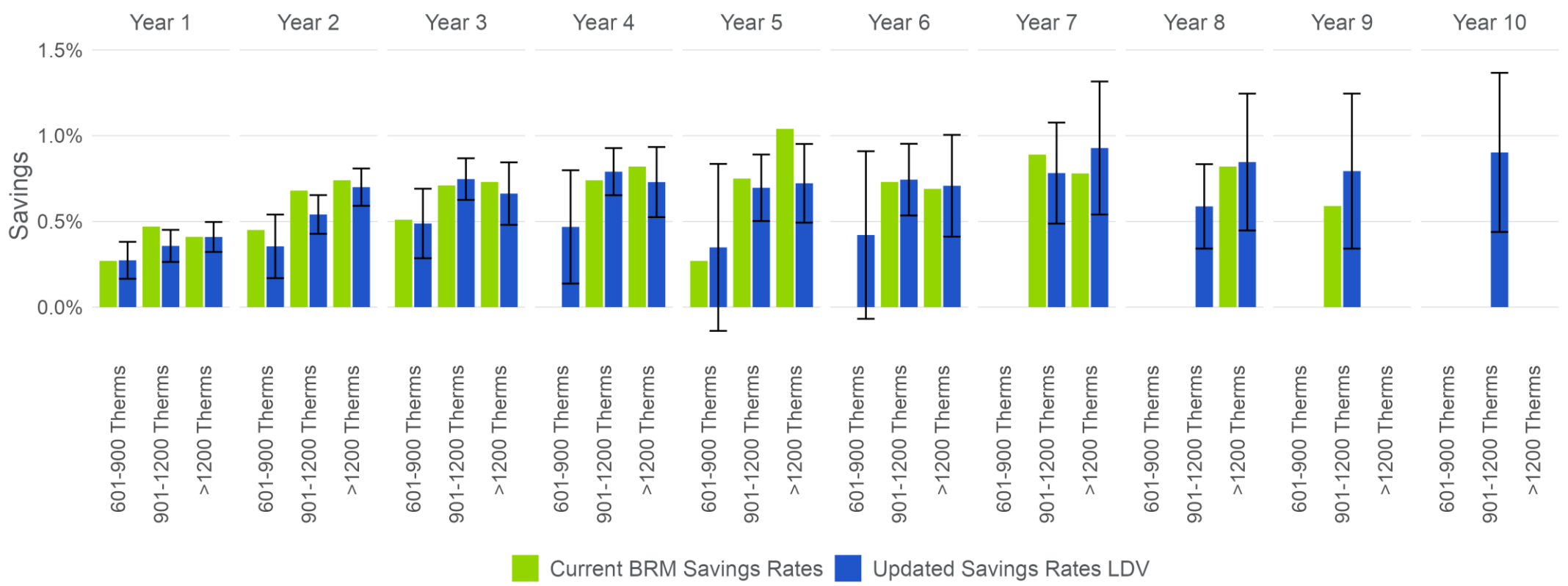
Note, while some calibrated results are not statistically different from zero, we recommend including the point estimate in the BRM as it is the best estimate available for the usage band/year at this time. Vertical lines on the blue bars represent 90% confidence bounds.

Source: Guidehouse analysis

5. Comparison of Calibrated Savings Values to the BRM

Comparisons of calibrated values to the current BRM values for *gas waves* are shown below. Generally, the newly calibrated values are generally similar to the current BRM with later years more likely to see larger changes because of the smaller amount of data.

Figure 8. Difference between BRM and Newly Calibrated Savings Rates - Gas



Note, while some calibrated results are not statistically different from zero, we recommend including the point estimate in the BRM as it is the best estimate available for the usage band/year at this time. Vertical lines on the blue bars represent 90% confidence bounds.

Source: Guidehouse analysis

6. Next Steps

Guidehouse will develop an updated measure workpaper for the BRM.

Table 5. Schedule for BRM Update

Activity	Deliverables	Due
Workpaper Submission to BRM	Modified BRM Measure Workpaper	Jul 1
Update BRM (Draft)	Modified BRM	Aug 1
Update BRM (Final)	Modified BRM	Sep 15
Publish BRM		Oct 10

- Per schedule agreed to after the 2020 Calibration Study, calibration should occur again in 2024.

