Energy Trust of Oregon 2020 Existing Buildings Evaluation Final Report

Submitted to

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Executive Summary

This report details the findings and methodology used to evaluate savings claimed in 2020 by Energy Trust of Oregon's Existing Buildings (EB) programs. Program tracks covered in this report include Lighting, Standard, Custom, and Strategic Energy Management (SEM). Findings and results are summarized below and covered in more detail in subsequent sections.

Evaluation Objectives

The objectives of this evaluation were to:

- Develop reliable estimates of EB program gas and electric savings for 2020 to establish realization rates. Realization rates are provided separately for SEM and non-SEM measures. This information will be used for future program savings projections and budget developments.
- Develop estimates of electricity demand savings at the measure category level (excluding SEM) and for the program overall (excluding SEM).
- Report observations from the evaluation and make recommendations to help Energy Trust understand substantial deviations from claimed savings, and to improve ex ante savings estimates and the effectiveness of future engineering studies and impact evaluations of Existing Buildings projects.

Methodology Overview

We used the process shown in Figure 1 to conduct the evaluation. A brief overview of each aspect of the process follows.

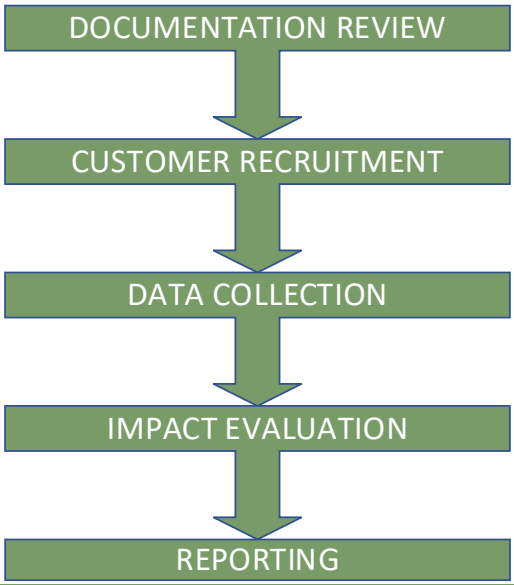

Figure 1. Evaluation Process Steps

Documentation Review

For each sampled site, we reviewed project documents supplied to us by Energy Trust. We determined whether or not sufficient documentation was present to perform an evaluation for the site. We requested any missing information from Energy Trust. We then determined the site treatment that would be used to perform data collection (desk review, virtual site visit, or physical site visit).

Customer Recruitment

Sampled customers were first contacted by the Program Management Contractor (PMC) which was TRC, Inc. for Custom, Lighting, and Standard sites and the Energy Trust SEM coaches for SEM sites. Once the sites were contacted by the PMC, we contacted the customer via email or phone, asking them to participate in the evaluation and providing specific details about data needed/interview questions.

If the customer was not willing or able to participate, we selected a replacement site. If the customer was unresponsive after three attempts at communication by us, we asked the PMC to attempt further contact. If contact was still unsuccessful at this point, we selected a replacement site, dropped the site from the sample, or performed a no-contact review.

Note that we experienced a number of recruitment challenges for the 2020 evaluation, due mainly to impacts customers experienced related to COVID-19. These challenges resulted in fewer projects evaluated as compared to the original sample. Relative precisions were also affected, but final results were still found to be statistically relevant. This is discussed further in the Findings section below.

Data Collection

For Standard and Lighting sites, we used measure-specific data collection plans developed by us and approved by Energy Trust. In most cases, these data collection plans were specific to the Measure Approval Document (MAD) governing the measure.

For Custom and SEM sites, we developed site-specific data collection plans. The overall structure of these site-specific plans was approved by Energy Trust. Additionally, Energy Trust's SEM team reviewed some site-specific data collection plans at random.

Approved data collection plans were used to conduct data collection for each site.

For desk reviews, data collection consisted of an email exchange and/or phone call with the customer to confirm data entries.

For virtual site visits, we set up a specific time with the customer to go over the project installation and any data needed. This included the customer taking photos, sending trend data, or if necessary, viewing the installed equipment with the reviewer on the phone.

For physical site visits, the reviewer travelled to the site and met with the site contact to go over project installation, view installed measures, take photos, and gather data.

In general, we found that a virtual site visit was the most efficient, allowing us the time and access necessary to obtain the required data, but without the additional time and resources required of a physical site visit. In some cases, however (e.g., large or complex projects), a physical site visit was still necessary.

Impact Evaluation

We developed evaluation workbooks to be completed by the reviewer for each site. The workbook was used to record all findings, estimate savings at the site, calculate the site level realization rates, and record reasons for any differences between claimed and evaluated savings.

The reviewer used project documentation and assembled data from the site to complete the evaluation workbook. A more senior engineer then performed a quality control (QC) check of the site evaluation. Once the QC check was completed the results for the site were considered final.

Reporting

We developed a system to report results at the sample and population level. This included a project database containing entries for each completed site evaluation and a series of scripts to combine results, extrapolate them to the population level, and to report out various aspects of the evaluation such as results by measure type, building type, patterns observed, etc.

Evaluation Results

This section presents a brief summary of the results. We provide a summary of results of the 2020 evaluation followed by a discussion of historical results as compared to 2020. A more detailed treatment of findings and results is presented in subsequent sections.

Summary of 2020 Evaluation Results

Table 1 and Table 2 show a summary of evaluation results by program track for each fuel (electric and gas). Program tracks are grouped by Capital (non-SEM) and SEM. This includes number of sampled measures/projects and total energy savings for both the population and sample, resulting realization rates, and relative precision of each track in the sample.

Overall, the electric realization rate was close to 1 at 0.98, with the Standard track being the highest (1.18) and the SEM track the lowest at 0.73.

Table 1: 2020 Electric Energy Savings and Realization Rates

Program Track	Electric Frame							
	Unique Measure Count	Unique Project Count	Evaluated Project Count	Population Claimed Savings (kWh)	% Savings Sampled	Population Evaluated Savings (kWh)	Realization Rate	Relative Precision @ 90% Confidence
Standard	788	711	22	7,314,502	22	8,646,480	1.18	28.3

Program Track	Electric Frame							
	Unique Measure Count	Unique Project Count	Evaluated Project Count	Population Claimed Savings (kWh)	% Savings Sampled	Population Evaluated Savings (kWh)	Realization Rate	Relative Precision @ 90% Confidence
Custom	145	106	18	14,107,041	60	12,854,743	0.91	15.1
Lighting	6,055	2,456	28	61,887,995	7	63,199,740	1.02	29.6
Capital	**6,988**	**3,273**	**68**	**83,309,538**	**17**	**84,700,963**	**1.02**	**22.4**
SEM	**285**	**285**	**40**	**12,792,774**	**50**	**9,377,044**	**0.73**	**14.6**
Grand Total	**7,273**	**3,558**	**108**	**96,102,312**	**22**	**94,078,008**	**0.98**	**20.2**

The overall gas realization rate was also close to 1 at 0.94. The Standard track had the highest realization rate at 0.99, with the Custom track being the lowest (0.90).

Table 2: 2020 Gas Energy Savings and Realization Rates

Program Track	Gas Frame							
	Unique Measure Count	Unique Project Count	Evaluated Project Count	Population Claimed Savings (Therms)	% Savings Sampled	Population Evaluated Savings (Therms)	Realization Rate	Relative Precision @ 90% Confidence
Standard	755	682	29	602,151	27	598,998	0.99	8.0
Custom	132	93	13	557,788	47	503,821	0.90	17.6
Capital	**887**	**775**	**42**	**1,159,939**	**36**	**1,102,819**	**0.95**	**9.1**
SEM	**269**	**269**	**33**	**371,699**	**52**	**340,759**	**0.92**	**18.6**
Grand Total	**1,156**	**1,044**	**75**	**1,531,638**	**40**	**1,443,579**	**0.94**	**8.2**

Figure 2 and Figure 3 show in graphical form the population-level realization rates by domain. Plotted circles within each domain represent sampled measures. The size of each circle represents the magnitude of claimed savings. Realization rate is shown by the circle's position on the y-axis. The error band is shown in red around the domain's realization rate (depicted as a red dot). The error band is a graphical representation of the relative precision of the domain's realization rate.

As can be seen in Figure 2, in the electric sample we found the highest realization rate (3) for a project in the Standard domain. We identified a number of projects on the electric side with realization rates of zero, most of which were found in the SEM and Lighting domains. All DI Lighting projects had a realization rate of 1. Most Midstream Lighting projects had a realization rate of either 1 or 0, with one exception around 0.50. Realization rates were more varied for other tracks. Note that error bands are larger for domains with more variance in project realization rates (eg. Midstream Lighting).

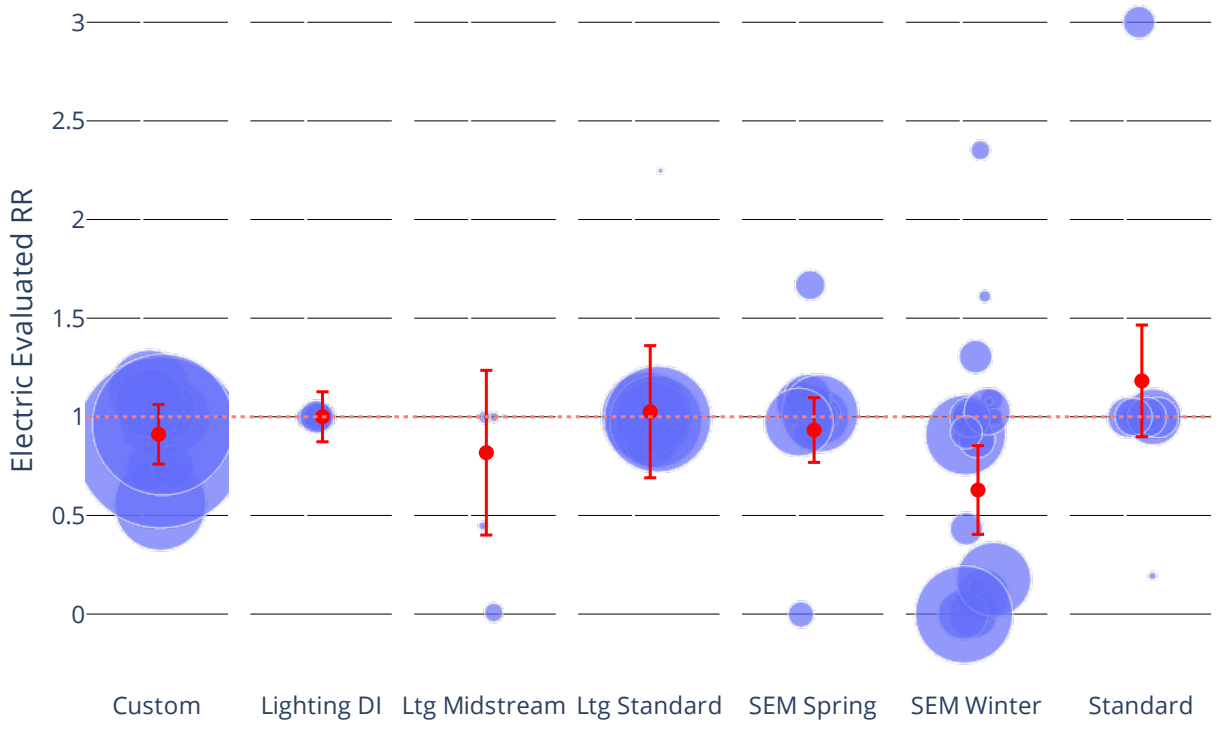

Figure 2. Electric Energy Savings Realization Rates by Domain

Figure 3 shows results for the gas sample. Most Standard projects had a realization rate at or near 1. Realization rates for other gas domains were more variable. Realization rates of zero were found mainly in the SEM Winter Group with a few in the Custom domain. Similar to the electric sample, error bands for domains with larger variability in project realization rate were larger (e.g., SEM Winter Group).

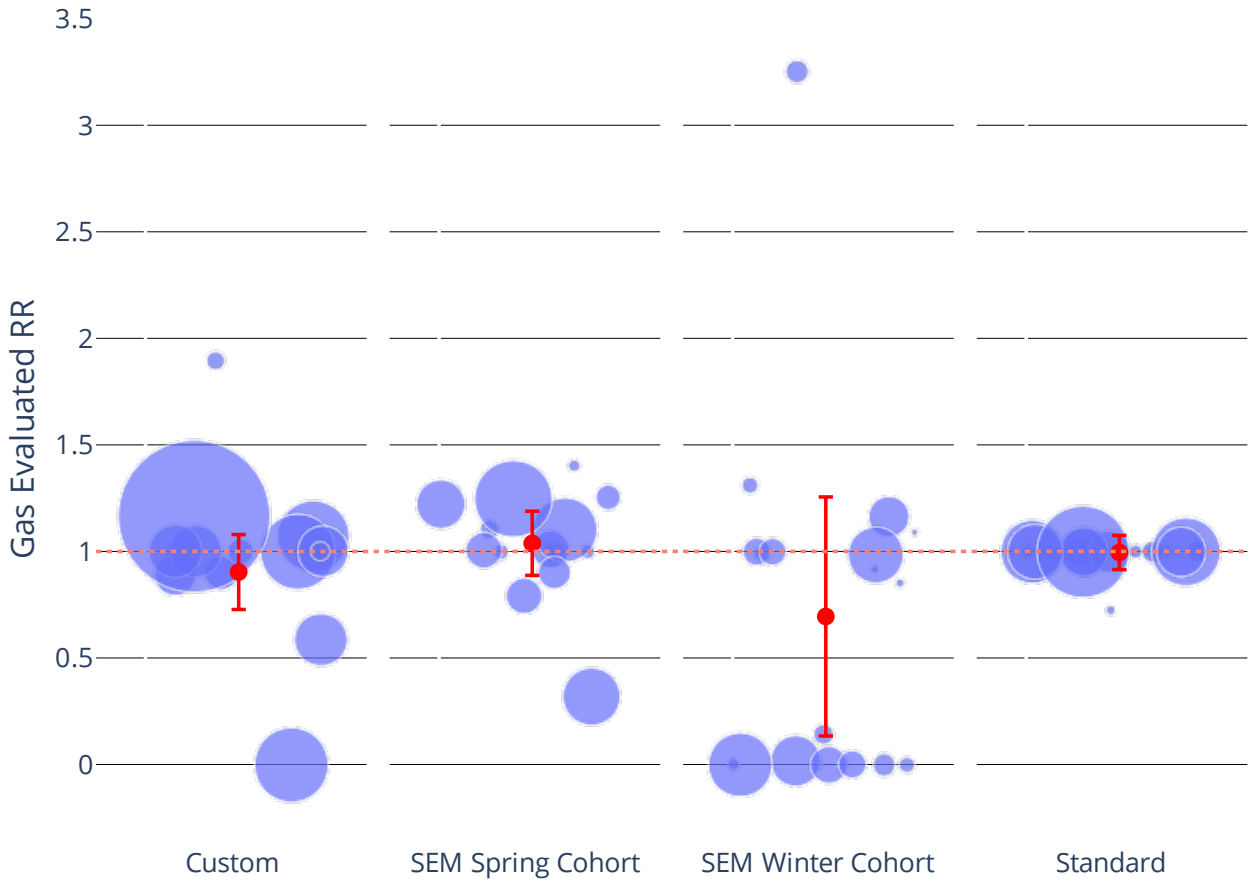

Figure 3. Gas Energy Savings Realization Rates by Domain

Table 3 shows a summary of kW demand savings results by program track. Demand savings were calculated for all non-SEM evaluated projects. To calculate demand savings, we used Energy Trust-supplied electric load profiles for non-hourly calculations and peak period definitions for hourly (Custom) calculations. We evaluated demand savings for both the summer and winter peaks.

Demand savings realization rates are shown together with kWh savings realization rates for comparison. Demand savings realization rates varied mainly due to variance in kWh savings and/or the use of the hourly peak period demand savings calculations in lieu of electric load profiles where appropriate. Custom had the smallest realization rates for both gas and electric, due primarily to changes in kWh savings during peak periods.

Table 3: Comparison of Electric Energy and Demand Savings Realization Rates

Program Track	kWh RR	Summer kW RR	Winter kW RR
Standard	1.18	1.02	1.45
Custom	0.91	0.86	0.92
Lighting	1.02	1.02	1.02

Program Track	kWh RR	Summer kW RR	Winter kW RR
Overall	**0.98**	**0.91**	**1.10**

Discussion of Historical Results

The following figures display historical evaluation results (total energy savings and realization rate) by year from 2008 to 2019 together with 2020 (the results of this evaluation). Results are shown separately for electric and gas, and for SEM and non-SEM program tracks.

The figures indicate the following:

- Non-SEM electric savings (Figure 4) shows an overall upward trend in total energy savings over time but with a significant drop in 2020. The realization rate is relatively steady in recent years at close to 1.

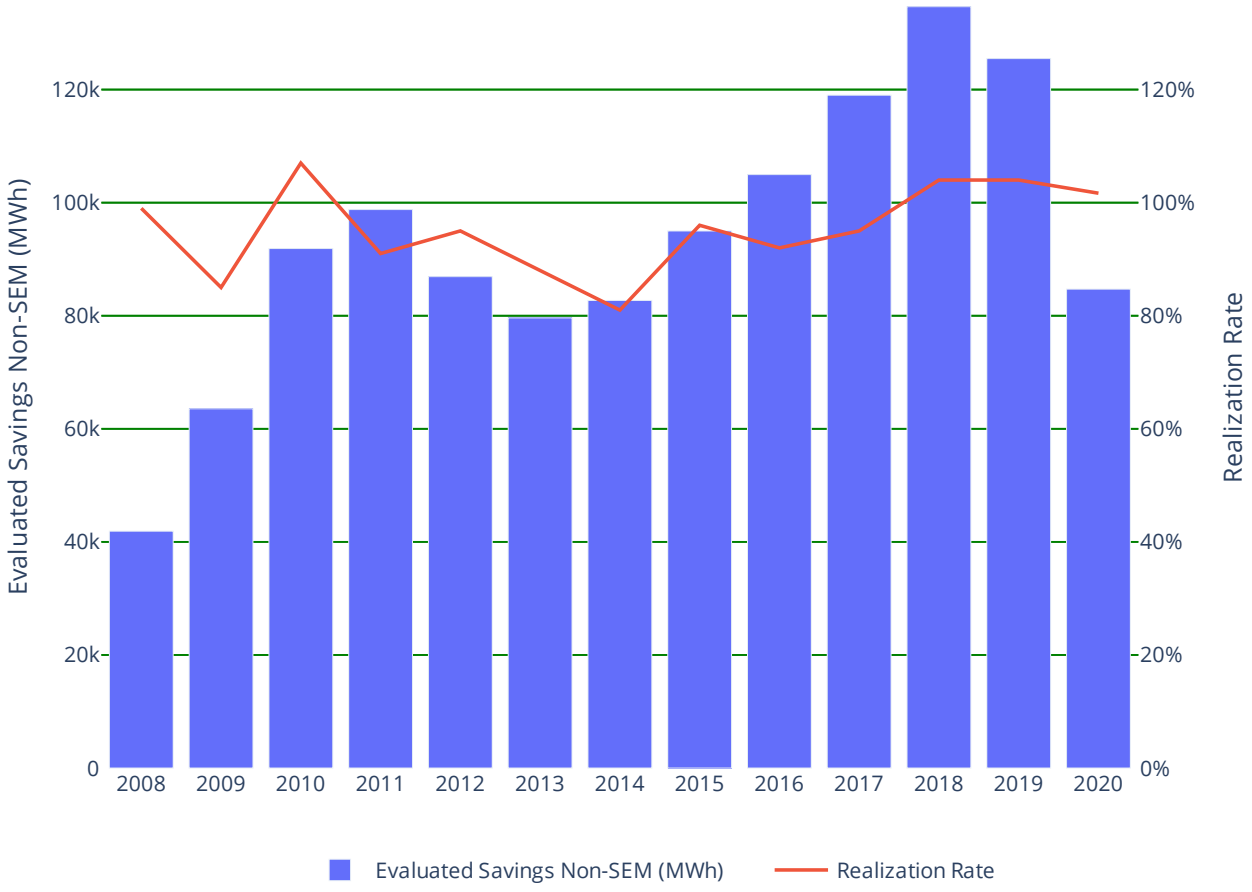

Figure 4. Historical Non-SEM Electric Energy Savings Evaluation Results

- The non-SEM gas savings trend is somewhat flat over time (Figure 5), with a realization rate lower than non-SEM electric but trending upwards (this upward trend continued for 2020).