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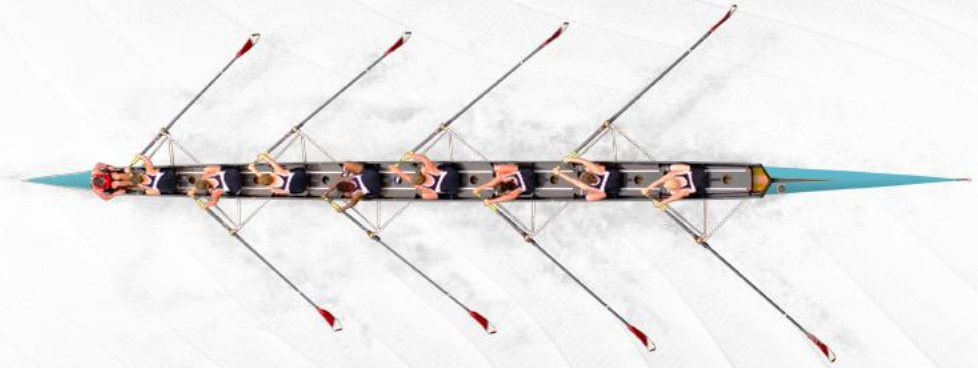

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Appendices

Appendix A. Energy Regression Model - LDV

The LDV model in Equation A1 was used to calculate energy savings.

Equation A1. LDV Model Specification[1]

$$ADU_{it} = \sum_{J} \beta_{1j} YrMo_{jt} + \sum_{J} \beta_{2j} YrMo_{jt} \cdot ADUlag_{it} + \beta_3 Treatment_i + \beta_4 CDD\_and\_or\_HDD_{it} + \sum_{W} \beta_5 Wave_{iw} + \beta_6 Utility_i + \varepsilon_{it}$$

Where:

- *i* indexes the customer
- *t* indexes time
- w indexes program wave
- ADU_{it} is the customer's average daily energy consumption during time *t*
- $ADUlag_{it}$ is the customer's average daily energy consumption during the same month as time *t* lagged to the pre-program year
- $YrMo_{jt}$ comprise a set of month-of-year indicators, which equal 1 if *t* falls in month-of-year *j*, and 0 otherwise
- $Treatment_i$ is a binary indicator that equals 1 if customer *i* is a treatment customer, and 0 otherwise
- CDD_{it} are the cooling degree-days during time *t* for customer *i*
- HDD_{it} are the heating degree-days during time *t* for customer *i*
- $Wave_{iw}$ is a binary indicator that equals 1 if customer *i* falls in wave *w*, and 0 otherwise (only included in pooled models)
- $Utility_i$ is a binary indicator for each utility, equal to 1 if customer i is a customer of the relevant utility, and 0 otherwise (only included in pooled models)
- The $\beta_1 - \beta_6$ are unknown parameters to be estimated
- ε_{it} is a mean-zero disturbance term

[1] Control customers in each wave are weighted to make them 1:1 with their respective treatment customers to ensure an unbiased savings estimate when combining multiple waves into the same regression.

Appendix A. Demand Regression Model

Analogous models were used to calculate demand savings.

- The model for demand savings used only the data from the coincident peak demand period (i.e., the three hottest, consecutive weekdays in July from 3 to 6 p.m.).
- For the LDV model, the usage lag ($ADUlag_{it}$) is defined as the average usage during the same hour on the three peak days from the pre-program year.

Appendix B. Waves in Calibration Study

Table B1 presents information about the DTE waves included in the energy savings calibration.

Table B1. Waves included in the Energy Savings Calibration[1]

Wave	Utility	Fuel	Start Date	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	Participants[2]	Controls[2]
dte_201107_d	DTE	Dual	7/1/2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	50,387	25,165
dte_201309_d	DTE	Dual	9/1/2013	Y	Y	Y	Y	Y	Y	Y**	Y**			109,117	32,094
dte_201309_e	DTE	Elec	9/1/2013	Y	Y	Y	Y	Y	Y	Y	Y			121,919	32,085
dte_201401_d	DTE	Dual	1/1/2014	Y	Y	Y	Y	Y	Y	Y	Y			79,181	21,996
dte_201401_e	DTE	Elec	1/1/2014	Y	Y	Y	Y	Y	Y	Y	Y			95,646	21,987
dte_201504_d	DTE	Dual	4/1/2015	Y	Y	Y	Y**	Y**	Y					31,446	15,721
dte_201504_e	DTE	Elec	4/1/2015	Y	Y	Y**	Y**	Y	Y					38,212	17,452
dte_201602_d	DTE	Dual	2/1/2016	Y	Y	Y	Y**	*	Y					20,472	9,984
dte_201602_e	DTE	Elec	2/1/2016	Y	Y**	*	*	Y	Y					17,385	9,993
dte_201602_g	DTE	Gas	2/1/2016	Y	Y	Y	Y	Y	Y					39,768	9,991
dte_201606_d	DTE	Dual	6/1/2016	Y	Y	Y	Y	Y						9,955	6,979
dte_201606_e	DTE	Elec	6/1/2016	Y	Y**	*	Y**	Y						19,964	12,975
dte_201610_g	DTE	Gas	10/1/2016	Y	Y	Y	Y**	Y**						21,982	4,994
dte_201710_d	DTE	Dual	10/1/2017	Y	Y	Y	Y							27,653	10,000
dte_201710_g	DTE	Gas	10/1/2017	Y	Y	Y	Y							72,344	10,000
dte_201711_g	DTE	Gas	11/1/2017	Y	Y	Y	Y							60,000	10,000
dte_201803_d	DTE	Dual	3/1/2018	Y	Y	Y								29,992	11,998
dte_201803_g	DTE	Gas	3/1/2018	Y	Y**	*								89,983	17,994
dte_201901_d	DTE	Dual	1/1/2019	Y	Y	*								30,941	9,985
dte_202004_d	DTE	Dual	4/1/2020	Y										129,565	39,871

[1] See Table B3 for waves excluded from calibration.

[2] Counts represent unique number of customers included in regression analysis across all years.

Source: Guidehouse analysis of customer billing data

* Program year/wave combination wholly excluded due to wave inactivity. Guidehouse counted program years from the wave start date regardless of wave activity.

** Program year/wave combination included less than 12 months of data associated with wave inactivity (see footnote 2 on slide 5).

Appendix B. Waves in Calibration Study

Table B2 presents information about the CE and SEMCO waves included in the energy savings calibration.

Table B2. Waves included in the Energy Savings Calibration[1]

Wave	Utility	Fuel	Start Date	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	Participants[2]	Controls[2]
cms_201105_d	CE	Dual	5/1/2011	Y	Y	Y	Y							50,129	24,849
cms_201203_d	CE	Dual	3/1/2012	Y	Y	Y								8,621	8,623
cms_201204_e_Musk	CE	Elec	4/1/2012	Y	Y	Y								50,574	7,000
cms_201303_e	CE	Elec	3/1/2013	Y	Y									128,077	26,197
segc_202011_g	SEMCO	Gas	11/1/2020	Y										157,807	25,000

[1] See Table B3 for waves excluded from calibration.
[2] Counts represent unique number of customers included in regression analysis across all years.
Source: Guidehouse analysis of customer billing data

Appendix B. Waves in Calibration Study

Table B3 presents information about all the waves excluded from the energy savings calibration.

Table B3. Waves Excluded from the Energy Savings Calibration

Wave	Utility	Fuel	Start Date	Participants	Controls	Reason
cms_201305_d	CE	Gas	5/1/2013	52,489	20,999	Usage was below 600 therms cutoff
cms_201204_e_bc	CE	Elec	4/1/2012	20,584	15,168	No zip codes for CDD/HDD
cms_201203_g	CE	Gas	3/1/2012	100,615	40,825	No zip codes for CDD/HDD
cms_201403_d	CE	Dual	3/1/2012	34,992	9,999	No zip codes for CDD/HDD

Source: Guidehouse analysis of customer billing data

Appendix B. Waves in Calibration Study

Table B4 presents information about all the waves included in the demand savings calibration. All other waves were excluded due to a lack of AMI data.

Table B4. Waves included in the Demand Savings Calibration

Wave	Utility	Fuel	Start Date	PY1	PY2	PY3	PY4	PY5	PY6	Participants[1]	Controls[1]
dte_201602_d	Dual	DTE	2/1/2016	Y	Y	Y	Y	*	Y	18,950	9,264
dte_201602_e	Elec	DTE	2/1/2016	Y	Y	*	*	Y	Y	16,986	9,738
dte_201606_d	Dual	DTE	6/1/2016	Y	Y	Y	Y	Y		9,218	6,462
dte_201606_e	Elec	DTE	6/1/2016	Y	Y	*	*	Y		19,669	12,811
dte_201710_d	Dual	DTE	10/1/2017	Y	Y	Y	Y			27,560	9,974
dte_201803_d	Dual	DTE	3/1/2018	Y	*	Y	Y			29,874	11,950
dte_201901_d	Dual	DTE	1/1/2019	Y	Y	*				30,850	9,943
dte_202004_e	Elec	DTE	4/1/2020	Y						129,008	39,708

[1] Counts represent unique number of customers included in regression analysis for demand savings across all years.
* Program year/wave combination excluded due to wave inactivity. Guidehouse counted program years from the wave start date regardless of wave activity.
Source: Guidehouse analysis of customer billing data