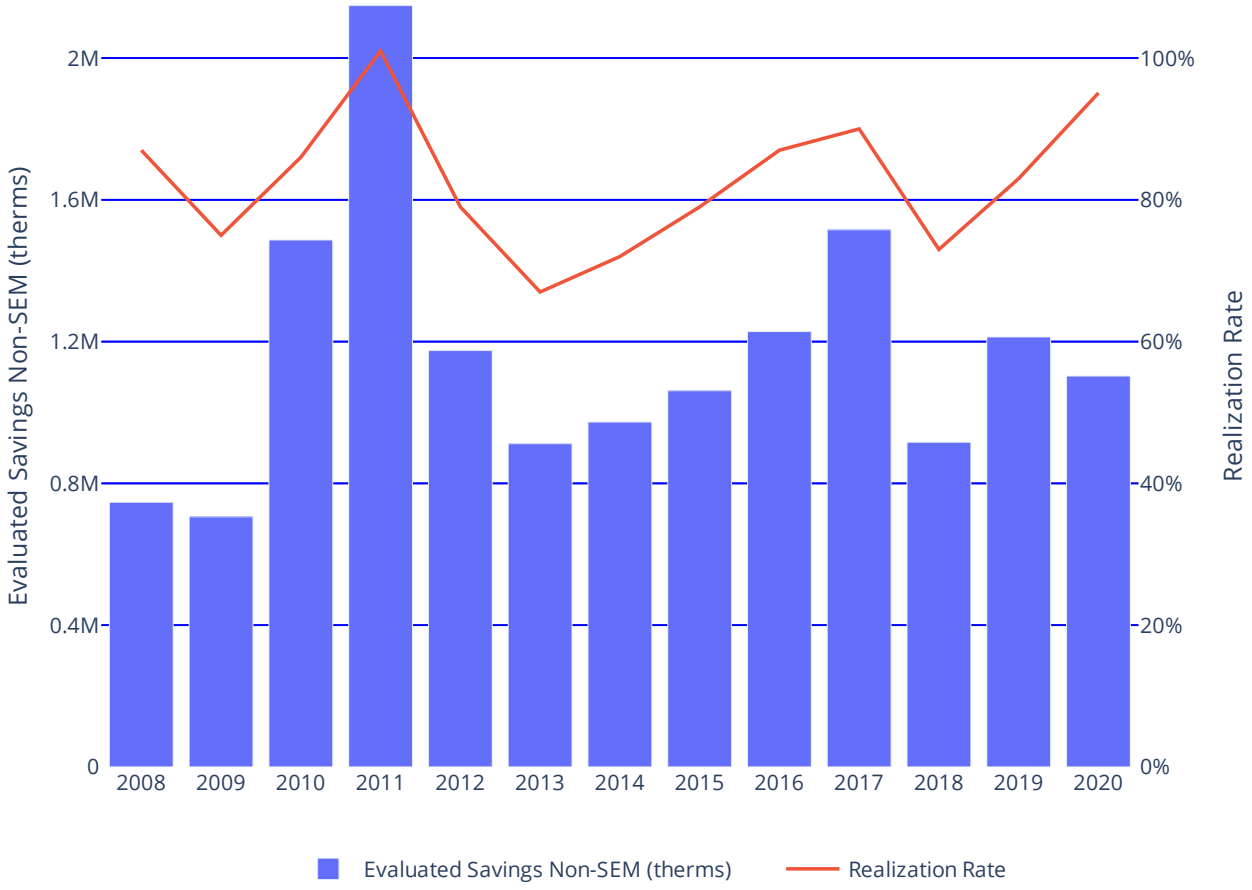

Figure 5. Historical Non-SEM Gas Energy Savings Evaluation Results

- SEM electric savings (Figure 6) show a significant increase after 2017 with a steady realization rate near 1 between 2014 and 2019. 2020 saw a notable decrease in realization rate. A downward trend in savings is also apparent between 2018 and 2020.

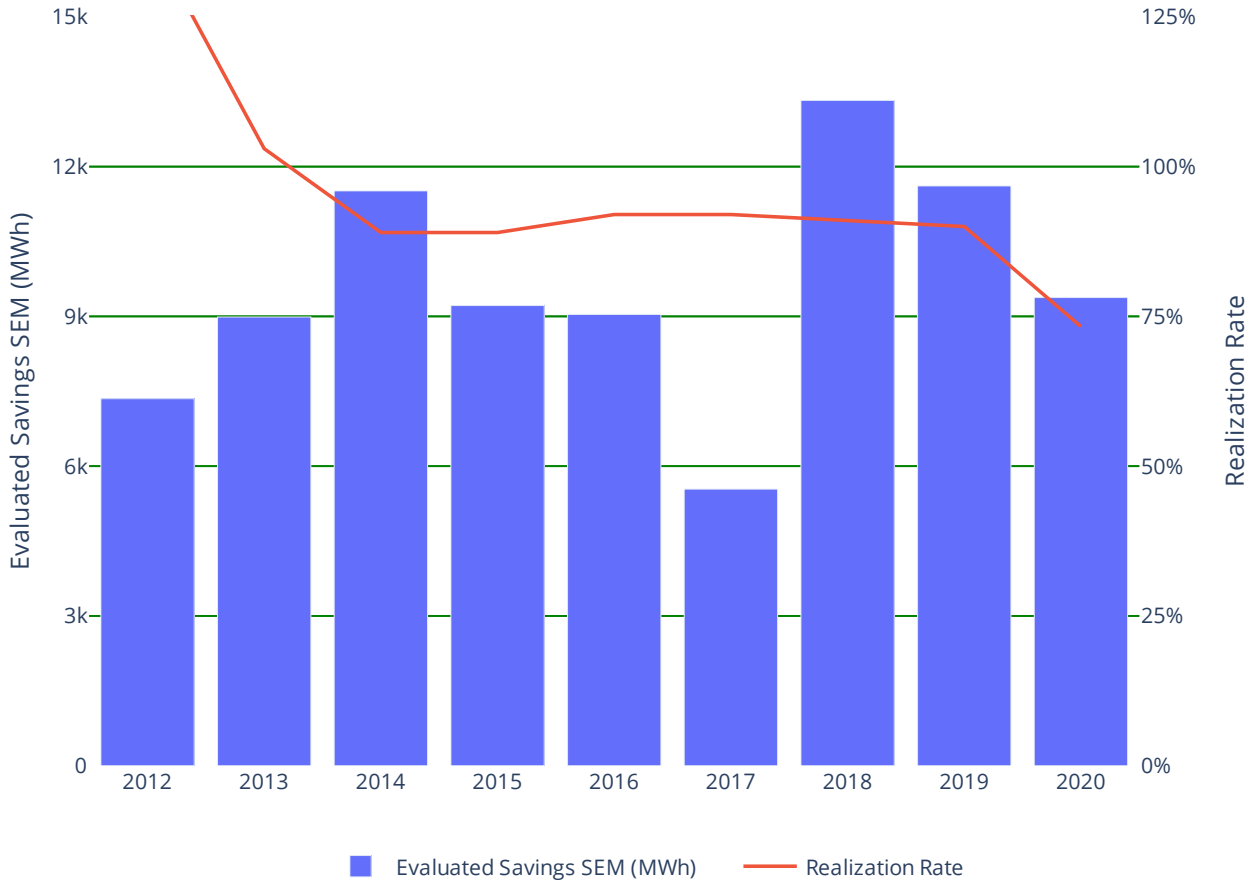

Figure 6. Historical SEM Electric Energy Savings Evaluation Results

- SEM gas savings (Figure 7) does not show a clear trend over time. Realization rate has been somewhat volatile with an average near 1. The realization rate remained near 1 for 2020, but gas savings decreased relative to 2018-2019.

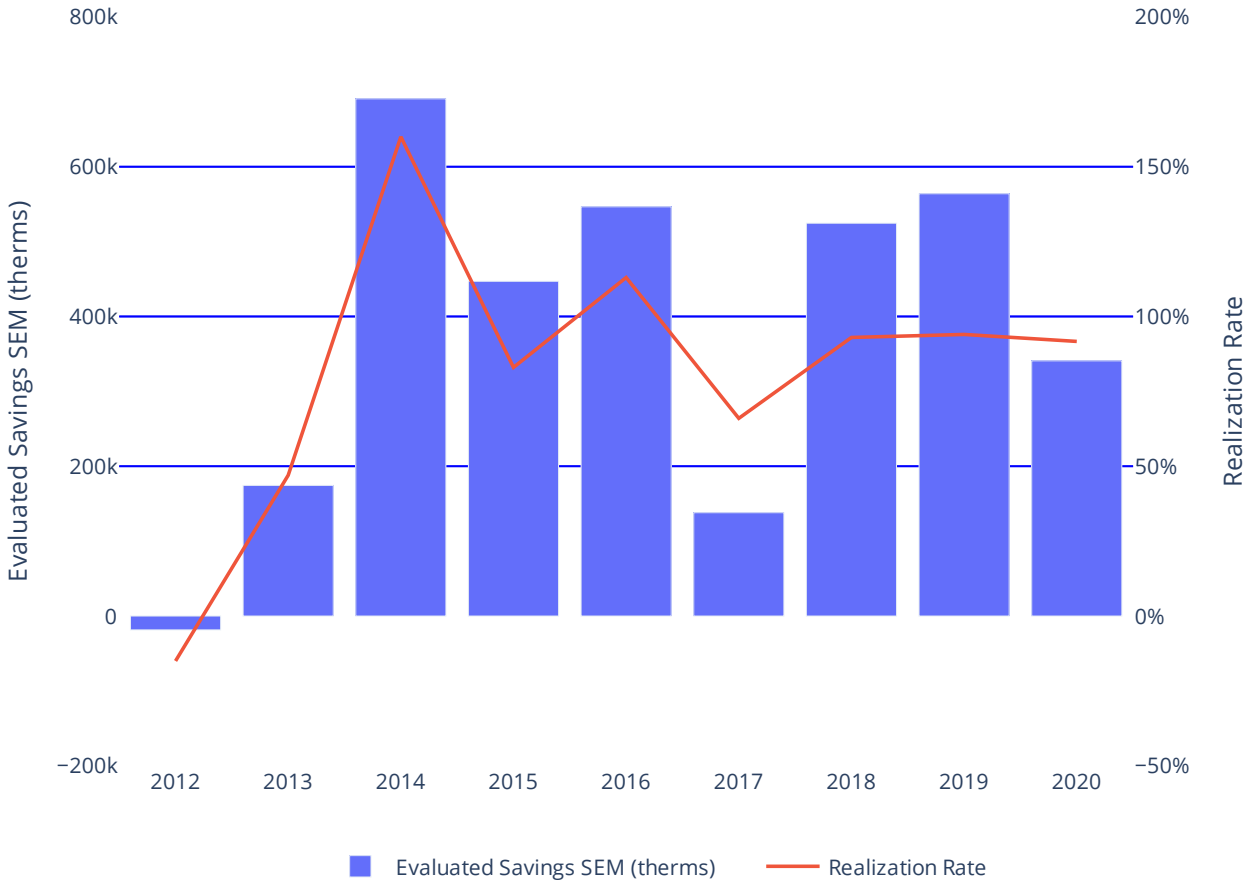

Figure 7. Historical SEM Gas Energy Savings Evaluation Results

Memo

To: Board of Directors

From: Sarah Castor, Evaluation & Engineering Manager
Wendy Gibson, Sr. Program Manager – Commercial
Kathleen Belkhayat, Program Manager – Commercial

cc:

Date: December 9, 2022

Re: Staff Response to the 2020 Existing Buildings Impact Evaluation

The 2020 Existing Buildings Impact Evaluation assessed the performance of projects claimed in the 2020 program year in the program's four main tracks: Custom, Lighting, Standard and Strategic Energy Management (SEM). The program management contractor (PMC) for 2020 was ICF International, with delivery of the lighting track subcontracted to Evergreen Consulting Group (program delivery contractor, or PDC). The results of the evaluation show that the program performed well in 2020, despite many challenges due to the COVID-19 pandemic. While 2020 savings were lower than some previous years, particularly for electricity, overall program realization rates were high, at 98% for electricity and 94% for natural gas.

Due to changes in building occupancy and operations during the pandemic, SEM used an alternative method of claiming savings for Winter group participants, rather than using estimated savings from energy models. This alternative method overstated electric savings on average, which resulted in an electric realization rate for the SEM track of 73%. Given the need to quickly pivot away from using energy models in 2020 and the inability to predict the wide-ranging effects of the pandemic, the program did the best it could to estimate savings. The program updated the alternative SEM savings methodology for 2021 and it will be evaluated in the next Existing Buildings impact evaluation, to be completed in 2023. The program plans to transition back to using energy models to claim savings by the end of 2023.

The evaluation encountered challenges in recruiting participants to provide information for evaluation due to turnover or loss of participant staff and a surge of COVID-19 cases in late 2021 and early 2022. Reduced participation in evaluation made evaluation results slightly less precise than we wanted. To address this, we revised the recruitment processes and protocols for the 2021 Existing Buildings Impact Evaluation and began data collection earlier in Q4 2022.

The evaluation confirmed that in 2020, the Existing Buildings program was generally accurate in its savings estimation, while noting that project documentation was often incomplete or inaccurate. There were no recommendations for major changes to the program. The Existing Buildings program will continue to explore ways to optimize its project documentation.

At the beginning of 2021, the program management contract was transitioned to TRC, with CLEAResult taking over as the PDC for Business Lighting (which also serves industrial customers). The 2021 impact evaluation, which is currently underway, will assess the performance of these contractors in estimating savings and documenting projects.

1 Background

1.1 Existing Buildings Program Overview

In 2020, the Existing Buildings (EB) program had four main program tracks:

- **Custom.** Custom track projects have their savings estimated through energy studies conducted by Allied Technical Assistance Contractors (ATACs). These studies involved engineering calculations (e.g., Excel workbooks) and/or energy simulation modeling (e.g., eQUEST, TRACE700, etc.).
- **Lighting (prescriptive and semi-prescriptive) measures including:**
  - Standard Lighting
  - Direct Install (DI) Lighting
  - Midstream/Buydown Lighting
  - Street Lighting (not sampled for this evaluation)

  Lighting track measures were installed directly by trade allies, while direct-install lighting measures were installed by a trade ally subcontractor to SmartWatt, under subcontract to the Program Management Contractor (PMC).

  Lighting track measures are specified in Energy Trust Measure Approval Documents (MADs).
- **Standard (prescriptive).** Standard track measures used savings estimates from reliable sources (including the Regional Technical Forum, ENERGY STAR, and others). Similar to Lighting track measures, Standard track measures are specified in Energy Trust MADs.
- **Strategic Energy Management (SEM).** SEM provides tools and education to help businesses understand their building energy use and identify and eliminate energy waste. SEM engagements last about a year and participants have the option of re-enrolling annually. SEM participants are divided into a Spring and a Winter Group. SEM savings are typically estimated based on a top-down analysis of building-level energy use and do not include savings from capital measures completed at the site through other program tracks during the SEM engagement. Savings for the Spring Group in 2020 were claimed using these typical methods. Due to COVID-19-related disruptions to building operations, savings for most of the Winter Group were assigned based on a projection of savings based on the first five months of engagement (which were unaffected by COVID-19). For Winter Group participants in their first year of engagement, who did not have sufficient data to project savings for the year, the program claimed savings based on a market segment average savings rate from prior years of program data. The program used a site-level savings rate cap for all participants to mitigate the risk of over-claiming savings.

Note that all non-SEM projects are referred to as "Capital" projects in this report. This includes the following:

- Non-SEM projects completed at non-SEM participant sites. These projects make up the bulk of the non-SEM sample for the evaluation.
- Non-SEM projects completed at SEM participant sites, but completed outside the SEM program as part of another program. Note that all capital projects completed at sampled SEM participant sites were evaluated to adjust SEM project savings appropriately. Some of these SEM capital projects are also in the non-SEM sample as well.

A few other tracks and pilots were maintained by the EB program during this time. These represented a small portion of program participants and savings and were therefore excluded from the scope of this evaluation.

1.2 Evaluation Objectives

The objectives of this evaluation were to:

- Develop reliable estimates of Existing Building (EB) program gas and electric savings for 2020 to establish realization rates. Realization rates are provided separately for SEM and non-SEM measures. This information will be used for future program savings projections and budget developments.
- Develop estimates of electricity demand savings at the measure category level (excluding SEM) and for the program overall (excluding SEM).
- Report observations from the evaluation and make recommendations to help Energy Trust understand substantial deviations from claimed savings, and to improve ex ante savings estimates and the effectiveness of future engineering studies and impact evaluations of Existing Buildings projects.

2 Evaluation Methdology

This section covers in detail the methodology and procedures used to evaluate each track (Lighting, Standard, Custom, SEM). We first developed a Sampling Plan to generate the sample for the evaluation. We then evaluated each sampled project following these steps:

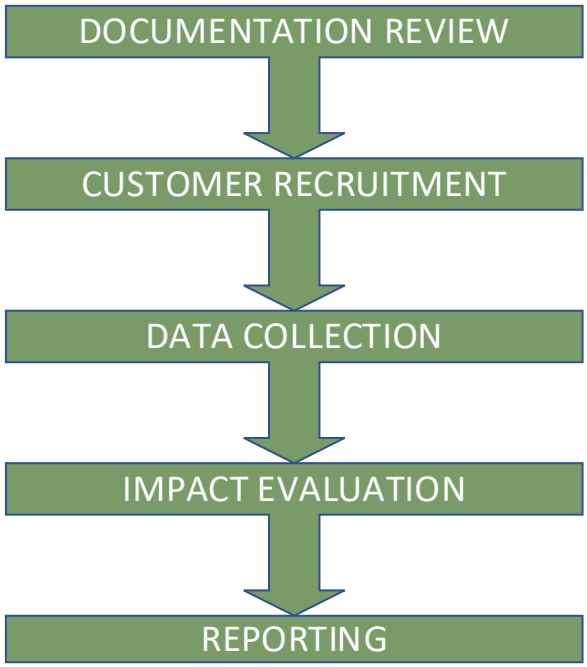

Figure 8. Evaluation Process Steps

2.1 Sampling Plan

We developed the sample design by first creating a sample frame from the 2020 program tracking data provided by Energy Trust. Energy Trust has multiple objectives for the sample design. One objective was to achieve reliable electric and gas savings estimates and realization rates separately for SEM and non-SEM measures. Another was to develop electricity demand savings estimates at the program track level, excluding SEM.

Our plan for accomplishing the first objective was as follows:

- **Create separate lists of projects.** One list contained all projects with electric energy savings. The other contained all projects at sites with gas savings. The sample unit was by project, except SEM which was by site. A project may have multiple measures and/or both gas and electric savings. A site may have multiple projects, or a project may be across multiple sites, like SEM. After the sample was drawn, the list was organized by site to minimize the burden on the customer.
- **Certainty selections of large savers.** Within each fuel and domain, we identified the projects with the largest savings and selected those with certainty. This ensured that the sites sampled accounted for a large fraction of the total savings claim for the domain.

- **Sampling projects.** For the remaining projects in each fuel and domain we developed an optimal stratification design. Strata were defined based on the program estimate of savings. We defined these strata using the Dalenius and Hodges method. A Neyman allocation was used to determine an optimum sampling fraction for each stratum and was informed by error ratios provided in the previous Existing Buildings evaluation. For selected SEM sites, we evaluated all capital projects implemented during the performance period[1]. Additional projects were selected at random to allow for replacements, if needed.

This sample plan was designed to achieve 10% precision at 90% confidence in estimating savings and realization rates separately for SEM and non-SEM domain projects by fuel.

Table 4: Sample Summary

Track/Domain	Sample Size				Precision @ 90% Confidence	
	Electric	Gas	Total Unique Projects	Total Unique Measures	Electric	Gas
DI Lighting	11	0	11	55	13%	
Midstream Lighting	9	0	9	12	32%	
Standard Lighting	11	0	11	53	23%	
Lighting	**31**	**-**	**31**	**120**	**20%**	
Standard Other	**22**	**29**	**50**	**61**	**9%**	**10%**
Custom	**23**	**19**	**37**	**61**	**10%**	**10%**
Spring Group	21	16	34	34	15%	14%
Winter Group	30	21	47	47	13%	13%
SEM	**51**	**37**	**81**	**81**	**10%**	**10%**
Overall	**127**	**85**	**199**	**323**	**13%**	**6%**

Note that Street Lighting measures under the Lighting Track were not sampled for this evaluation due to the small number of measures (and associated savings) completed in 2020 as well as historically high realization rates for this lighting domain.

The SEM sample design comprised 45 unique SEM customers with the majority of those customers having at least two sites in the electric and/or gas sample. The intent was to allow us to provide evaluation feedback at the customer level, in addition to the site level.

For the second objective, we calculated demand savings from peak coincidence factors provided by Energy Trust.

[1] Only SEM capital projects that were also sampled in other domains are included in evaluation results for their respective domains.

The final sample frame was used to initialize the program evaluation database and track each sampled project throughout the evaluation process.

2.2 Customer Recruitment

This section details procedures for recruiting customers to participate in the evaluation. The goal of the recruitment process was to recruit customers efficiently while avoiding undue hassle to the customer and minimizing dropped sites.

The recruitment process proceeded as follows:

- SBW provided Energy Trust and the Program Management Contractor (PMC) the final sample detailing all primary sites to be evaluated.
- The PMC reviewed the customer contact information for sampled sites in the program tracking database and made changes as necessary to ensure the best available contact information to support recruitment.
- SBW drafted email introductions to be used by the PMC for the first contact with each site. This email established the importance of this work and Energy Trust/PMC/SBW role in performing the work. It also introduced SBW as the evaluation contractor.
- Once the sample was finalized, the PMC used the email introduction provided by SBW to contact each of the sampled sites and cc SBW on the communication.
- SBW notified the PMC when we were ready to begin initial contacts.
- The PMC identified customers for which there was a sensitive relationship. In these cases, the PMC or Energy Trust was more directly involved in the recruitment process. If the PMC/Energy Trust was unable to assist in recruitment in these cases, SBW obtained permission from Energy Trust to attempt recruitment.
- SBW called or emailed the appropriate site contact to recruit the customer for the evaluation. The target for this communication was within one week of first contact by the PMC. At this stage we attempted to confirm that the customer was able to provide a person that was knowledgeable about the measure(s). If successful, for the sampled measures requiring site visits, we also attempted to determine the most appropriate contact for the site visit (virtual or in-person). This step was targeted to be completed within three weeks of first contact by the PMC.
- If the recruitment was not successful, we considered replacing the sampled case with another case from the same stratum in the sample. For this particular evaluation, the number of unresponsive customers was such that we dropped many from the sample. The recruitment was considered unsuccessful under the following conditions:
  - The customer refused to participate.
  - A person with adequate knowledge of installed measures could not be confirmed.

- Reasonable access to the measure was needed but was not possible.
- The customer did not respond to repeated communication attempts. In this case, SBW attempted communication at least twice. If the customer did not respond, we asked the PMC to attempt to contact the customer. If the customer did not respond to the PMC's attempt, we considered the recruitment unsuccessful.
- In cases where recruitment was unsuccessful, we dropped the site from the sample and added a replacement site or performed a no-contact review where reasonable. If neither of these solutions was possible, we dropped the site without review or replacement. As the latter would result in a reduced sample, we discussed this with Energy Trust before proceeding.

We worked closely with Energy Trust and the PMC to avoid dropping and replacing sites to minimize non-response bias.

2.3 Documentation Review

We assigned a lead analyst and QC engineer to each sampled site. The lead analyst was given primary responsibility for both data collection and analysis of gross savings. The QC engineer was a more experienced member of the team responsible for advising the lead analyst and reviewing evaluation results for the project.

Energy Trust provided electronic copies of the project files. For custom measures, Energy Trust also provided electronic versions of the savings calculation spreadsheets, simulation input/outputs and other information to support the program savings estimate. The spreadsheets and simulation inputs/outputs were checked to ensure they were in a form that allowed us to easily reproduce the program estimate of expected energy savings. Projects that had major documentation issues or other issues that could impede the evaluation of savings were dropped from the sample and replaced, but we worked closely with Energy Trust to minimize this so that bias did not become an issue.

The documentation review had the following goals:

- Determine if there were any issues with the provided data such as missing documents, mis-matched model files, or other issues that would hinder the evaluation. We worked with Energy Trust staff, PMCs, Allied Technical Assistance Contractors (ATACs), and SEM coaches as necessary to resolve any issues found. If issues could not be resolved, we proceeded in the same way as for sites with unsuccessful recruitments (see recruitment process above).
- Identify data needed to complete evaluation for each track (Lighting, Standard, Custom, SEM). For Custom and SEM tracks, we developed site-specific data collection plans.
- For each site, we determined whether it would be treated via a desk review, virtual site visit, or physical site visit.

Track-specific aspects of documentation review are discussed in the following sections.

2.3.1 Documentation Review: Standard/Lighting Tracks

The Standard and Lighting tracks include measures of lower complexity. Measures for these tracks are typically defined as Prescriptive (using deemed values to define savings) or Semi-Prescriptive (using a simplified calculator with a few inputs to calculate savings). Both Prescriptive and Semi-Prescriptive measures are defined in Energy Trust Measure Approval Documents (MADs).

The reviewer was instructed to follow a documentation checklist developed based on the measure's related MAD. The reviewer checked to ensure all information necessary to recreate savings inputs as required in the MAD were present (e.g., quantity/type of installed units, equipment efficiency, size, etc.).

2.3.2 Documentation Review: Custom Track

Custom track projects typically include whole building energy models (eQUEST, EnergyPlus, TRACE 700 or equivalent) or custom Excel spreadsheet calculations. They tend to be more complex and require a higher level of rigor. Reviewers followed a documentation checklist developed for this track with a specific emphasis on energy model methodology and inputs. This included the following:

- Check of justification for all model inputs.
- If default inputs were used, check of justification.
- Check of model files provided to allow the reviewer to run the model and reproduce the documented savings.
- Check that weather files were provided if applicable.
- Check that necessary information was provided to calculate demand savings.

2.3.3 Documentation Review: SEM Track

We checked to see if SEM track projects included a model for each affected site. If not, we asked Energy Trust if a model could be provided or if another means was used to claim savings. The reviewer followed a documentation checklist developed for this track. This included the following:

- Documentation should include accounting of non-routine events (NRE's) or capital projects installed during baseline and reporting periods.
- All meters used in the modeling should be identified with meter and account numbers.
- Any weather data used should be provided.
- Regression models should be provided in a form that allowed the reviewer to reproduce documented savings.

- The baseline and reporting periods should be defined.

2.3.4 Site Treatment

As part of the documentation review for each site, the lead analyst and QC engineer assessed whether the information and data in the project documents, along with a phone interview, was sufficient to reliably calculate savings without a site visit. If a site visit was needed, we determined if a virtual site visit was sufficient, or if a physical site visit should be performed. The following criteria were used to determine if a virtual/physical site visit was needed:

- Measures could not be verified/measured with existing project documentation and site contact interview alone.
- The project was highly complex.
- Large savings was present, in particular those large enough to be in the certainty strata of the sample design.

We reserved physical site visits for sites requiring the highest level of rigor as defined by the flowchart in Figure 9.

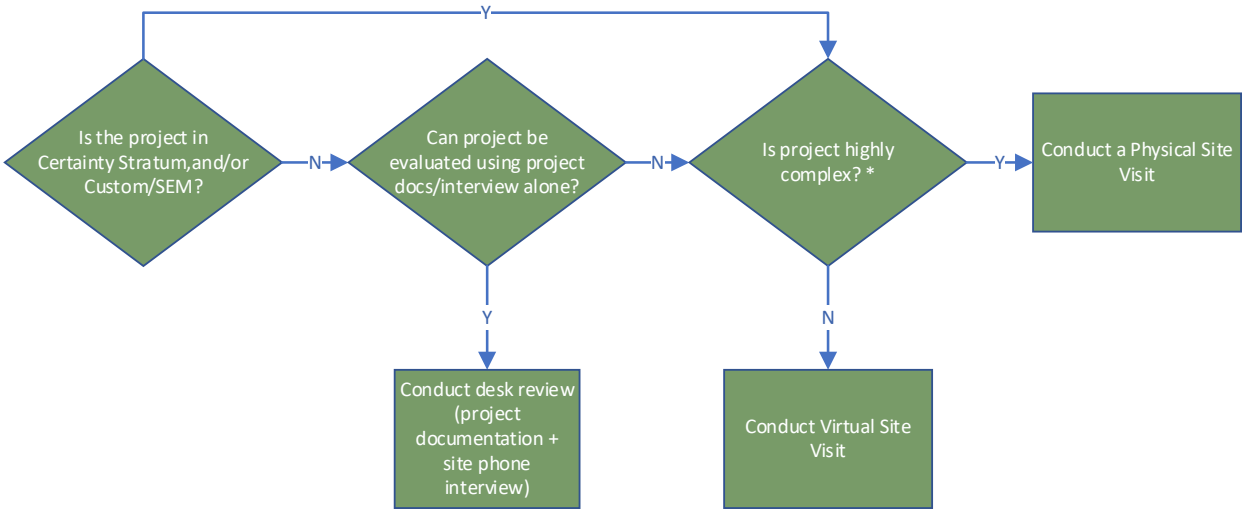

Figure 9. Determination of Site Treatment

* Highly complex projects were defined as having multiple complex systems/measures requiring large number of inputs (e.g., central plants or multiple interacting systems, interactions with renewable energy sources, etc.). Complexity was defined by the lead analyst (and confirmed by the QC engineer) using engineering judgment.

Desk Reviews

For those sites identified as needing Desk Review only, we collected data through phone/email interviews with the site contact or other site personnel and information contained in project

documentation. The information was organized for use in re-estimating savings. Special attention was placed on understanding and documenting post-installation changes in operating parameters and associated assumptions, and the implication of these changes on the estimates of energy savings. If the evaluation values were significantly different than the program values, we investigated to determine the reasons for the differences.

Virtual Site Visits

Virtual site visits included aspects of the Desk Review with the addition of photos and/or a video tour of the installed measures and any areas of the site that pertained to the evaluation of installed measures. We coordinated with site personnel before the virtual visit to develop a virtual site visit agenda. A checklist was developed detailing the aspects of the site that we needed to view, and this list was shared with the site personnel prior to the virtual site visit. We anticipated that the customer would take photos and/or conduct the video tour using their own equipment/mobile devices. If devices were not available for a video tour, we explored alternatives including sending equipment on-site, or switched to a physical site visit.

Physical Site Visits

Physical site visits included all aspects of the Desk Review with the addition of a visit to the site. For in-person visits, we coordinated with site personnel to plan the visit. This included time for an interview and a checklist of all items to be viewed during the visit. We also discussed any access requirements with site personnel beforehand (including customer's COVID restrictions), any need for gathering trend data from the control system, and any need for on-site metering setup and retrieval. We finalized the visit plan with the site contact prior to visiting.

2.4 Data Collection

This section describes the processes and procedures we used to plan and conduct data collection and interviews to support the impact evaluation.

2.4.1 Data Collection Guide

The Data Collection Guides were developed to contain all information needed to conduct an evaluation for all measures present at each sampled site to determine current state of installed measures, information on facility operation, and program participation. A data collection guide specific to each track was developed (Lighting, Standard, Custom, SEM) as well as sections specific to each method of evaluation (desk review, virtual site visit, physical site visit). Site-specific guides were written for the Custom and SEM tracks.

Each data collection guide included three program-related questions to be asked of all participants to aid in answering Energy Trust-provided research questions. The questions asked were:

- "Did you receive a bonus incentive in 2020 due to the COVID-19 pandemic, and if so, what influence did the bonus have on your decision or ability to complete your project?"

- "Were there any impacts to your facility in 2020 due to the COVID-19 pandemic (occupancy or schedule changes, changes in operation or project installation, etc.)? If so, how long do you expect these changes to persist?"
- "What influence did the energy efficiency incentive you received from Energy Trust have on your decision or ability to complete your project?"

Aspects of the data collection guide for each track/site included the following:

2.4.1.1 Lighting/Standard Tracks

For Lighting and Standard tracks, the data collection guide was a collection of checklists detailing data needs by measure type/MAD. It detailed the level of rigor and list of data elements to be gathered for each measure type as well as interview questions for facility managers/staff, and whether or not a site visit was needed. All Lighting/Standard track evaluations were done via desk review.

2.4.1.2 Custom/SEM Tracks

For Custom/SEM, the guides detailed elements needed to inform rigor level and collection plans specific to each project. A higher rigor level was expected for these projects and data collection included trend data, utility bills, weather data, and on-site metering as required. We expected most of these to require a virtual or physical site visit.

Custom Track

For Custom sites using energy models, the data collection plan included all information necessary to complete an energy model of the facility for both the pre- and post-installation cases. This information was used to update the existing model and included data for building envelope, lighting systems, HVAC systems, process systems, plug loads, renewable energy generation, and any other elements needed to inform model inputs as needed.

SEM Track/Regression Models

Data sufficient to generate a regression model was gathered, including baseline and reporting period weather data and meter use data for each affected fuel at the most granular level available. We focused significant data-gathering efforts on NRE detection and definition. Non-SEM capital projects that were implemented during the evaluation reporting year were evaluated separately so that savings could be accounted for appropriately.

For all tracks, data collection guides were used to generate a data collection workbook specific for each project. These workbooks were used by the analysts to record data gathered and results of the evaluation. The workbooks were also used to compile evaluation data together.

A sample of project-specific SEM plans were shared with Energy Trust staff for review/approval prior to finalization.

2.4.2 On-Site Measurements/Metering

If necessary, we planned for one-time measurements to be taken on site (e.g., power readings, temperature readings, etc.) during physical site visits. We also planned to request site personnel to take measurements if reasonable. Note that for this evaluation we did not find it necessary to use our own measurements/logging for any of the sampled projects.

Trend logging data was obtained by capturing trend logs from customer control systems. In these cases, specific parameters to be measured/metered were specified in the site-specific data collection plan.

2.5 Impact Evaluation Methodology

The purpose of these procedures was to analyze gross savings for each sampled measure and to use these results to estimate gross savings and realization rates at the program/track level. This was accomplished as follows.

- **Review program algorithms.** For Custom and SEM tracks, we began the analysis task by examining the program algorithms associated with the sampled measures. We did not attempt to review standardized algorithms used for the Standard/Lighting tracks as these are approved by Energy Trust separately. We took advantage of the knowledge available from Energy Trust Planning and Program and PMC staff if we had questions about savings estimation methods. In a few cases we contacted the ATAC directly after obtaining permission from Energy Trust. We documented the results of each review, and reported recommendations for improvements (if any) to the algorithms that would increase the accuracy of the gross savings estimates. If we found algorithms that were substantially inaccurate, we noted these in the review workbook.
- **Re-estimation of measure-level gross savings.** Algorithms for estimating savings were adjusted for any substantial inaccuracies as described above. Baseline and as-built inputs to these algorithms came from our field data collection, including as appropriate, trend logging and energy usage data. For some sites, where measure savings were large compared to billed energy use, we used billing regression techniques as a sanity check for calculated savings.
- **Reasonableness check.** For each evaluated Custom project in which billing data was available, we compared the program and evaluation savings estimates to the overall energy consumption at the site to ensure they were of reasonable magnitude.
- **Track reasons for differences.** For all evaluated measures, to the extent possible, reasons for differences between the program and evaluation savings estimates were documented.
- **COVID-19 Pandemic implications.** For projects that had energy usage that had changed more than ± 10% relative to the assumptions in the program savings, we worked with the site personnel about their estimate for the change in values during the 2020 evaluation year as compared to the previous year. Based on the length of time the operations were expected to remain consistent we determined which parameters to use in the calculation based on the

Evaluation Guidelines. We also determined if the changes were COVID-19 related. If the operational characteristics were expected to remain ± 10% relative to the working savings for more than half the measure life, we used the current post-installation conditions to calculate ex post savings. This approach is shown graphically in Figure 10 below.

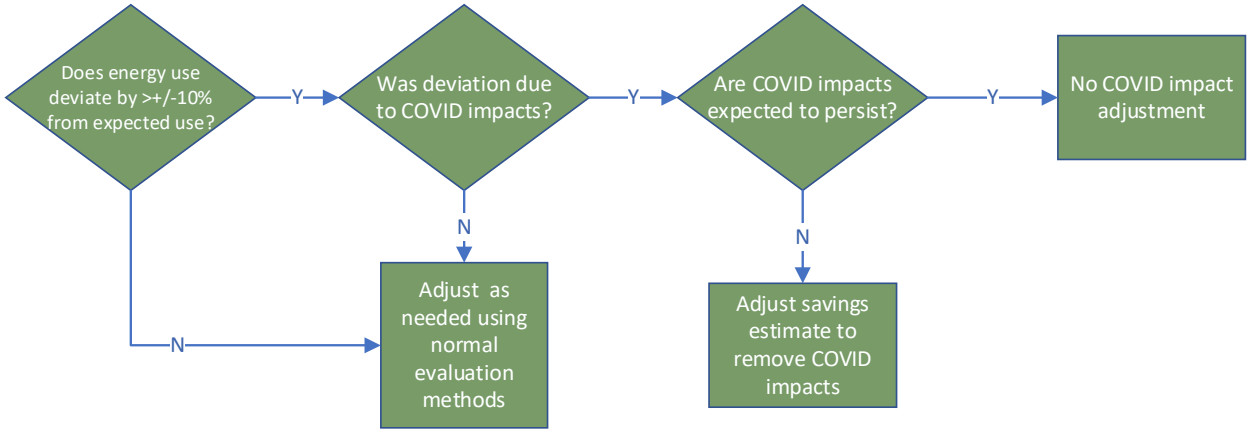

Figure 10. Determination of COVID Savings Impacts

The following discusses track-specific aspects of the impact evaluation stage.

2.5.1 Impact Evaluation: Standard/Lighting Tracks

The Standard and Lighting tracks include measures of lower complexity. Measures for these tracks are typically defined as Prescriptive (using deemed values to define savings) or Semi-Prescriptive (using a simplified calculator with a few inputs to calculate savings). Both Prescriptive and Semi-Prescriptive measures are defined in Energy Trust Measure Approval Documents (MADs).

For prescriptive/semi-prescriptive, the reviewer examined only the inputs used to determine measure savings. The reviewer did not attempt to review the MAD or savings calculators themselves, but documented any recommendations for improvement observed during the evaluation. The reviewer checked the measure against savings values and measure requirements from the MAD to ensure accuracy and eligibility. The reviewer adjusted inputs as necessary to provide an accurate representation of savings based on data collected for the evaluation.

2.5.2 Impact Evaluation: Custom Track

Custom track projects typically included whole building energy models (eQUEST, EnergyPlus, TRACE 700 or equivalent) or custom Excel spreadsheet calculations. They tended to be more complex and require a higher level of rigor.

Custom project evaluation included a full review of the methodology and inputs used in the savings model. The methodology used to determine savings was modified or replaced as needed. Model inputs were also modified as appropriate. This includes both inputs related to

installed measures as well as inputs defining the affected buildings/spaces, but with an emphasis on measure-related inputs.

For measures where an hourly simulation was used as the basis for the ex-ante and verification estimates and major changes were needed to the original model, the analysis included the calibration of the simulation to post-retrofit billing records. This included comparison to total annual usage as well as monthly usage profiles.

2.5.3 Impact Evaluation: SEM Track

Overview

SEM savings were derived from regression models of meter data following Energy Trust's modeling guidelines (Commercial O&M Measurement and Verification Guideline, v 2.3) as well as other best statistical practices as described in ASHRAE Guideline 14 and IPMVP for meter-based applications.

All the regression models and supporting data for every SEM site were provided in the form of an Excel macro-enabled workbook called the Performance Tracking Tool (PTT). Models in the PTT were generated at the monthly level since billing data was only available at the monthly level. The PTT included sheets describing the timing and nature of the SEM activities as well as any incentivized non-SEM capital projects. It included the baseline model for each fuel, along with graphical and tabular summaries of the models' residuals, total savings, net SEM savings, and incremental SEM savings for each reporting year. Our task was to evaluate the incremental SEM savings for the evaluation year.

Total savings for the reporting year were defined as the adjusted baseline energy use minus the billed energy use over the reporting year. Where there were non-SEM capital projects installed during current or previous reporting years, the net SEM savings for the reporting year were defined as the total savings minus the non-SEM capital savings that accrued over that year, where the claimed non-SEM capital savings were first multiplied by the Savings Realization Adjustment Factor (SRAF) for the year claimed. Incremental SEM savings were defined as the net savings for the reporting year minus the maximum positive net savings claimed in previous reporting years.

For the SEM Spring Group sites, the evaluations year ended in early 2020, before the onset of the COVID pandemic. For the Winter Group sites, the evaluation year ended in late 2020, after the onset of COVID. For Winter Group sites the PTT includes an additional sheet to adjust for impacts of COVID. The COVID adjustment protocol was outlined in the Energy Trust memo "Program Memo 16_202007 - 2020 Savings Methodology". Per this protocol, gas savings for the reporting year was only claimed for the months leading up to the Governor's Stay Home executive order. By contrast, electric savings for the reporting year were claimed for the full 365-day year, but those savings were based only on the rate of savings observed during the months leading up to the executive order and were limited to a nominal percentage of baseline energy usage determined by the site's Market Sector. The protocol was applied to all Winter Group

sites except for Prisons and Correctional Facilities. The protocol assumed in all cases that Prisons and Correctional Facilities did not have an energy impact from COVID. This COVID adjustment protocol methodology was relatively simple to implement and provided consistency in handling the problem of COVID without the need for the substantial amount of additional work that would have been required to identify and assess the specific impacts of COVID at each site.

Where a non-SEM incentivized capital project was completed at a SEM site during our evaluation year, we tried to obtain the engineering reports and calculation workbooks associated with those projects and evaluate them separately to better inform our evaluation of the SEM project. For these sites that we were able to evaluate we changed the capital savings in the PTT workbook to be equal to our evaluated result and we did not apply the SRAF. Unless we sampled a non-SEM capital project under another domain, any changes we made to the capital project savings under the SEM domain did not impact the realization rate for the other sampled domain.

We interviewed the SEM energy champion at each site to better understand all SEM and non-SEM energy-impacting events and activities. Some of those interviews were conducted on-site, but most were conducted via teleconference.

For SEM sites in their second, third or fourth year of engagement, we assumed that the incremental SEM savings shown in the PTT for all years prior to our evaluation year were beyond our scope and we "locked" those savings before we made any adjustments or modifications to the PTT.

For each site we addressed the following SEM savings factors:

- Non-SEM Capital Measures
  - Baseline Years
  - Reporting Years
- Baseline Models
  - Statistical goodness-of-fit tests (GOF)
  - Degree day base temperatures
  - Additional change points
  - Completeness of data streams
  - Non-Routine Events (NREs)
- COVID Impact in Winter Group
- NREs in the Reporting Year

Non-SEM Capital Measures

To account for non-SEM capital measures, we reviewed the entries in the PTT and interviewed the site contact to clarify what measures were implemented, when they were implemented and to differentiate SEM measures from non-SEM capital measures.

Non-SEM capital measures that were implemented during reporting years were directly deducted from the total savings to arrive at the net savings, as described in the Overview above. We made corrections as necessary to ensure the appropriate non-SEM capital savings were correctly deducted from the total savings to arrive at the net savings.

Non-SEM capital measures that were implemented during the baseline years were handled in one of two ways, both of which were different than the way they were handled in reporting years.

The first approach impacted the model's dependent variable stream by adding a "Deduct Meter" to effectively lower the actual metered energy use during all time periods prior to the installation of the measure(s) by an amount equal to the savings that would have accrued over that time had the measure(s) already been implemented. Where this approach was applied, we made corrections as necessary to be sure that the "Deduct Meter" accurately reflected the timing and the savings of the associated capital measure(s).

For the second approach we added an independent variable to the model in the form of a binary or weather-interactive indicator variable. With this approach we set the indicator variable to either zero or non-zero, where the zeros were applied to all instances occurring prior to or following the installation of the capital measure, and the non-zero values were applied to the balance of the time. If the zeros were applied to all time periods prior, then the non-zero indicator variable needed to be provided for all time periods following the installation of the non-SEM measure up to the end of the current reporting year. Where this approach was applied, we made corrections as necessary to be sure that the data stream of indicator variables was complete for all time periods and that it switched from zero to non-zero on the correct date.

Baseline Models

We checked the Goodness of Fit (GOF) statistics to be sure the baseline models satisfied the following statistical criteria tests outlined by the program M&V guide:

- t-statistics for the regression coefficients of the independent variables > 2.0, or p-values for t-statistics < 0.1
- CV(RMSE) < 0.2
- $R^2 > 0.75$
- Fractional savings uncertainty (FSU)[2] of the total savings < 50% at 68% confidence level

[2] FSU: Fractional Savings Uncertainty, also referred to as the relative uncertainty or precision, is the ratio of the standard uncertainty of the measured savings to the measured savings. It is discussed in detail in ASHRAE Guideline 14, and is viewed as a critical statistic for validating energy savings.

We reported statistical failures in our evaluation workbooks. If a model failed any of these tests, we tried to improve it within the PTT, or we created our own model in the ECAM application. We then used whichever model had the lowest absolute uncertainty. We did not adjust our evaluated savings in any way based on the results of these statistical tests.

Virtually every model applied weather in the form of heating and/or cooling degree days as an independent variable. For these models, we checked that the degree day base temperatures were optimized using the PTT's built-in optimizing macro. In some cases, the macro did not work so we attempted to manually find the optimum base temperatures. In other cases, we created an ECAM model using outside air temperature (OAT) rather than degree days. Using ECAM allowed us to automatically optimize for multiple change point temperatures, not just the base temperature.

Some PTT models used a second HDD independent variable to represent a second change point in the model. In these cases, if the R^2 for the two HDD variables was greater than 0.75 we deemed them to be collinear. Since the t-statistics associated with collinear variables are not reliable we either removed one of the variables from the model and re-optimized the base temperature for the remaining variable, or we created an ECAM model as a function of OAT. ECAM automatically models the weather change points without the need for multiple, possibly collinear, variables.

We checked for the completeness of the data streams of independent and dependent variables. Where billing data were missing, we obtained UCI data to fill it in. Where weather data were missing, we filled it in with data from the appropriate NOAA weather station.

After making the aforementioned corrections to the model we then tested for outliers (i.e., NREs) in the baseline using Chauvenet's Criterion. Chauvenet's Criterion states that for a sample of 'n' points the probability associated with a given point's distance away from the sample mean can normally be expected to be greater than 1/2n. If a point falls so far away from the mean that its probability is less than 1/2n then it can be considered an outlier. This test contrasts with the typical fixed standard deviation test since it accounts for the size of the sample. For example, where the sample size is 365, as it might be for a daily model of annual energy consumption, Chauvenet would tag as an outlier any point for which the number of standard deviations from the mean (t-score) has a probability less than 1/(2x365) ~ 0.14%. Assuming a normal distribution of points, this corresponds to any point that falls more than 3.23 standard deviations from the mean. By contrast, where the sample size is only 24, as is typical in a monthly baseline model in this program, then Chauvenet would tag as an outlier any point that has a probability less than 1/(2x24) ~ 2.08%. This corresponds to any point with a t-score greater than 2.47. For a sample of only 12 points, as is typical for a reporting year in this program, Chauvenet would tag as an outlier any point with a t-score greater than 2.28. In other words, the smaller the sample size the smaller the t-score threshold for outlier detection.

We applied Chauvenet's Criterion to the daily average residuals for each month in the baseline model. If a residual fell so far from the mean that the probability was smaller than Chauvenet's

Criterion we tagged it as an outlier and omitted it from the baseline model. We did not omit it if doing so reduced the model's range of coverage of independent variables.

COVID Impact on Winter Group

SEM sites were divided into two Groups, Winter and Spring. The reporting year for the Spring Group ended early in 2020 prior to the onset of the COVID pandemic, so the Spring Group was not impacted by COVID. By contrast, the reporting year for the Winter Group ended late in 2020 so the Winter Group could have been impacted by COVID. Energy Trust assumed that COVID impacted sites in the Winter Group (with the exception of prisons/correctional facilities) and applied an algorithm to adjust the claimed savings for these sites. Energy Trust assumed that COVID did not affect prisons/correctional facilities and therefore did not apply the adjustment algorithm to them.

For the evaluation, we applied statistical tests to each Winter site to determine whether or not there was a significant COVID impact, using statistical criteria outlined in Energy Trust's O&M M&V guide. For each site, we generated a pre-post model of energy consumption as a function of the independent variables in our optimized model, using indicator variables to represent the respective reporting years as well as the period presumed to have been impacted by COVID, where that period was identified per Energy Trust's COVID adjustment algorithm. If the t-statistic for the indicator variable for the COVID period was greater than 2 or its p-value was less than 0.1 we deemed the indicator variable to be significant and therefore assumed that COVID significantly impacted the site. In those cases, we applied Energy Trust's COVID adjustment algorithm. Where the indicator variable did not meet the criteria for significance, we then generated a similar pre-post model of the energy intensity (rather than energy consumption) and repeated the significance tests for the COVID indicator variable in that model. If it still proved insignificant, we then generated a pre-post model of the residuals of the PTT model (rather than energy consumption or energy intensity) and again repeated the significance tests. If the indicator variable proved to be insignificant in all three of these pre-post models, we concluded that COVID did not have a significant impact on the site, and we did not apply Energy Trust's COVID adjustment algorithm. By contrast, if the indicator variable proved significant in any one of those three models, we assumed that the COVID impact was significant.

Non-Routine Events in the Reporting Year

To detect non-routine events, we applied Chauvenet's Criterion to the average daily residuals in the twelve months of the reporting year. Where we found an outlier, we tried to determine its cause through review of the entries in the PTT and discussion with the site contact. Where we were confident that the outlier was not caused by SEM measures, we replaced the residual with the average of the residuals from the two months immediately preceding and immediately following the outlier months. For sites which we assessed as having been significantly impacted by COVID we applied Chauvenet's Criterion not to the 12 months of the reporting year but rather to the 12 months leading up to and including the last month in the reporting year prior to

the Governor's Executive Order, where the last month was determined by Energy Trust's COVID adjustment protocol.

2.5.4 Evaluation of Demand Savings

For all non-SEM sampled measures (Custom track, Lighting track, Standard track) in which non-hourly calculations were used, we evaluated the load profile used in the savings estimate. If we did not agree with the chosen profile, we selected a more appropriate profile based on peak demand information/definitions provided by Energy Trust. We calculated evaluation demand savings by multiplying measure-level savings by peak coincidence factors (based on measure load shape) supplied by Energy Trust.

For measures using hourly calculations, we used Energy Trust supplied peak periods to calculate demand savings for the measure.

2.6 Population Estimation of Evaluation Results

The purpose of this task was to estimate population savings and relative precision from the sampled projects for each domain and by SEM and non-SEM program domains by fuel. We did this using stratified mean estimation.[3] For the stratified mean gross savings estimation method, the basic steps are as follows:

1. Mean savings for each stratum in each domain, claimed and evaluated, uses Equation 1.

$$\bar{y}_{st} = \sum_{h=1}^{L} W_h \bar{y}_h \quad (1)$$

where:

W_h $= \frac{N_h}{N}$ which is the stratum weight

N_h = population of stratum h

N = population of Program Domain

$\bar{y}_h$ = the mean of y for stratum h

$\bar{y}_{st}$ = the mean resulting from a stratified random sample (*st* for *stratified*).

2. Total savings for each domain for each fuel type uses Equation 2.

$$\hat{Y}_{Program\ Domain\ i} = N \times \bar{y}_{st} \quad (2)$$

3. Variance of the reporting unit mean, s^2, uses Equation 3.

$$s^2(\bar{y}_{st}) = \sum_{h=1}^{L} \frac{W_h^2 s_h^2}{n_h} - \sum_{h=1}^{L} \frac{W_h s_h^2}{N} \quad (3)$$

[3] Cochran, William G. (1977). Sampling Techniques. New York: John Wiley & Sons.

where:

s_h^2 = the stratum variance and n_h is the stratum sample size.

The second term in the equation represents the finite population correction.

4. Relative precision of the reporting mean at 90% confidence uses Equation 4.

$$RP_{Program\ Domain\ i} = \frac{1.645 \times s(\bar{y}_{st})}{\bar{y}_{st}} \quad (4)$$

where:

$s(\bar{y}_{st})$ = the standard error of the stratified mean

Then we calculated Realization Rate (RR) for each domain by fuel and across the SEM program domains and non-SEM program domains by fuel as the ratio of the population estimate of evaluated savings to total claimed savings for each level, as shown in Equation 5.

$$RR_{Summary\ Level} = \frac{\text{Evaluated } \hat{Y}_{Summary\ Level}}{\text{Claimed } \hat{Y}_{Summary\ Level}} \quad (5)$$

We applied Equations 6 through 8 to calculate the relative precision of the SEM, non-SEM, and overall estimates.

$$EB_{Program\ Domain\ i} = RP_{Program\ Domain\ i} \times \hat{Y}_{Program\ Domain\ i} \quad (6)$$

For estimating the RP for the realization rate at the higher summary levels, we propagated the Program Domain error bounds (EB Program Domain) across each sublevel to the next higher level using Equation 7, with RP calculated as Equation 8.

$$EB_{Summary\ Level} = \sqrt{\sum (EB_{Program\ Domain\ i})^2} \quad (7)$$

$$RP_{Summary\ Level} = \frac{EB_{Summary\ Level}}{\sum \text{Evaluated } \hat{Y}_{Program\ Domain\ i}} \quad (8)$$

3 Findings

This section details all reporting of results and recommendations to Energy Trust.

3.1 Final Sample Disposition

Table 5 shows the final sample disposition. Total number of evaluated projects and measures are shown, along with the percent of projects completed relative to the original sample. Note that in most cases, we did not complete 100% of the original sample. We experienced a number of challenges related to recruitment that restricted the number of sites we were able to complete. This affected the final relative precision for the sample as well. Specific recruitment challenges and the methods we used to address them are discussed directly below.

Table 5: Sample Disposition

Program Track	Electric			Gas		
	Completed Sample		% Complete	Completed Sample		% Complete
	Projects	Measures	Projects	Projects	Measures	Projects
Standard	22	27	100%	29	38	100%
Custom	18	30	78%	13	23	68%
DI	9	41	82%			
Standard	10	58	91%			
Midstream	9	14	100%			
Lighting	28	113	90%			
Capital	**68**	**170**	**89%**	**42**	**61**	**88%**
Spring Group	16	16	76%	14	14	88%
Winter Group	24	24	80%	19	19	90%
SEM	**40**	**40**	**78%**	**33**	**33**	**89%**
Grand Total	**108**	**210**	**85%**	**75**	**94**	**88%**

3.1.1 Recruitment Challenges

In a typical evaluation, it is normal for evaluators to experience some challenge in recruiting customers. There can be various reasons for this, including customers going out of business, turnover in personnel, customer refusal to participate, etc. For the 2020 evaluation, we experienced a significantly higher number of challenges and issues than in previous evaluations in both getting customers recruited and in getting customers to continue cooperation throughout the evaluation process. The number of recruitment issues had the potential to greatly reduce the statistical significance of results. Due to the high number of issues, we did not use site replacement to mitigate this as replacement sites were likely to have the same recruitment issues.

Many of the challenges stemmed from the impacts of the COVID-19 pandemic. In 2020 itself, most businesses experienced some sort of impact and in many cases these impacts have extended post-pandemic. For our recruitment process, we found that businesses experienced very significant personnel reductions and/or changes. Original site contacts were either no longer working for the customer or had taken on additional roles and become too busy to participate in the evaluation. New contacts often had no knowledge of the installed measures.

To mitigate these challenges, we attempted multiple contacts by both phone and email. If a customer still proved unresponsive, we worked with the PMC to attempt re-contacts. If this further step was unsuccessful, rather than immediately dropping the project from the sample, we considered whether or not we could reasonably evaluate savings at the site using project documentation alone (a "no-contact" review). For a no-contact review, we required some sort of documented proof of measure installation in the provided documentation package such as invoices, inspection reports, etc. We considered the complexity of the measure as well (highly complex measures requiring significant post-period data were excluded). We also attempted to confirm that the customer was still in operation by checking for current websites or calling the business to see if phones were still being answered. We discussed this approach with Energy Trust for approval before proceeding with no-contact reviews. The following shows the number of no-contact reviews we performed per program track:

- Custom Track: 0 projects
- Lighting Track: 4 projects
- Standard Track: 11 projects
- SEM: 7 projects

Despite recruitment challenges, we were able to complete a sufficient number of project evaluations to result in a reasonable relative precision overall. Our original goal was a 90/10 sample (a relative precision of 10% at a 90% confidence level) for each fuel by SEM and non-SEM projects. Our final sample showed the following relative precisions for each group:

- Non-SEM electric: 22.4%
- SEM electric: 14.6%
- Non-SEM gas: 9.1%
- SEM gas: 18.6%

Overall, this equated to a 20.2% relative precision for the electric frame and 8.3% relative precision for the gas frame.

Note that the relative precision in the final results, although affected by completed project/savings magnitude, is also affected by the scatter of realization rates within each domain. Domains with large scatter tended to have less precision. For example, the SEM Winter Group gas sample had a number of both high and low realization rates, and this resulted in a higher (less precise) relative precision.

3.2 Evaluation Savings and Realization Rates

In this section we discuss the overall evaluation savings and resulting realization rates. For this discussion, measure domains are grouped by Capital (all non-SEM projects) and SEM. The Capital grouping includes the Standard, Lighting, and Custom program tracks. Standard and Custom are each their own domain, and Lighting includes three separate domains (Direct Install, Midstream/Buydown, and Standard Lighting). SEM has two domains (Spring and Winter Groups). The SEM savings groups are defined based on when an SEM project completed its enrollment year and claimed savings (the reporting period is either in March or December).

Once project evaluations were complete, we analyzed results to determine patterns. We examined realization rates by fuel, domain, measure (technology) type, and building type. We found that results varied (significantly in some cases) by domain and fuel, but we did not find any detectable pattern in results by either measure (technology) or building type. Measure level results for all individual measures completed in the sample are listed in Table 9 in the Appendix.

3.2.1 Electric Energy Savings and Realization Rates

Table 6 shows electric energy savings and realization rates (RR) by domain, along with the relative precision at 90% confidence for each result. As a whole, electric savings showed a high realization rate (98%), with most domains near this number. The most notable exceptions were a high RR for the Standard track domain, and low RR for the SEM Winter Group domain.

Table 6: 2020 Electric Energy Savings and Realization Rates by Domain

Program Track	Electric Frame							
	Unique Measure Count	Unique Project Count	Evaluated Project Count	Population Claimed Savings (kWh)	% Savings Sampled	Population Evaluated Savings (kWh)	Realization Rate	Relative Precision @ 90% Confidence
Standard	788	711	22	7,314,502	22	8,646,480	1.18	28.3
Custom	145	106	18	14,107,041	60	12,854,743	0.91	15.1
DI	1,473	438	9	6,961,079	6	6,961,079	1.00	12.7
Standard	4,338	1,813	10	54,451,093	7	55,849,392	1.03	33.5
Midstream	244	205	9	475,823	15	389,269	0.82	41.7
Lighting	6,055	2,456	28	61,887,995	7	63,199,740	1.02	29.6
Capital	**6,988**	**3,273**	**68**	**83,309,538**	**17**	**84,700,963**	**1.02**	**22.4**
Spring Group	98	98	16	4,385,643	55	4,090,371	0.93	16.4
Winter Group	187	187	24	8,407,131	48	5,286,673	0.63	22.5
SEM	**285**	**285**	**40**	**12,792,774**	**50**	**9,377,044**	**0.73**	**14.6**
Grand Total	**7,273**	**3,558**	**108**	**54,451,093**	**16**	**55,849,392**	**0.98**	**20.2**

3.2.2 Gas Energy Savings and Realization Rates

Table 7 shows gas energy savings and realization rates by domain, along with the relative precision at 90% confidence for each result. Gas savings showed a slightly lower realization rate overall than electric at 94%, with most domain RRs close to this number. The only domain falling below a 90% realization rate was the SEM Winter Group. Track-specific results are discussed in more detail below.

Table 7: 2020 Gas Energy Savings and Realization Rates by Domain

Program Track	Gas Frame							
	Unique Measure Count	Unique Project Count	Evaluated Project Count	Population Claimed Savings (Therms)	% Savings Sampled	Population Evaluated Savings (Therms)	Realization Rate	Relative Precision @ 90% Confidence
Standard	755	682	29	602,151	27	598,998	0.99	8.0
Custom	132	93	13	557,788	47	503,821	0.90	17.6
Capital	**887**	**775**	**42**	**1,159,939**	**36**	**1,102,819**	**0.95**	**9.1**
Spring Group	93	93	14	240,452	46	249,580	1.04	15.0
Winter Group	176	176	19	131,247	64	91,179	0.69	56.1
SEM	**269**	**269**	**33**	**371,699**	**52**	**340,759**	**0.92**	**18.6**
Grand Total	**1,156**	**1,044**	**75**	**602,151**	**43**	**598,998**	**0.94**	**8.2**

The following sections discuss results by program track.

We have provided "waterfall" charts in these sections to graphically illustrate estimated changes in measure energy savings by reason. Claimed savings are shown as a bar on the left of the chart, with final evaluated savings shown as a bar on the right end. In between the two, reasons for differences are listed, with a qualitative magnitude of impact on savings (based on engineering judgment) shown. "Cases" in these charts represents the estimated primary reason for change in savings for each adjusted measure. Note that in instances where a measure had multiple reasons for savings changes, secondary reasons were omitted from these charts for brevity. Cases with "no change" represent the number of measures in the domain that did not change.

3.2.3 Standard Track Results

Standard track documentation was found to be excellent, with all items necessary to perform an evaluation present for the vast majority of sampled projects. This included application, savings worksheet, invoices, equipment cutsheets, and any applicable measure exceptions.

We were unable to recruit 11 projects in the Standard track due to lack of response from the customer, but documentation was sufficient that we were able to complete no-contact reviews for all 11, and all projects in the original sample thus were evaluated.

Overall, the kWh realization rate for the Standard track was 1.18 with 22 projects evaluated. The higher RR for this track was the result of one insulation project in which the affected area of insulation was significantly understated. Our correction resulted in a RR of 3 for this project (this can be seen in Figure 11 below). Most projects received a realization rate at or near 1.0. One project (installation of VFDs on rooftop units) received a RR of 0.2. One of three measures in this project was found to be ineligible due to a violation of measure requirements.

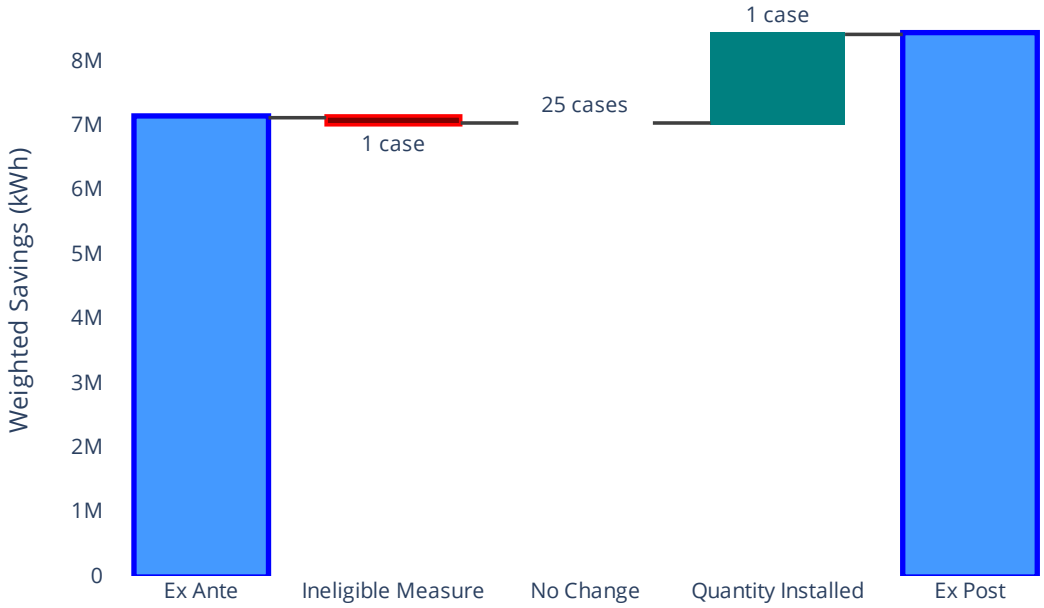

Figure 11. Decomposition of Electric Energy Use Change by Reason (Standard Track)

The therm savings realization rate for Standard Track was 0.99, representing 29 evaluated projects, of which 4 received no-contact reviews. Most projects in this portion of the sample received RRs of close to 1.0. We did not find any zero savers.

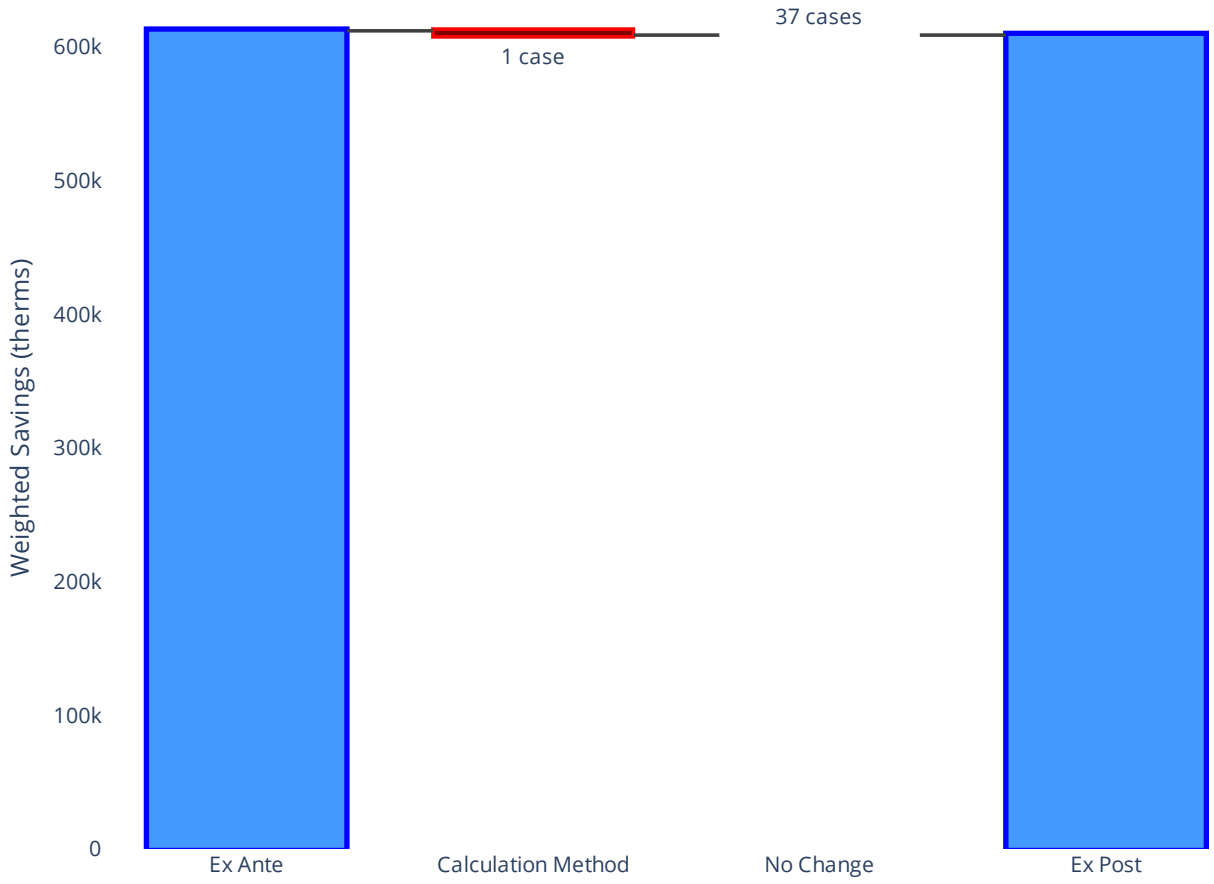

Figure 12. Decomposition of Gas Energy Use Change by Reason (Standard Track)

3.2.4 Lighting Track Results

The Lighting Track was sampled under the following domains (kWh fuel only):

- Direct Install (DI) Lighting
- Midstream Lighting
- Standard Lighting

3.2.4.1 Direct Install (DI) Lighting Results

Direct Install Lighting projects were completed under MAD 18 (Small Commercial Direct-Install Lighting). We found documentation for this set of projects to be relatively good, but oftentimes specific post-installation documentation, such as invoices and post-installation verification forms, was absent.

We were able to evaluate 9 of 11 originally sampled projects. We were not able to recruit three sites, one of which received a no-contact review. The remaining two unresponsive sites were dropped from the sample due to lack of adequate post-installation documentation.

The DI lighting domain received a realization rate of 1.0 with no issues identified with these projects.

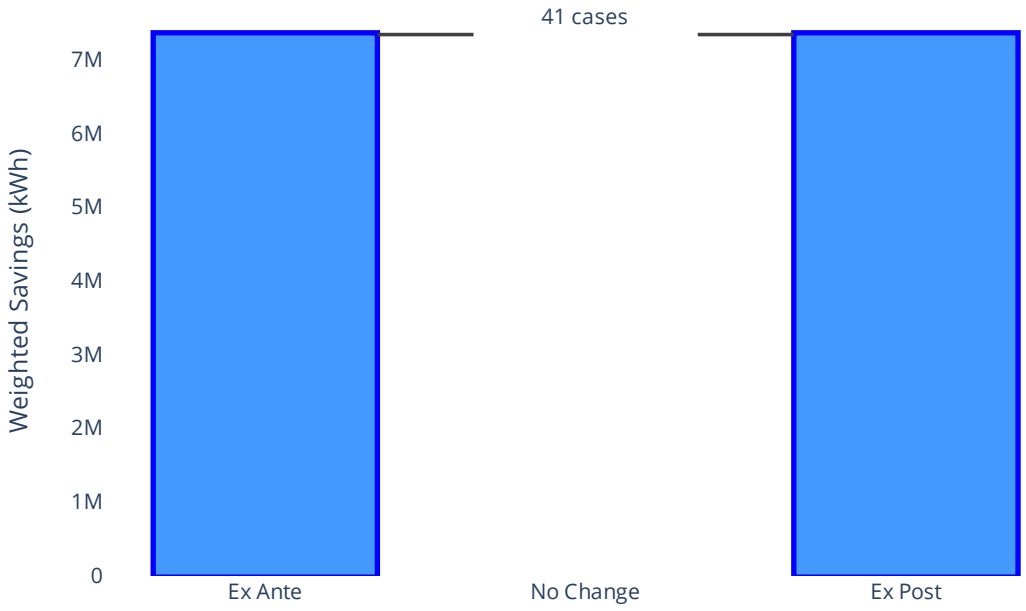

Figure 13. Decomposition of Electric Energy Use Change by Reason (DI Lighting)

3.2.4.2 Midstream Lighting Results

Mid-stream (buydown) lighting projects were completed under MAD 44 (Commercial and Industrial Distributor Buy-Down of LED Lighting). We found documentation to be excellent for these projects, with all documentation needed to perform evaluations. We evaluated 9 of 9 (100%) of originally sampled projects. We did no-contact reviews for two unresponsive sites.

This domain received a realization rate of 0.82. The lower realization rate was caused by multiple measures across three projects which specified products that were not on an approved Qualified Products List (QPL). These are listed as "Ineligible Measures" in Figure 14.

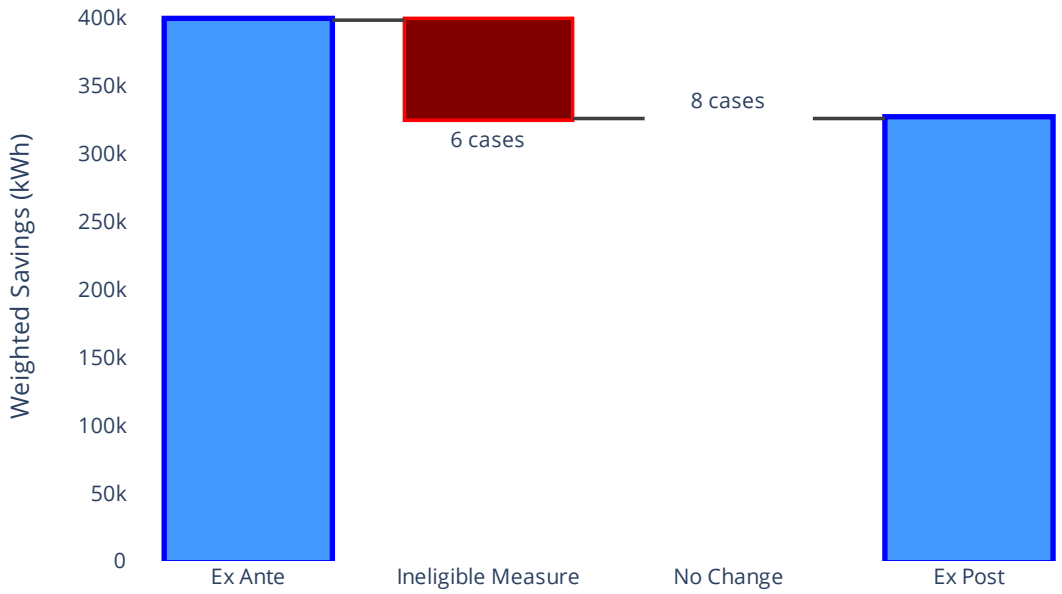

Figure 14. Decomposition of Electric Energy Use Change by Reason (Midstream Lighting)

3.2.4.3 Standard Lighting Results

Standard Lighting projects were completed under a variety of MADs and use of the Energy Trust Lighting Tool. We found documentation to be adequate in describing proposed measures, with some post-installation documentation in the form of post-inspection reports, but many times invoices for the installed measures were not available. When post-installation documentation was not available, we relied on customer interviews to confirm installation. We performed evaluations on 10 of 11 originally sampled projects. Two sites were unresponsive, one of which received a no-contact review, and one of which was dropped from the sample due to lack of available post-installation documentation.

We calculated the realization rate for the Standard Lighting Domain to be 1.03. We found seven measures in which products were not on an approved QPL and were therefore ineligible. This reduced the overall realization rate. For one project at a large athletic facility (project 190), we discovered that the hours of use originally specified were much lower than the hours indicated by the customer. This adjustment resulted in a realization rate of 2.25 for the affected measure and increased the domain's realization rate above 1. Reasons for differences are shown in Figure 15 which shows graphically the effects of the primary changes in electric energy savings. Note that secondary changes are excluded from this chart for brevity.

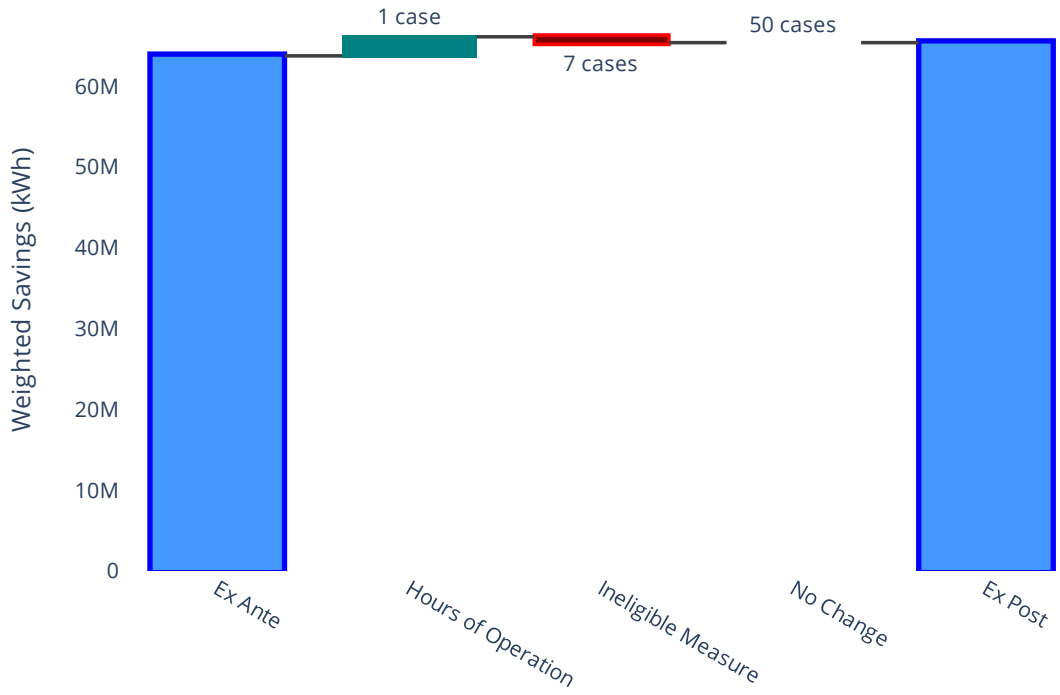

Figure 15. Decomposition of Electric Energy Use Change by Reason (Standard Lighting)

3.2.5 Custom Track Results

We completed 17 of 24 originally sampled electric project evaluations and 11 of 22 sampled gas evaluations. Due to the complex nature of the remaining unresponsive sites, we were not able to perform no-contact reviews and were forced to drop them from the sample. The relative precisions in this domain however were still sufficient to provide reasonable results (see discussion of final sample disposition in 3.1 above).

Figure 16 and Figure 17 show graphically the effects of the primary changes in electric energy and gas savings respectively. Note that secondary changes are excluded from these charts for brevity. Reasons for changes varied widely between and among projects and are discussed in more detail below.

We found the electric realization rate to be 0.91. On the electric side, the largest number of adjustments was due to issues involving the baseline. These required various adjustments to baseline model inputs to correct the existing conditions. Other reasons centered around control setting issues found, necessitating changes to the baseline and/or installed-case inputs.

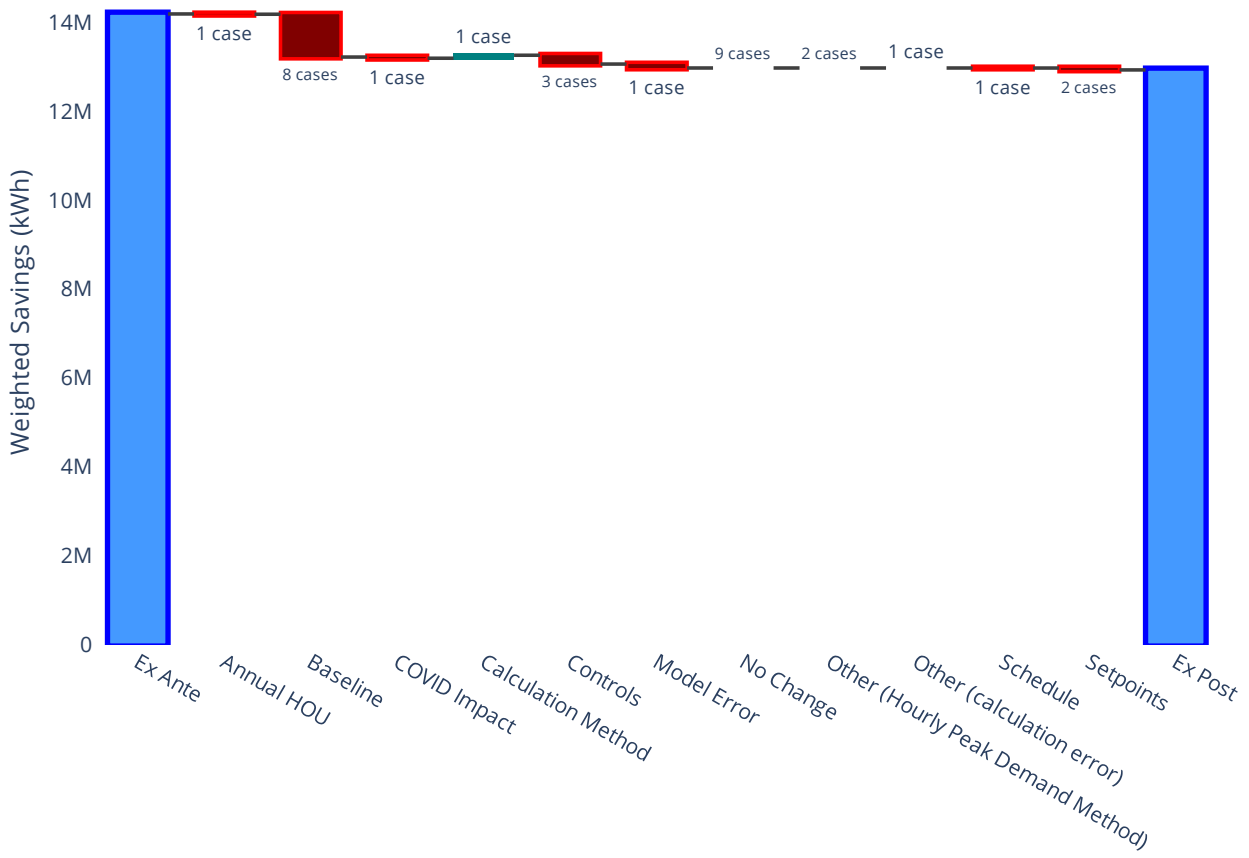

Figure 16. Decomposition of Electric Energy Use Change by Reason (Custom Track)

The gas side realization rate was slightly lower than the electric side at 0.90. We noted fewer reasons for differences here. The major cause of savings reduction in the gas sample was an issue at a hospital central plant (project 114) in which heat recovery chillers, which provided all the proposed gas savings for the project, could not be operated due to uncorrectable controls issues.

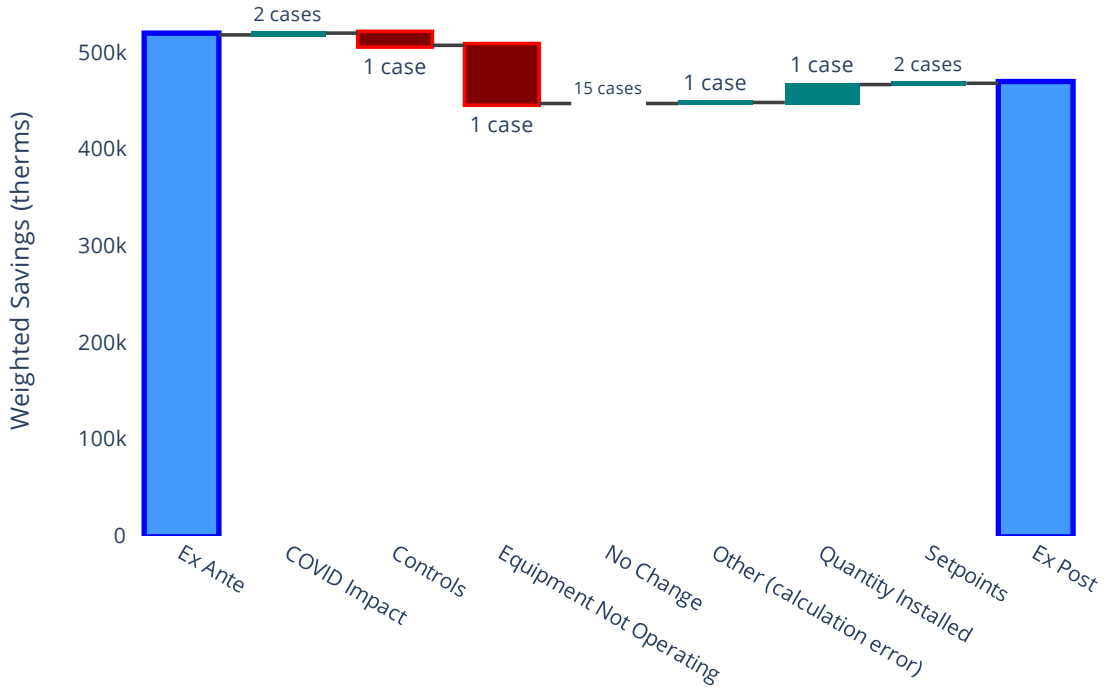

Figure 17. Decomposition of Gas Energy Use Change by Reason (Custom Track)

3.2.6 SEM Track Results

In this section we discuss results for the SEM Winter and Spring Groups, followed by a discussion of reasons for differences in estimated savings that were found.

3.2.6.1 SEM Spring Group Results

For the SEM Spring Group sample, we were able to evaluate 16 of 21 originally sampled projects on the electric side, with five unresponsive sites that could not be completed with no-contact reviews and were dropped from the sample. On the gas side we completed 14 of 16 originally sampled projects, with three unresponsive sites, one of which was completed with a no-contact review and two of which we dropped from the sample.

Included in this results section are two gas sampled sites and eight electric sampled sites that the Energy Trust had identified as being in the Spring Group when they were actually in the Winter Group. We noted this but left them as specified in our original sample to avoid affecting the sample design statistics.

We calculated the electric savings realization rate to be 0.93 with a gas realization rate of 1.04.

Figure 18 and Figure 19 show graphically the effects of the primary changes in electric energy and gas savings respectively. Note that secondary changes are excluded from these charts for brevity. Reasons for changes varied widely between and among projects and are discussed in more detail below.

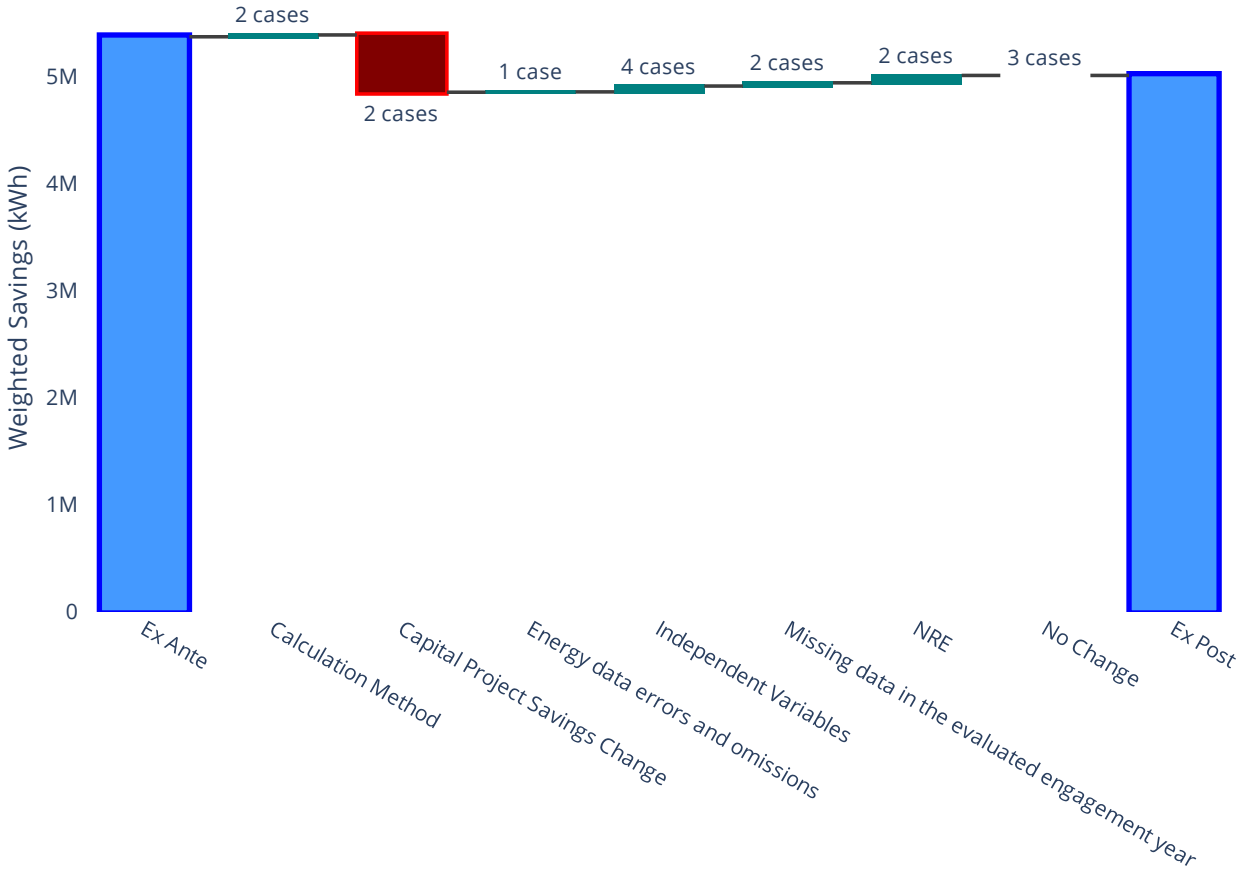

Figure 18. Decomposition of Electric Energy Use Change by Reason (SEM Spring Group)

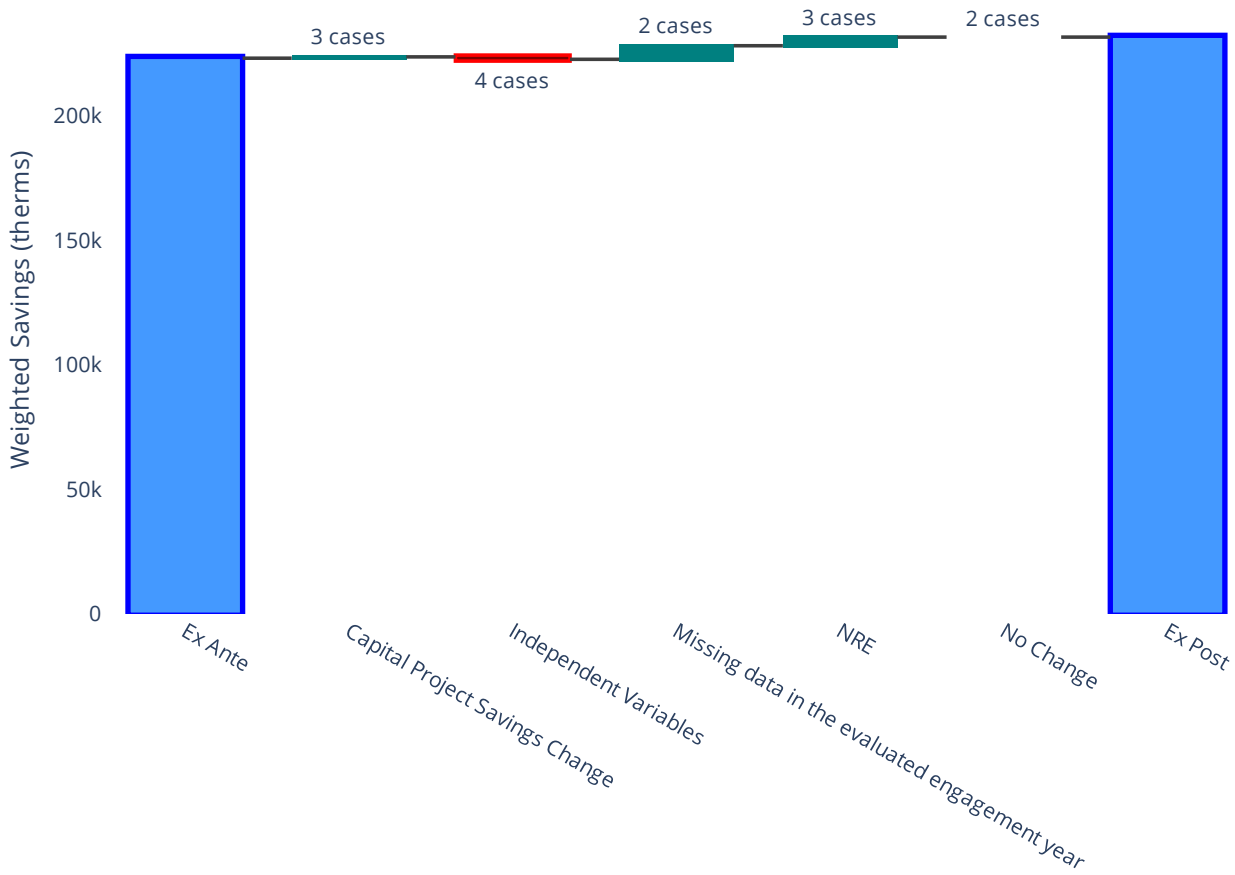

Figure 19. Decomposition of Gas Energy Use Change by Reason (SEM Spring Group)

3.2.6.2 SEM Winter Group Results

For the SEM Winter Group, we completed 24 of 30 originally sampled electric projects, with 11 sites unresponsive. We performed five no-contact reviews on these, with six being dropped from the sample. On the gas side, we completed 19 of 21 originally sampled projects, with one non-responsive site receiving no-contact reviews and two non-responsive sites dropped from the sample.

Figure 20 and Figure 21 show graphically the effects of the primary changes in electric energy and gas savings respectively. Note that secondary changes are excluded from these charts for brevity. Reasons for changes varied widely between and among projects and are discussed in more detail below.

Realization rates were lower for the Winter Group than for the Spring Group at 0.63 for electric and 0.69 for gas. COVID impacted the Winter Group but not the Spring Group, and as can be seen in the graphs below, the biggest primary reason for the lower evaluated savings in the Winter Group is "COVID Impact". As discussed above in 2.5.3 (see COVID Impact on Winter Group), we used an alternative method to assess COVID impacts . For further details on this see "COVID Impact" in the Reasons for Differences section below. Also, as shown in the graphs

above and below where NREs were the primary reason for differences, adjusting for those NREs resulted in lower savings for the Winter Group, particularly on the gas side, and slightly higher savings for the Spring Group.

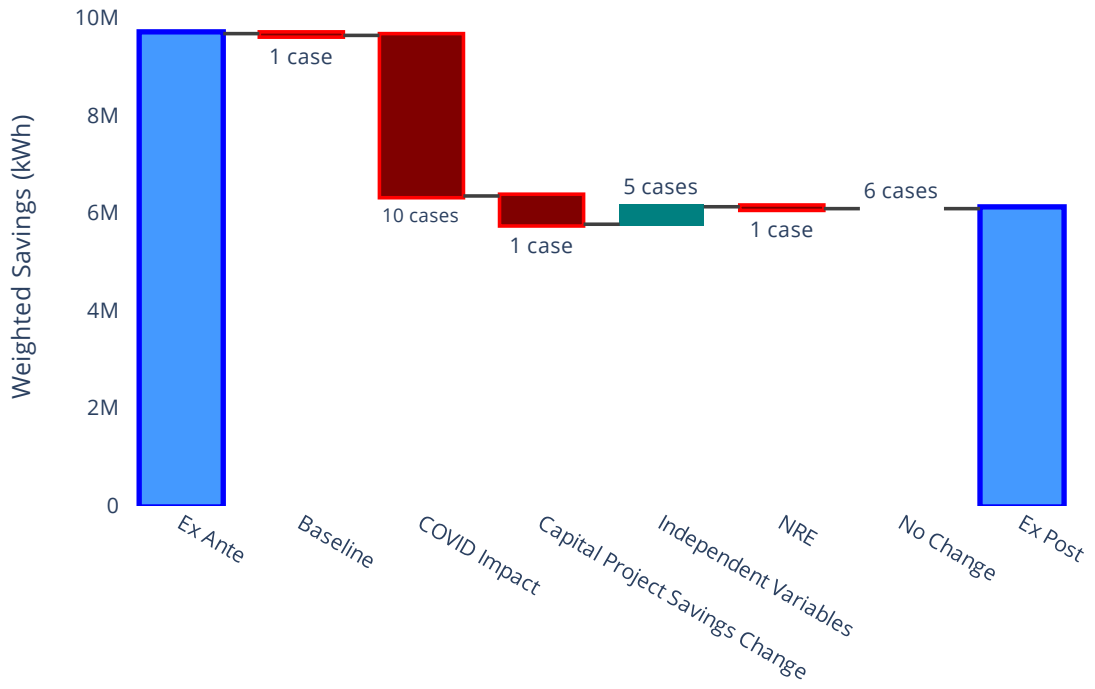

Figure 20. Decomposition of Electric Energy Use Change by Reason (SEM Winter Group)

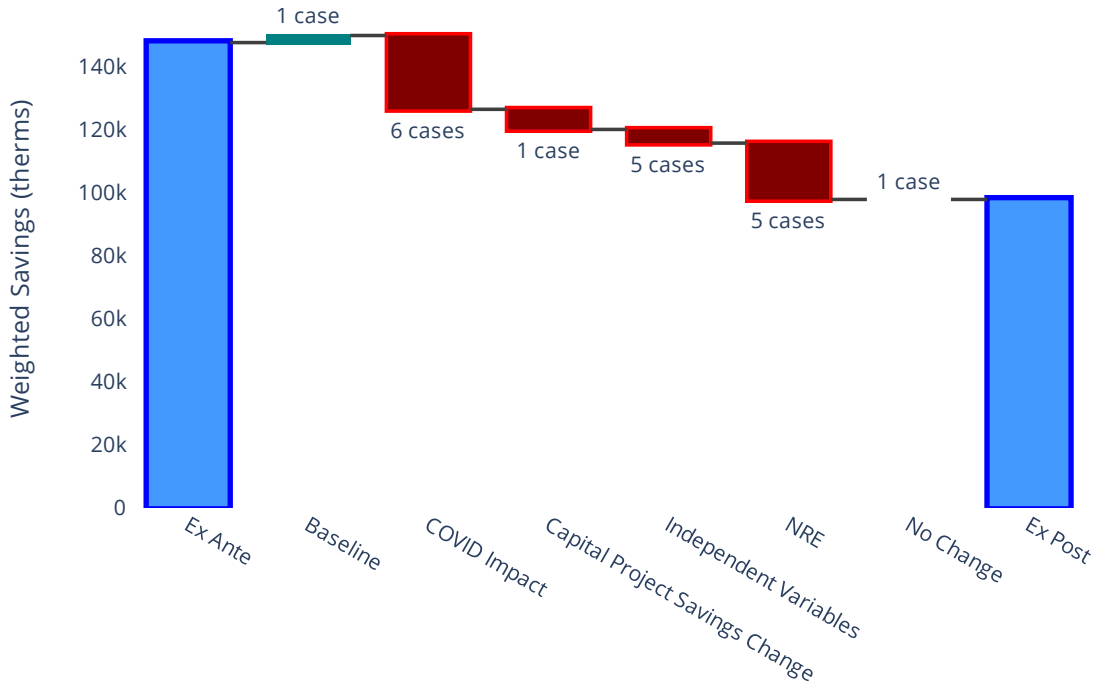

Figure 21. Decomposition of Gas Energy Use Change by Reason (SEM Winter Group)

3.2.6.3 SEM Results by Customer

We have included SEM realization rate results by customer (anonymized) in Appendix B at the end of this report. We present this data for SEM only as this track tends to be distributed under specific sets of customers more so than other tracks. Table 10 shows average RR by customer and RR for each customer's projects for the electric sample. Table 11 shows the same information for the SEM gas sample. Overall, we found that realization rate did not follow any particular pattern by customer when looking at customers with multiple sampled projects. Some projects had a large variability in RR, while others had a relatively uniform distribution of RR. In a few cases, (eg. customer 2296 on the electric side, and customer 3965 on both the electric and gas side) a customer had low realization rates across all sampled projects.

3.2.6.4 SEM Reasons for Differences

As noted above, reasons for differences for the SEM track varied widely, with multiple reasons present for a single project in many cases. We treat these reasons in a specific discussion here.

Non-SEM Capital Project Savings Change

This category includes non-SEM capital projects implemented anytime during the engagement. (Note that unless we sampled the non-SEM capital project under another domain any changes we made to the capital project savings under this domain do not impact the realization rate for the other domain.)

In several SEM projects where capital projects were implemented during the baseline period, we adjusted the way in which those capital projects were accounted for.

Similarly, we also adjusted several SEM projects where the capital projects were implemented during previous reporting years.

In 11 of the SEM sampled projects that we evaluated we found a total of 15 non-SEM capital projects that were implemented during our evaluation reporting year. Of those 11:

- In four, we found that the Savings Realization Adjustment Factor (SRAF) had been based on the wrong claim year or had been omitted altogether.
- In four, we found that the non-SEM capital savings were moot:
  - Two where the capital projects were implemented after COVID impacts set in, so they did not factor into the evaluated SEM savings per the COVID adjustment protocol.
  - One where the evaluated incremental SEM savings were so far negative that changing the impacts of the two capital projects could not possibly redeem the SEM savings.
  - One where the capital project savings only impacted the total savings by a negligible amount of 0.7%.
- In three, our evaluation of the non-SEM capital savings was different than what was claimed in the capital project files. In one of those three we found the capital project savings were zero when we learned that the project was not actually implemented.
- In sample ID 266 we found that a non-SEM capital project implemented during the evaluation year had been omitted from the Performance Tracking Tool (PTT). We learned about this because it was sampled under another track. We corrected the PTT to include our evaluated savings for that capital project.

Non-Routine Events (NREs)

Non-Routine Events (NREs): This category covers both NREs and outliers. We found and adjusted for outliers in the savings models for 24 projects. Fifteen models had outliers in their baseline and 10 had outliers in the evaluated reporting period. We identified and treated these outliers as described in the Methodology section (2.5.3).

In one project we learned through interview of a fuel-switching NRE that occurred twice but the PTT only accounted for it once.

Independent Variables

In almost half the sites that we evaluated we found models with sub-optimal HDD and/or CDD base temperatures. The effect of optimizing the base temperature ranged from negligible to substantial. For example, in sample ID 277 the optimization macro in the PTT didn't work, so we searched for the optimal base temperature manually. Changing the CDD base temperature from 67F to 74F improved the goodness of fit of the model and increased SEM savings by almost 300% from the original claim.

In a couple of sites we found models using two variables that were collinear because they were both based on HDD, where the second HDD term was intended to serve as a proxy for a change point in the model. We made corrections to those models as described above in the Methodology section.

COVID Impact

Energy Trust's methodology for handling the energy impacts resulting from COVID was relatively simple to implement and provided consistency across the program without the need for the substantial amount of additional work that would have been required to identify and assess the specific impacts of COVID at each site. As described above in 2.5.3, our approach was to use statistical means to identify specifically those sites that were significantly impacted by COVID. Where we found the impact was significant, we applied Energy Trust's COVID adjustment methodology like they did using the formulas found in the COVID adjustment sheet in the PTT. Where we found the impact was insignificant, we did not apply that adjustment.

We found nine sites in the winter group that were not significantly impacted by COVID. Energy Trust applied the COVID adjustment protocol to those sites, but we did not. Those sites tended toward high realization rates.

Conversely, we found four correctional facilities that were significantly impacted by COVID where Energy Trust had assumed they were not. We determined that these sites were likely impacted due primarily to the Governor's compassionate release program implemented as a direct result of COVID. This program reduced the occupancy of many correctional facilities during the pandemic, with resulting impacts on energy use. We applied COVID impact adjustments to these sites. These projects tended toward very low realization rates, as shown in Appendix A for sample IDs 261, 264, 280, 284, and 289.

The site in sample ID 296 was closed in November 2019 in anticipation of the COVID pandemic and did not open again until the fall of 2020. We zeroed the savings at that site since COVID significantly impacted every month of the reporting year.

At another site we found that COVID began to impact the site a month earlier than had been assumed by the COVID adjustment protocol. After discounting for that month, we found no incremental savings.

We found one site where COVID appeared to only impact a single month. We treated that month as an NRE.

Missing Data in Evaluation Engagement Year

A couple of electric sample points and a couple of gas sample points in the Spring Group were missing the 12th month of reporting year data. We obtained the missing data and completed the analysis for the full year. Overall, this led to additional savings for both fuels.

Baseline

In one gas site we reduced the baseline timeframe from 24 months to 12 months in order to avoid complications with non-SEM capital measures.

Calculation Method

We found one project where a baseline non-SEM capital project was not handled by the usual means outlined in the M&V guideline involving either "manual adjustment" or "indicator variables" but was instead deducted from the modeled savings in a manner usually reserved for capital projects implemented in the reporting period. We applied the manual adjustment method for all dates leading up to the installation of the baseline capital measure.

In one COVID-impacted project we found that the baseline consumption that was used to calculate the market sector savings cap was based on an arbitrary twelve-month baseline time period rather than the actual baseline time period found in the PTT model.

Energy Data Errors and Omissions

We found two sites for which there were errors in the billing dates and/or energy values. At one site where two kWh billing entries had been mis-entered, the savings increased 2% after correcting those entries. At another site where a baseline capital project had been accounted for using a "deduct meter" but not "included" in the model, the savings decreased by 11% after including that deduct meter in the model.

No Change

In the Spring Group we found no reason to make changes to five projects (two gas and three electric), or 17% of the projects we evaluated in the Spring Group. In the Winter Group we found no reason to make any changes to seven projects (one gas and 6 electric), or 16% of the projects we evaluated from Winter Group.

3.2.6.5 SEM Findings not Captured in Reasons for Differences

High RRs

On the gas side we found the largest savings change in sample ID 257, where the realization rate was 3.25. This is the site where the difference in our approach to handling COVID had the biggest impact. Energy Trust assumed that there was a significant COVID impact over the whole reporting period after its onset and therefore applied the COVID adjustment protocol. We found that COVID impacted only April in the reporting year, which we treated as an NRE. So instead of limiting the gas savings to the first five months of the reporting year we evaluated

the savings over all 12 months. Note that this site was a hospital in which gas usage varied seasonally, but with significant gas usage in all seasons.

On the electric side we found the largest savings change in sample ID 277, where the realization rate was 2.35. In this case our adjustment resulted in a large change in savings by optimizing the CDD base temperature.

High Fractional Savings Uncertainty (FSU)

We found 15 sites where we calculated the FSU for the total savings to be greater than the target of 50% at 68% confidence level. Twelve of those were on gas models and the other three were on electric models. All three electric models were in the Winter Group for which our calculated FSU was based on only the months prior to the onset of COVID as determined by the Energy Trust's SEM COVID adjustment protocol. FSUs for those three were all in excess of 100%. Of the 12 gas models, 10 were in the Winter Group and 2 were in the Spring Group. Of the 10 in the Winter Group, 8 were impacted by COVID so the FSUs were based on only the months prior to the onset of COVID. Three of those eight that were impacted by COVID returned negative incremental savings, which we evaluated as zero.

Negative Incremental Savings

We found negative incremental savings on 6 gas models and 3 electric models across 8 sites. Three of those models also had FSUs greater than the target of 50% at the 68% confidence level. Primary reasons for these findings include COVID Impact (4 models), NREs (3 models), Independent Variables (1 model), and Capital Project Savings Change (1 model). For those projects we evaluated the incremental savings as zero.

Low Overall Realization Rates in Winter Group

The low realization rates associated with the overall gas and electric energy savings in the Winter Group are primarily due to the way we identified and handled COVID impacts. The six sites that had the largest downward impact on overall savings were: 261, 264, 266, 268, 284, and 296. Three of those were correctional facilities (261, 264, and 284). Of those six sites, COVID impact was the main reason for discrepancy in all but 266 (for details see discussion above about COVID Impact). The main reason for discrepancy at site 266 was the impact of a previously unaccounted non-SEM capital project (for details see discussion above about Capital Project Savings Change). In order of decreasing impact on the electric side:

- 296 (-925,020 kWhs)
- 284 (-432,162 kWhs)
- 266 (-236,406 kWhs)
- 268 (-230,919 kWhs)
- 261 (-221,685 kWhs)

In order of decreasing impact on the gas side:

- 268 (-19,876 therms)
- 261 (-11,824 therms)
- 264 (-6,469 therms)

3.2.7 Demand Savings Results

Summer and Winter peak demand savings were calculated for all tracks except SEM. Table 8 shows demand realization rates by track, with kWh realizations rates shown for comparison.

Table 8: Comparison of Electric Energy and Demand Savings Realization Rates by Track

Program Track	kWh RR	Summer kW RR	Winter kW RR
Standard	1.18	1.02	1.45
Custom	0.91	0.86	0.92
Lighting	1.02	1.02	1.02
Overall	**0.98**	**0.91**	**1.10**

Custom had the smallest demand savings realization rates for both summer and winter, due mainly to changes in kWh savings during peak periods and the use of hourly peak period definitions instead of peak factors to calculate demand savings. Standard and Lighting projects had RRs higher than 1 due to increased kWh savings overall.

We did note some profiles for prescriptive measures (Lighting and Standard tracks) that did not match the site's specific use/building type. We did not attempt to change demand savings by adjusting these profiles because the profile itself is specified in the MAD and cannot be changed.

3.2.8 Participant Questionnaire Results

As noted in the Data Collection section above, we asked each recruited participant three additional questions to aid in answering research questions supplied by Energy Trust. About two-thirds of recruited participants answered all three questions. Below details how customers answered each question.

- "Did you receive a bonus incentive in 2020 due to the COVID-19 pandemic, and if so, what influence did the bonus have on your decision or ability to complete your project?" Answers: "No" (56%), "Yes" (26%), "Not sure" (18%). Most customers answered No to this question. A significant number were not sure if they received a COVID bonus. This indicates that either most customers did not receive a COVID bonus, or possibly that the bonus was delivered to them in such a way as they were not aware of the it. There seemed to be uncertainty around the bonus when talking to customers. Many seemed to be unaware

of the bonus and/or unsure of whether the bonus was tied to or separate from the program incentive.

- "Were there any impacts to your facility in 2020 due to the COVID-19 pandemic (occupancy or schedule changes, changes in operation or project installation, etc.)? If so, how long do you expect these changes to persist?" Answers: "Yes, but not expected to continue" (58%), "No" (21%), "Yes, expected to continue" (18%), "Not sure" (3%). In all, 79% of participants responding confirmed some sort of COVID impact, with the vast majority indicating that impacts had lifted and/or were not expected to continue.
- "What influence did the energy efficiency incentive you received from Energy Trust have on your decision or ability to complete your project?" Answers: "Major influence" (64%), "Minor influence" (24%), "No influence" (7%), "Not sure" (5%). Overall, the program incentives have a mostly major influence on the decision by customers to install a project. Only 7% reported no influence (i.e., free ridership).

3.3 Observations and Recommendations

The purpose of this task was to document observations made about the program during the course of the evaluation and to make recommendations to help Energy Trust improve the effectiveness of the program and the accuracy of the expected savings in future program years.

The data collection and analysis procedures described above support documenting observations in a standardized way to facilitate qualitative and, in some cases, quantitative findings on how well the program is operating. Observations include categorization of reasons for differences between claimed and evaluation savings, causes of low realization rates (and recommendations to improve), etc.

We also present in this section observations and recommendations concerning each of the research questions listed in the RFP, as discussed with Energy Trust (see below).

3.3.1 Observational Questions

The following questions were asked by Energy Trust staff. We present the questions along with any findings here.

- Are there project files for every site and do those files contain complete information? Are there obvious errors in any of the assumptions used in the energy analysis?

  Findings: We found numerous issues with project documentation during the course of the evaluation. These included items missing from the document package or incorrect versions of the technical analysis study, savings calculation files, etc. We observed three categories of documentation issues overall: missing documentation, incorrect model/calculation version provided, and incorrect document version provided. We found the fewest issues with the Standard track projects. We found the highest number of issues with Lighting, followed by SEM and Custom track projects. Below is a summary of our findings by issue category:

- Missing Documentation (documentation critical to performing evaluation was missing): Lighting (22 instances), SEM (17 instances), Custom (7 issues), Standard (1 issue).
- Incorrect Model/Calculation Version (savings from model or calculation files provided did not match claimed/documented savings): SEM (13 instances), Custom (4 instances).
- Incorrect Document Version (documentation provided did not match claimed savings): SEM (1 instance), Custom (1 instance).

- For Custom track measures, are there trends in savings realization by ATAC firm completing the energy study?

  Findings: Projects in the Custom track were spread across 14 ATACs with some projects having a blank ATAC assignment. One ATAC with a large number of assigned projects showed a realization rate of zero for almost all gas sampled sites. Most of these realization rates were the result of conditions that had changed between the original savings estimate and the evaluation (not a result of errors made by the ATAC). We also noted that ATACs with a larger number of assigned sites tended to have realization rates nearer to the mean, as expected (more projects were influencing the domain realization rate).

- Are the projects using the appropriate baseline (existing conditions or current market) to estimate savings and cost-effectiveness? (Note: results may not be statistically significant but will provide an overall check).

  Findings: We did not identify any significant issues with specification of baseline type in any program track. This indicates that baseline type in general is being applied appropriately. We did note some issues with specific baselines, especially existing baselines in the Custom track as discussed in the findings above.

- For Standard track measures, do the measure approval documents used by the program include sufficient information to estimate reliable savings, and if not, what specific changes should be made to improve them?

  Findings: As discussed above, we checked each applicable measure against the appropriate MAD to ensure that the measure met all eligibility requirements and was specified correctly. During this process, we did not identify any issues with the MADs and found them to be well laid out and easy to use. Note that the research question specifically mentions the Standard program track, but this finding applies to the Lighting program track as well.

- What changes to the guidelines would improve model development and the accuracy of savings estimates?

  Findings: We suggest the following potential modifications to the guidelines relating to SEM:

  - Add verbiage to the guidelines to address issues around collinearity of variables.

- Consider using tools that generate break-point models such as ECAM, which is an Excel-based tool, or RM&V2.0, which is an R package, both of which are open-source.
- We suggest more clarity in the discussion of how to handle models with large fractional savings uncertainty (FSU), bearing in mind that a large FSU could be because the model is poor or because the savings is small, or both. Consider applying an FSU cutoff above which savings are zero'd because they are statistically no different than zero.
- Consider the uncertainty in the incremental savings, not just the total savings.
- Consider optimizing the base temperatures to minimize the absolute uncertainty of the total savings.

- Were recommendations made in the previous two years' impact evaluations implemented, and if so, how have these changes affected the realization or verification of program savings?

  Findings: These findings are covered in their own section (3.3.2 below).

- What recommendations does SBW have regarding analysis approaches and assumptions, or customer behavior or decision-making that would be helpful to Energy Trust in designing, implementing, and evaluating its programs in the future?

  Findings:

  - SEM Track: We strongly recommend using interval data if at all possible for regression-based savings models. Interval data usually results in much smaller uncertainty as compared to monthly data. Our understanding is that interval data is difficult to obtain from utilities at the time of this report writing. Utilities would benefit greatly from sharing this data as it would increase model accuracy and therefore aid in increased energy efficiency.
  - Custom Track: As presented in the Findings section, we did not observe many issues with this track. We recommend paying special attention to the inputs to savings estimates defining the baseline condition as we observed the most issues here.
  - Lighting Track: See "Previous Report Recommendations and Status" and "Evaluation Observations/Recommendations" below.
  - Standard Track: See "Previous Report Recommendations and Status" and "Evaluation Observations/Recommendations" below.
  - Customer Behavior/Decision-Making: Due to the recruitment difficulties mentioned above, for future evaluations we recommend increased focus on recruitment process both in terms of the actual procedure used to recruit as well as timing (begin recruitment as early as possible). It may also be beneficial to further emphasize the possibility and need for evaluation to customers during the application process.

- For customers who received a bonus incentive in 2020 due to the COVID-19 pandemic, what influence did the bonus have on their decision or ability to complete their project?

Findings: Note that COVID-19 bonuses did not apply to SEM projects. Most customers indicated that they did not receive a COVID bonus or were unsure if they had received one (see 3.2.8 for results of this survey). However, we found that incentives in general when received played a major role in the customer's decision to install a project. There seemed to be uncertainty around the bonus when talking to customers. If future bonuses are offered to customers, we recommend clearly differentiating the bonus from the program incentive offered from the project.

- Are there economic or other trends that are impacting the program's ability to forecast and estimate savings? (Note: We will study impacts qualitatively).

  Findings: We observed significant changes to the customer population (likely as a result of the COVID pandemic) that may impact the program's ability to forecast and estimate savings. These observations include:

  - Many offices and similar building types experienced drastically reduced occupancy. Although occupancy appears to be rebounding at the time of this report writing, many customers indicated they were unsure whether or not occupancy levels would return to pre-COVID levels.
  - Many customers experienced significant organizational changes as a result of the pandemic including staff downsizing, loss of personnel, reduced roles/hours, mergers/buyouts, etc. This resulted in significant challenges to us (the evaluators) in contacting and recruiting customers. Based on what we observed, we feel like these impacts will persist into at least the near future. These impacts may present challenges to the program's interaction with their customer base.
  - We observed that many education and healthcare facilities increased their ventilation (outside airflow) to help cope with the pandemic. Many if not most of these customers indicated that they did not plan to return to pre-pandemic ventilation levels. We observed significant increase of energy use at these facilities due to this, and we feel it is likely to persist into at least the near-term future. While this increases energy use, it may also present additional opportunities for energy savings (better controls, O&M, etc).

SEM Research Questions

- Are the original SEM models and savings well documented?

  Findings: A lot more emphasis could be put on filling out the Opportunity Register to make it clearer which activities were expected to impact savings, when exactly those activities were expected to begin impacting savings, and by how much they were expected to impact savings.

- Were there any deviations from the SEM modeling guidelines or savings methodology memo, and if so, was there a satisfactory explanation and were the deviations justified?

  Findings: In one case the PTT was used to generate a pre-post model instead of a forecast model. This deviation was justified to accommodate a significant NRE, but it was not

explained well. In another case a non-SEM capital measure that was implemented in the baseline period was not treated as called out in the modeling guidelines but was instead treated as if it had been implemented in the reporting period. This deviation also was not explained.

- Were any important variables omitted from the original model?

  Findings: None that we found.

- Were capital measures properly accounted for in the estimation of SEM savings?

  Findings: Mostly yes, but with some exceptions. In one case we found an incentivized non-SEM capital measure was implemented but it wasn't accounted for in the PTT. In another case we found the opposite where the capital measure was accounted for in the PTT, but it wasn't actually implemented. There were also a handful of cases where there were [mostly minor] errors in the way the capital measures were accounted for.

3.3.2 Previous Report Recommendations and Status

In this section we list the recommendations from the 2019 evaluation report and provide an update on the status of each.

Lighting track

The 2019 evaluation report recommended decreasing annual hours of use (HOU) assumed for DI lighting measures from 3,600 hours to 3,000 hours (for non-control measures) to more closely align with actual consumption. Hours of use at the time of this report writing are currently set at 3,800 for commercial direct install lighting. This is based on the "Other" building type defined in RTFs standard protocol for non-residential lighting retrofits. There are also specific building type HOUs specified in this protocol, but using specific building types for the measure would result in a much larger number of measure applications and may not be practical.

Note that the RTF currently considers their non-residential hours of use estimates to be uncertain, and they plan to conduct additional research to improve confidence in this parameter in the future. We do not know the timeline for this research, but Energy Trust could conceivably conduct its own research to establish more certain values for HOU.

The HOU from the RTF may change in the future but as long as Energy Trust uses RTF's standard protocol, HOU will be based upon this source. We feel that this current approach (using the RTF source) is the most appropriate option for defining HOU unless Energy Trust considers performing their own research to replace or modify the RTF estimate.

Standard track

The 2019 evaluation report noted an issue with projects completed under corporate accounts, in which the site contact (Engineering Rebate Manager) who was not located on-site, did not have

adequate knowledge of the measure installation, and there was often difficulty finding a contact who was knowledgeable.

The report recommended limiting the number of projects applied through Engineering Rebate Managers and/or making it a program requirement to provide a contact with adequate technical knowledge of the measure.

We found similar issues in our evaluation. Oftentimes the corporate contact either did not have adequate knowledge or had moved on from the position, with the replacement having no knowledge of the measure installation. We understand that limiting projects applied for in this way may negatively affect program participation, but agree that these projects tend to be more difficult to evaluate. We recommend that in these cases a local knowledgeable contact should be specified if at all possible, or that the rebate manager retain adequate documentation of the project to be able to aid in any evaluation.

The 2019 report noted that the vast majority of Standard track boiler projects (in particular for schools) evaluated for 2019 had reduced savings due to an error in energy analysis assumptions determined via site-specific gas regression models. The report recommended reviewing gas consumption for this type of site and flagging projects for which savings was estimated to be 20% or greater of site annual consumption.

This recommendation was not implemented specifically (this would have required site-specific savings estimates to be calculated for high % savings projects), but the latest version of the applicable MAD (MAD 88 Commercial and Multifamily Condensing Boilers) has added an additional unit of measure (savings by sqft) in part to address this concern specifically.

To further address this issue a requirement could be added to the MAD to use a Custom site-specific approach for boiler projects with high relative estimated savings as defined by % of annual consumption, total savings relative to portfolio, or total proposed boiler capacity.

Custom track

The 2019 report noted that program models continued to estimate savings that were significantly greater than what was apparent from regression analyses performed by the evaluators. The 2019 evaluators noted that COVID-19 impacts made it difficult to apply regression analysis testing to a point that would yield actionable results. For the 2020 evaluation, we did note significant continuing COVID-19 impacts and did not attempt separate regression analysis to compare to modeled savings. We recommend that for future evaluations, once COVID impacts are gone, a regression analysis of a sample of custom projects should be performed to check accuracy of modeled savings.

SEM Track

Finding (from the 2019 report) – The Strategic Energy Management program has become a more complicated program over time, which has increased the cost to evaluate the program. The increase in complication is primarily driven by the increase in performance tracking tools (PTTs) used to estimate program savings. While it appears that improvement and consolidation

of PTTs is occurring, there are still incidents where model inputs and information are located in inconsistent areas or are not appropriately accounted for in the model.

Recommendation (from the 2019 report) – DNV recommends that Energy Trust continue its efforts to create simplified and consistent PTT tools for program participants to use. DNV recommends the creation of a "NonRoutine Events" (NRE) log within the PTT that documents all capital projects (both those in the baseline and those during program years), any weather adjustments made, and any other NREs that are accounted for in the model (including baseline adjustments and gas curtailments). The log should state how the NRE is accounted for in the savings calculation."

Answer (from SBW): A non-routine events log has been added to the Aggregation sheet but it only tags outliers in the baseline where the t-score is greater than 3. We suggest that if using monthly models, the t-score threshold be lowered following Chauvenet's Criterion. We also suggest that the log be used to tag outliers in the reporting year also. Include a test to ensure that values of independent variables in the reporting period do not fall too far beyond the range of values upon which the baseline model was built.

3.3.3 Evaluation Observations/Recommendations

We made the following observations during the evaluation process. For each observation, we are providing a recommendation for improvement.

- **Small Commercial Direct-Install Lighting Projects (MAD 18)/Standard Lighting Projects (various MADs):** We were not able to obtain invoices for these project types (all 11 DI Lighting projects and all 11 Standard Lighting projects) from available Energy Trust documentation, and many times customers were not able to supply an invoice at our request. This made it difficult to evaluate these projects. In particular, we did not have a manufacturer/model of installed units to check against the Qualified Products List (QPL).

  Recommendation: Require the installer/customer to supply the itemized invoice showing quantity, manufacturer, and model number of installed units. Note that this may be difficult due to the nature of direct installs, but it would be very helpful in documenting the installation of the measures.

- **Mid-Stream Lighting (MAD 44):** We found that a significant number of products that were incentivized were not on EnergyStar or DLC QPLs, making them ineligible. We did not see documentation of exceptions granted for these products.

  Recommendation: Ensure that all products are on an approved QPL per MAD requirements and document any program exceptions to these requirements in the project's documentation package.

- **SEM:** Please see responses to Observational Questions and Previous Report Recommendations.

A. Measure-Level Results

The following tables show evaluation results by measure with customer information excluded.

Result tables are presented by sampled fuel (electric or gas) and domain (DI Lighting, Midstream Lighting, Standard Lighting, Standard, Custom, SEM Spring Group, SEM Winter Group).

For each sampled measure, we have included reasons for differences (if applicable) between program savings and evaluation savings. Most reasons provided are self-explanatory. Less obvious reasons include Setpoints (eg. thermostat settings, hot water supply setpoints, etc.), Controls (eg. hot/chilled water reset schedules, VFD fan speed sequences, schedules, etc.).

Table 9: 2020 Evaluation Sample Measure-Level Results

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
102-1	Custom	Air conditioning	0.90	0.90	0.90	0.00	Setpoints, COVID Impact
102-2	Custom	Custom HVAC	1.00	1.00	1.00	1.00	
102-3	Custom	Custom building controls				1.00	
102-4	Custom	Custom Variable Frequency Drive	1.00	1.00	1.00		
102-5	Custom	Custom insulation				1.11	Other (calculation error)
107-1	Custom	Custom building controls				0.90	Setpoints, Controls
110-1	Custom	Custom Variable Frequency Drive	1.00	1.00	1.00		
110-2	Custom	Custom building controls	1.00	1.00	1.00	1.00	
110-3	Custom	Custom Variable Air Volume	1.00	1.00	1.00		
111-1	Custom	Custom building controls				0.59	Controls
114-1	Custom	Custom HVAC				0.00	Equipment Not Operating
115-1	Custom	Retro Commissioning					
115-2	Custom	Retro Commissioning				1.00	
115-3	Custom	Retro Commissioning					
116-1	Custom	Custom Variable Air Volume				1.00	
116-2	Custom	Custom HVAC				1.00	
119-1	Custom	Custom building controls				1.24	Setpoints, Controls
119-2	Custom	Custom heat recovery				1.00	
121-1	Custom	Custom insulation				1.00	

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
122-1	Custom	Custom building controls	1.00	1.00	1.00	1.00	
124-1	Custom	Custom other measure				1.17	Other (Utilization Factor), Quantity Installed, Capacity/Size
126-1	Custom	Retro Commissioning	1.00	1.00	1.00	1.00	
127-1	Custom	Custom Variable Air Volume				1.90	COVID Impact
128-1	Custom	Custom building controls	1.14	1.14	1.14	0.77	Controls
129-1	Custom	Custom building controls	1.03	1.03	1.03	0.92	Setpoints, Controls
130-1	Custom	Ductless heat pump	0.93	0.93	0.93		Setpoints, Controls
131-1	Custom	Custom building controls	0.78	0.78	0.78		Baseline, Setpoints, Schedule
131-2	Custom	Custom building controls	0.58	0.58	0.58	1.59	Setpoints, Schedule
133-1	Custom	Custom Variable Frequency Drive	0.98	0.98	0.98		Annual HOU, Quantity Installed
134-1	Custom	Custom Variable Frequency Drive	1.00	1.00	1.00		
135-1	Custom	Custom building controls	1.00	1.15	0.46		Other (Hourly Peak Demand Method)
136-1	Custom	Custom chiller	1.00	0.00	1.43		Other (Hourly Peak Demand Method)
138-1	Custom	Custom building controls	0.56	0.56	0.56		Baseline, Controls
139-1	Custom	Custom Variable Frequency Drive	1.07	1.04	0.96		Calculation Method, Schedule
141-1	Custom	Custom building controls	0.74	0.74	0.74		Baseline, Controls
142-1	Custom	Custom building controls	0.71	1.44	0.04		Model Error, Schedule
142-2	Custom	Custom Variable Frequency Drive	0.99	11.29	0.50		Schedule
143-1	Custom	Custom building controls	0.87	0.87	0.87		Controls
144-1	Custom	Retro Commissioning	0.89	0.18	0.22		Baseline
144-2	Custom	Retro Commissioning	0.94	0.52	0.20		Baseline, Schedules
144-3	Custom	Retro Commissioning	0.89	4.37	5.36		Baseline, Schedules
144-4	Custom	Retro Commissioning	1.43	0.54	4.21		Baseline, Setpoints, Schedules
144-5	Custom	Retro Commissioning	1.29	0.60	0.26		Baseline, Setpoints, Schedules
154-1	Lighting DI	Lighting	1.00	1.00	1.00		
154-2	Lighting DI	Lighting	1.00	1.00	1.00		

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
155-1	Lighting DI	Lighting	1.00	1.00	1.00		
155-2	Lighting DI	Lighting	1.00	1.00	1.00		
157-1	Lighting DI	Lighting	1.00	1.00	1.00		
157-2	Lighting DI	Lighting	1.00	1.00	1.00		
157-3	Lighting DI	Lighting	1.00	1.00	1.00		
157-4	Lighting DI	Lighting	1.00	1.00	1.00		
157-5	Lighting DI	Lighting	1.00	1.00	1.00		
157-6	Lighting DI	Lighting	1.00	1.00	1.00		
158-1	Lighting DI	Lighting	1.00	1.00	1.00		
158-2	Lighting DI	Lighting	1.00	1.00	1.00		
158-3	Lighting DI	Lighting	1.00	1.00	1.00		
158-4	Lighting DI	Lighting	1.00	1.00	1.00		
158-5	Lighting DI	Lighting	1.00	1.00	1.00		
160-1	Lighting DI	Lighting	1.00	1.00	1.00		
160-2	Lighting DI	Lighting	1.00	1.00	1.00		
160-3	Lighting DI	Lighting	1.00	1.00	1.00		
160-4	Lighting DI	Lighting	1.00	1.00	1.00		
160-5	Lighting DI	Lighting	1.00	1.00	1.00		
160-6	Lighting DI	Lighting	1.00	1.00	1.00		
160-7	Lighting DI	Lighting	1.00	1.00	1.00		
160-8	Lighting DI	Lighting	1.00	1.00	1.00		
161-1	Lighting DI	Lighting	1.00	1.00	1.00		
162-1	Lighting DI	Lighting	1.00	1.00	1.00		
162-2	Lighting DI	Lighting	1.00	1.00	1.00		
162-3	Lighting DI	Lighting	1.00	1.00	1.00		
163-1	Lighting DI	Lighting	1.00	1.00	1.00		
163-2	Lighting DI	Lighting	1.00	1.00	1.00		
163-3	Lighting DI	Lighting	1.00	1.00	1.00		
163-4	Lighting DI	Lighting	1.00	1.00	1.00		
163-5	Lighting DI	Lighting	1.00	1.00	1.00		
163-6	Lighting DI	Lighting	1.00	1.00	1.00		
164-1	Lighting DI	Lighting	1.00	1.00	1.00		
164-2	Lighting DI	Lighting	1.00	1.00	1.00		
164-3	Lighting DI	Lighting	1.00	1.00	1.00		
164-4	Lighting DI	Lighting	1.00	1.00	1.00		
164-5	Lighting DI	Lighting	1.00	1.00	1.00		
164-6	Lighting DI	Lighting	1.00	1.00	1.00		
164-7	Lighting DI	Lighting	1.00	1.00	1.00		
164-8	Lighting DI	Lighting	1.00	1.00	1.00		

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
171-1	Lighting Midstream	Lighting	1.00	1.00	1.00		
172-1	Lighting Midstream	Lighting	1.00	1.00	1.00		
172-2	Lighting Midstream	Lighting	1.00	1.00	1.00		
173-1	Lighting Midstream	Lighting	0.00	0.00	0.00		Ineligible Measure
174-1	Lighting Midstream	Lighting	1.00	1.00	1.00		
175-1	Lighting Midstream	Lighting	1.00	1.00	1.00		
176-1	Lighting Midstream	Lighting	1.00	1.00	1.00		
177-1	Lighting Midstream	Lighting	1.00	1.00	1.00		
178-1	Lighting Midstream	Lighting	1.00	1.00	1.00		
178-2	Lighting Midstream	Lighting	0.00	0.00	0.00		Ineligible Measure
179-1	Lighting Midstream	Lighting	0.00	0.00	0.00		Ineligible Measure
179-2	Lighting Midstream	Lighting	0.00	0.00	0.00		Ineligible Measure
179-3	Lighting Midstream	Lighting	0.74	0.74	0.74		Ineligible Measure
179-4	Lighting Midstream	Lighting	0.00	0.00	0.00		Ineligible Measure
190-1	Lighting Standard	Lighting	2.25	2.25	2.25		Hours of Operation
191-1	Lighting Standard	Lighting	1.00	1.00	1.00		
192-1	Lighting Standard	Lighting	1.00	1.00	1.00		
192-2	Lighting Standard	Lighting	1.00	1.00	1.00		
193-1	Lighting Standard	Lighting	1.00	1.00	1.00		
193-2	Lighting Standard	Custom lighting control	1.00	1.00	1.00		
194-1	Lighting Standard	Lighting	1.00	1.00	1.00		
194-2	Lighting Standard	Lighting	1.00	1.00	1.00		

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
194-3	Lighting Standard	Lighting	1.00	1.00	1.00		
194-4	Lighting Standard	Lighting	1.00	1.00	1.00		
194-5	Lighting Standard	Lighting controls	1.00	1.00	1.00		
194-6	Lighting Standard	Custom lighting control	1.00	1.00	1.00		
194-7	Lighting Standard	Lighting controls	1.00	1.00	1.00		
195-1	Lighting Standard	Lighting	1.00	1.00	1.00		
195-2	Lighting Standard	Lighting	1.00	1.00	1.00		
195-3	Lighting Standard	Lighting	1.00	1.00	1.00		
195-4	Lighting Standard	Custom lighting control	1.00	1.00	1.00		
196-1	Lighting Standard	Lighting	1.00	1.00	1.00		
196-2	Lighting Standard	Lighting	1.00	1.00	1.00		
196-3	Lighting Standard	Lighting	1.00	1.00	1.00		
196-4	Lighting Standard	Lighting	0.00	0.00	0.00		Ineligible Measure
196-5	Lighting Standard	Lighting	1.00	1.00	1.00		
196-6	Lighting Standard	Lighting	1.00	1.00	1.00		
196-7	Lighting Standard	Lighting	0.00	0.00	0.00		Ineligible Measure
196-8	Lighting Standard	Lighting	0.00	0.00	0.00		Ineligible Measure
196-9	Lighting Standard	Lighting	0.00	0.00	0.00		Ineligible Measure
197-1	Lighting Standard	Lighting	1.00	1.00	1.00		
197-10	Lighting Standard	Lighting	1.00	1.00	1.00		
197-11	Lighting Standard	Lighting	1.00	1.00	1.00		
197-12	Lighting Standard	Lighting	1.00	1.00	1.00		

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
197-13	Lighting Standard	Lighting	1.00	1.00	1.00		
197-2	Lighting Standard	Lighting	0.00	0.00	0.00		Ineligible Measure
197-3	Lighting Standard	Lighting	1.00	1.00	1.00		
197-4	Lighting Standard	Lighting	1.00	1.00	1.00		
197-5	Lighting Standard	Lighting	1.00	1.00	1.00		
197-6	Lighting Standard	Lighting	1.00	1.00	1.00		
197-7	Lighting Standard	Lighting	1.00	1.00	1.00		
197-8	Lighting Standard	Lighting	1.00	1.00	1.00		
197-9	Lighting Standard	Lighting	1.00	1.00	1.00		
198-1	Lighting Standard	Lighting	1.00	1.00	1.00		
198-2	Lighting Standard	Lighting	0.40	0.40	0.40		Ineligible Measure
198-3	Lighting Standard	Lighting	1.00	1.00	1.00		
198-4	Lighting Standard	Lighting	1.00	1.00	1.00		
198-5	Lighting Standard	Lighting	1.00	1.00	1.00		
198-6	Lighting Standard	Lighting	1.00	1.00	1.00		
198-7	Lighting Standard	Custom lighting	1.00	1.00	1.00		
198-8	Lighting Standard	Lighting	1.00	1.00	1.00		
198-9	Lighting Standard	Lighting	1.00	1.00	1.00		
199-1	Lighting Standard	Lighting	1.00	1.00	1.00		
199-10	Lighting Standard	Lighting	1.00	1.00	1.00		
199-2	Lighting Standard	Lighting	1.00	1.00	1.00		
199-3	Lighting Standard	Lighting	1.00	1.00	1.00		

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
199-4	Lighting Standard	Lighting	1.00	1.00	1.00		
199-5	Lighting Standard	Lighting	0.00	0.00	0.00		Ineligible Measure
199-6	Lighting Standard	Lighting	1.00	1.00	1.00		
199-7	Lighting Standard	Lighting	1.00	1.00	1.00		
199-8	Lighting Standard	Custom lighting	1.00	1.00	1.00		
199-9	Lighting Standard	Lighting	1.00	1.00	1.00		
200-1	SEM Spring Group	Custom Operations & Maintenance				1.10	Missing data in the evaluated engagement year, Independent Variables
201-1	SEM Spring Group	Custom Operations & Maintenance				1.41	Missing data in the evaluated engagement year, Independent Variables
202-1	SEM Spring Group	Custom Operations & Maintenance				1.00	Independent Variables
203-1	SEM Spring Group	Custom Operations & Maintenance				1.00	
204-1	SEM Spring Group	Custom Operations & Maintenance				1.26	Independent Variables, NRE
205-1	SEM Spring Group	Custom Operations & Maintenance				1.00	
206-1	SEM Spring Group	Custom Operations & Maintenance				1.01	NRE
207-1	SEM Spring Group	Custom Operations & Maintenance				0.79	Independent Variables, NRE
208-1	SEM Spring Group	Custom Operations & Maintenance				1.10	Capital Project Savings Change, Independent Variables
210-1	SEM Spring Group	Custom Operations & Maintenance				0.90	Independent Variables, NRE
211-1	SEM Spring Group	Custom Operations & Maintenance				1.01	Independent Variables
212-1	SEM Spring Group	Custom Operations & Maintenance				0.32	Capital Project Savings Change, Independent Variables
213-1	SEM Spring Group	Custom Operations & Maintenance	1.07			1.22	Missing data in the evaluated engagement year, Independent Variables, NRE
216-1	SEM Spring Group	Custom Operations & Maintenance				1.25	Capital Project Savings Change, NRE, Independent Variables

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
218-1	SEM Spring Group	Custom Operations & Maintenance	1.04				Missing data in the evaluated engagement year
219-1	SEM Spring Group	Custom Operations & Maintenance	1.00				
220-1	SEM Spring Group	Custom Operations & Maintenance	1.00				
221-1	SEM Spring Group	Custom Operations & Maintenance	1.02				Calculation Method
222-1	SEM Spring Group	Custom Operations & Maintenance	1.00				Capital Project Savings Change, Independent Variables
223-1	SEM Spring Group	Custom Operations & Maintenance	1.00				Independent Variables
224-1	SEM Spring Group	Custom Operations & Maintenance	0.90				Independent Variables, NRE
225-1	SEM Spring Group	Custom Operations & Maintenance	0.00				Capital Project Savings Change
228-1	SEM Spring Group	Custom Operations & Maintenance	1.67				Calculation Method, NRE, Independent Variables
230-1	SEM Spring Group	Custom Operations & Maintenance	1.08				Independent Variables
232-1	SEM Spring Group	Custom Operations & Maintenance	1.02				Energy data errors and omissions
233-1	SEM Spring Group	Custom Operations & Maintenance	1.00				
236-1	SEM Spring Group	Custom Operations & Maintenance	1.10				Independent Variables, NRE
237-1	SEM Spring Group	Custom Operations & Maintenance	1.02				Calculation Method
238-1	SEM Spring Group	Custom Operations & Maintenance	0.97				Capital Project Savings Change, Independent Variables
247-1	SEM Winter Group	Custom Operations & Maintenance	0.00			0.99	Independent Variables
248-1	SEM Winter Group	Custom Operations & Maintenance				0.00	Independent Variables, NRE
249-1	SEM Winter Group	Custom Operations & Maintenance				0.92	Independent Variables, NRE
250-1	SEM Winter Group	Custom Operations & Maintenance				0.00	Independent Variables, NRE

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
251-1	SEM Winter Group	Custom Operations & Maintenance				1.31	Capital Project Savings Change, COVID Impact
252-1	SEM Winter Group	Custom Operations & Maintenance				1.09	Independent Variables, COVID Impact
253-1	SEM Winter Group	Custom Operations & Maintenance				0.14	Independent Variables, NRE
255-1	SEM Winter Group	Custom Operations & Maintenance				0.00	Independent Variables, NRE
256-1	SEM Winter Group	Custom Operations & Maintenance				0.85	Independent Variables, COVID Impact
257-1	SEM Winter Group	Custom Operations & Maintenance				3.25	NRE, COVID Impact
259-1	SEM Winter Group	Custom Operations & Maintenance				0.00	Independent Variables
260-1	SEM Winter Group	Custom Operations & Maintenance				1.16	Baseline, NRE
261-1	SEM Winter Group	Custom Operations & Maintenance	0.00			0.02	Independent Variables, NRE, COVID Impact, Data Entry
262-1	SEM Winter Group	Custom Operations & Maintenance	0.91			1.00	Independent Variables
263-1	SEM Winter Group	Custom Operations & Maintenance				1.00	
264-1	SEM Winter Group	Custom Operations & Maintenance				0.00	COVID Impact
266-1	SEM Winter Group	Custom Operations & Maintenance	0.10				Capital Project Savings Change, NRE, Independent Variables
267-1	SEM Winter Group	Custom Operations & Maintenance				0.98	Independent Variables, NRE
268-1	SEM Winter Group	Custom Operations & Maintenance	0.00			0.00	COVID Impact
269-1	SEM Winter Group	Custom Operations & Maintenance	1.00				Independent Variables

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
270-1	SEM Winter Group	Custom Operations & Maintenance	1.09				NRE, COVID Impact
271-1	SEM Winter Group	Custom Operations & Maintenance	0.91				Independent Variables, NRE
272-1	SEM Winter Group	Custom Operations & Maintenance	1.61				Independent Variables, NRE, COVID Impact
273-1	SEM Winter Group	Custom Operations & Maintenance	1.00				
274-1	SEM Winter Group	Custom Operations & Maintenance	1.00				
275-1	SEM Winter Group	Custom Operations & Maintenance	1.00				
276-1	SEM Winter Group	Custom Operations & Maintenance	1.00				
277-1	SEM Winter Group	Custom Operations & Maintenance	2.35				Independent Variables, NRE, COVID Impact
279-1	SEM Winter Group	Custom Operations & Maintenance	1.08				Independent Variables
280-1	SEM Winter Group	Custom Operations & Maintenance	0.14				Independent Variables, COVID Impact
281-1	SEM Winter Group	Custom Operations & Maintenance	1.00				
282-1	SEM Winter Group	Custom Operations & Maintenance	0.89				Baseline
284-1	SEM Winter Group	Custom Operations & Maintenance	0.18				Calculation Method, Independent Variables, COVID Impact
286-1	SEM Winter Group	Custom Operations & Maintenance	1.00				
289-1	SEM Winter Group	Custom Operations & Maintenance	0.43				Independent Variables, COVID Impact
290-1	SEM Winter Group	Custom Operations & Maintenance	1.03				Independent Variables

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
292-1	SEM Winter Group	Custom Operations & Maintenance	0.92				Independent Variables, NRE, COVID Impact
293-1	SEM Winter Group	Custom Operations & Maintenance	1.31				Capital Project Savings Change, Independent Variables, COVID Impact
296-1	SEM Winter Group	Custom Operations & Maintenance	0.00				COVID Impact
312-1	Standard	Food equipment				1.00	
313-1	Standard	Food equipment				1.00	
314-1	Standard	Food equipment				1.00	
315-1	Standard	Food equipment				1.00	
316-1	Standard	Food equipment				1.00	
317-1	Standard	Food equipment				1.00	
318-1	Standard	Food equipment				1.00	
319-1	Standard	Food equipment				1.00	
320-1	Standard	Food equipment				1.00	
321-1	Standard	Food equipment				1.00	
322-1	Standard	Tanked water heater				0.73	Calculation Method
324-1	Standard	Food equipment				1.00	
325-1	Standard	Food equipment				1.00	
326-1	Standard	Food equipment				1.00	
328-1	Standard	Food equipment				1.00	
329-1	Standard	Boiler				1.00	
329-2	Standard	Boiler				1.00	
331-1	Standard	Food equipment				1.00	
332-1	Standard	Ceiling insulation	1.00	1.00	1.00	1.00	
332-2	Standard	Dishwasher	1.00	1.00	1.00	1.00	
333-1	Standard	Ceiling insulation				1.00	
333-2	Standard	Ceiling insulation				1.00	
334-1	Standard	Boiler				1.00	
334-2	Standard	Boiler				1.00	
334-3	Standard	Boiler				1.00	
335-1	Standard	Wall insulation				1.00	
335-2	Standard	Ceiling insulation				1.00	
336-1	Standard	Ceiling insulation				1.00	
337-1	Standard	Ceiling insulation				1.00	
339-1	Standard	Ceiling insulation	1.00	1.00	1.00	1.00	
340-1	Standard	Ceiling insulation				1.00	

SBW ID	Domain	Evaluation Description	Realization Rate				Reasons for Difference
			Electric	Demand - Winter	Demand - Spring	Gas	
341-1	Standard	Boiler				1.00	
341-2	Standard	Boiler				1.00	
342-1	Standard	Refrigerator	1.00	1.00	1.00	1.00	
343-1	Standard	Boiler				1.00	
343-2	Standard	Boiler				1.00	
344-1	Standard	Steam traps				1.00	
344-2	Standard	Steam traps				1.00	
356-1	Standard	Ceiling insulation	1.00	1.00	1.00	1.00	
357-1	Standard	Ceiling insulation	1.00	1.00	1.00		
357-2	Standard	Wall insulation	1.00	1.00	1.00		
358-1	Standard	Economizer	1.00	1.00	1.00		
358-2	Standard	Demand Control Ventilation	1.00	1.00	1.00		
358-3	Standard	Ventilation	0.00	0.00	0.00		Ineligible Measure
359-1	Standard	Ceiling insulation	1.00	1.00	1.00		
360-1	Standard	Motors	1.00	1.00	1.00		
361-1	Standard	Lighting	1.00	1.00	1.00		
362-1	Standard	Economizer	1.00	1.00	1.00		
363-1	Standard	Heat pump	1.00	1.00	1.00		
364-1	Standard	Heat pump	1.00	1.00	1.00		
365-1	Standard	Heat pump	1.00	1.00	1.00		
366-1	Standard	Heat pump	1.00	1.00	1.00		
367-1	Standard	Heat pump	1.00	1.00	1.00		
368-1	Standard	Heat pump	1.00	1.00	1.00		
369-1	Standard	Heat pump	1.00	1.00	1.00		
370-1	Standard	Ceiling insulation	3.00	3.00	3.00		Quantity Installed
371-1	Standard	Heat pump	1.00	1.00	1.00		
372-1	Standard	Heat pump	1.00	1.00	1.00		
372-2	Standard	Heat pump	1.00	1.00	1.00		
373-1	Standard	Heat pump	1.00	1.00	1.00		
374-1	Standard	Heat pump	1.00	1.00	1.00		

B. SEM Customer-Level Results

This section presents realization rates by customer and fuel for the SEM track. Customers are identified by anonymized numbers.

Table 10: 2020 SEM Electric Realization Rates by Customer

Customer / SBW ID	kWh RR
403	**1.10**
236	1.10
603	**1.00**
195	1.00
805	**1.07**
122	1.00
128	1.14
1042	**0.67**
358	0.67
1046	**1.00**
134	1.00
1049	**0.00**
296	0.00
1209	**1.00**
342	1.00
1240	**0.66**
266	0.10
274	1.00
282	0.89
1276	**2.25**
190	2.25
1322	**3.00**
370	3.00
1363	**1.00**
174	1.00
1381	**1.00**
374	1.00
1393	**1.00**
176	1.00

Customer / SBW ID	kWh RR
1505	**0.98**
133	0.98
1552	**0.85**
142	0.85
1588	**1.09**
144	1.09
1607	**1.00**
154	1.00
1686	**1.00**
365	1.00
366	1.00
1695	**0.97**
269	1.00
271	0.91
276	1.00
290	1.03
292	0.92
1757	**1.00**
162	1.00
1827	**1.00**
362	1.00
1892	**0.56**
138	0.56
1927	**0.93**
130	0.93
1945	**1.00**
232	1.02
238	0.97
1950	**0.68**
131	0.68
2009	**1.00**
194	1.00
2016	**0.92**
198	0.93
199	0.90

Customer / SBW ID	kWh RR
2019	**1.00**
193	1.00
2025	**1.00**
357	1.00
2042	**1.00**
360	1.00
2129	**1.00**
161	1.00
2174	**1.00**
372	1.00
2183	**1.00**
359	1.00
371	1.00
2225	**1.00**
273	1.00
2240	**0.00**
268	0.00
2244	**1.00**
367	1.00
2246	**1.00**
126	1.00
286	1.00
2270	**0.18**
179	0.18
2296	**0.29**
280	0.14
289	0.43
2308	**1.00**
177	1.00
2350	**0.77**
196	0.56
197	0.92
2385	**1.00**
275	1.00
281	1.00

Customer / SBW ID	kWh RR
2394	**1.00**
363	1.00
2471	**1.00**
160	1.00
2516	**1.00**
364	1.00
2536	**1.35**
270	1.09
272	1.61
2590	**0.91**
262	0.91
2597	**1.00**
158	1.00
2612	**1.00**
163	1.00
2643	**0.78**
102	0.97
141	0.74
221	1.02
225	0.00
2745	**1.00**
368	1.00
2755	**1.00**
220	1.00
2758	**1.00**
157	1.00
2771	**1.00**
332	1.00
2817	**1.07**
139	1.07
2862	**1.00**
222	1.00
2904	**1.00**
155	1.00
2906	**1.00**

Customer / SBW ID	kWh RR
110	1.00
2913	**1.29**
224	0.90
228	1.67
2928	**1.00**
339	1.00
2978	**1.00**
172	1.00
2993	**1.00**
361	1.00
3026	**1.00**
136	1.00
223	1.00
3061	**1.00**
171	1.00
3154	**1.00**
191	1.00
3194	**1.02**
237	1.02
3204	**1.51**
143	0.87
277	2.35
293	1.31
3258	**1.05**
213	1.07
218	1.04
3373	**1.00**
369	1.00
3423	**1.03**
129	1.03
3454	**1.00**
164	1.00
3518	**1.08**
279	1.08
3615	**0.50**

Customer / SBW ID	kWh RR
178	0.50
3735	**0.00**
173	0.00
3763	**1.00**
373	1.00
3853	**1.00**
175	1.00
3965	**0.09**
261	0.00
284	0.18
3999	**1.00**
356	1.00
4148	**1.00**
192	1.00
4359	**1.03**
219	1.00
230	1.08
233	1.00
4663	**1.00**
135	1.00

Table 11: 2020 SEM Gas Realization Rates by Customer

Customer / SBW ID	Therm RR
524	**1.25**
216	1.25
798	**1.00**
325	1.00
805	**1.00**
122	1.00
263	1.00
341	1.00
809	**1.00**
324	1.00
866	**1.00**

Customer / SBW ID	Therm RR
333	1.00
901	**1.00**
312	1.00
1140	**1.10**
208	1.10
1156	**1.00**
321	1.00
1209	**1.00**
342	1.00
1223	**1.00**
320	1.00
1240	**2.21**
257	3.25
260	1.16
1299	**1.00**
331	1.00
1403	**1.00**
319	1.00
1481	**1.00**
313	1.00
1543	**1.00**
329	1.00
1554	**1.17**
124	1.17
1695	**0.00**
255	0.00
259	0.00
1806	**1.01**
206	1.01
1827	**1.00**
116	1.00
1950	**0.89**
249	0.92
256	0.85
1966	**1.00**

Customer / SBW ID	Therm RR
316	1.00
2084	**1.00**
328	1.00
2126	**1.00**
318	1.00
2229	**0.73**
322	0.73
2240	**0.00**
268	0.00
2244	**1.00**
335	1.00
2246	**1.16**
126	1.00
251	1.31
2261	**1.01**
211	1.01
2301	**1.00**
314	1.00
2308	**0.90**
210	0.90
2339	**1.00**
326	1.00
2361	**1.00**
336	1.00
2528	**1.00**
115	1.00
2536	**0.98**
267	0.98
2590	**1.00**
262	1.00
2615	**1.00**
317	1.00
2643	**0.81**
102	0.78
111	0.59

Customer / SBW ID	Therm RR
203	1.00
205	1.00
2693	**1.12**
119	1.12
2729	**1.90**
127	1.90
2755	**1.01**
204	1.26
207	0.79
343	1.00
2771	**1.00**
332	1.00
2825	**1.00**
337	1.00
2906	**1.00**
110	1.00
340	1.00
2928	**1.00**
339	1.00
3026	**0.32**
212	0.32
3062	**0.98**
107	0.90
334	1.00
3068	**0.99**
247	0.99
3091	**1.00**
315	1.00
3144	**0.07**
250	0.00
253	0.14
3194	**1.00**
344	1.00
3208	**1.00**
202	1.00

Customer / SBW ID	Therm RR
3258	**1.24**
200	1.10
201	1.41
213	1.22
3338	**1.09**
252	1.09
3518	**0.00**
248	0.00
3600	**1.00**
121	1.00
3965	**0.01**
261	0.02
264	0.00
4327	**0.00**
114	0.00