Public Utility Commission of Texas

FINAL Volume 1. Statewide Energy Efficiency Portfolio Report Program Year 2021

TETRA TECH

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ACKNOWLEDGEMENTS

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ACRONYMS

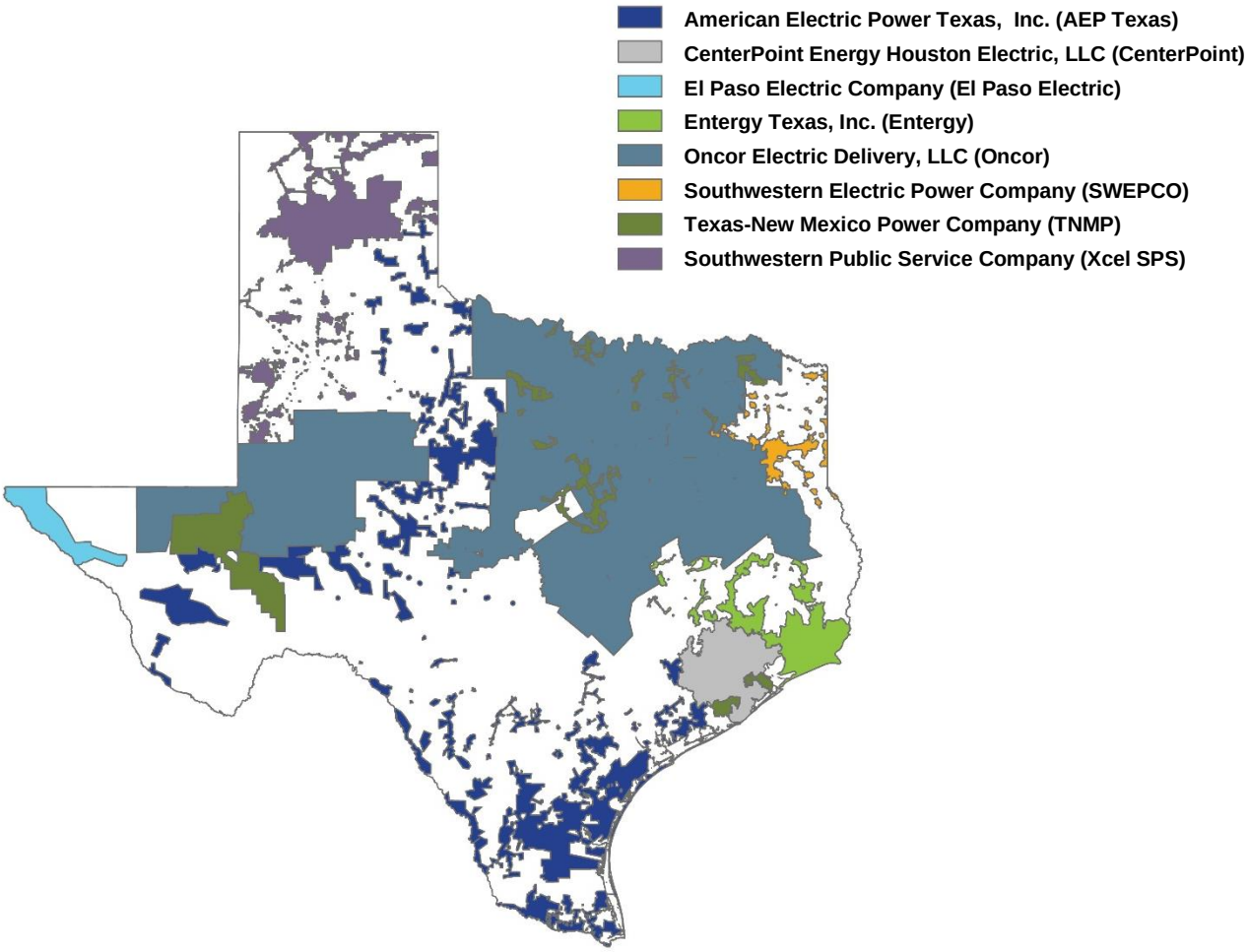
AEP TCC	American Electric Power Texas Central Division
AEP TNC	American Electric Power Texas North Division
C&I	Commercial and industrial
CNP	CenterPoint Energy Houston Electric, LLC
CSOP	Commercial standard offer program
DI	Direct install
EEIP	Energy efficiency implementation project
EEPR	Energy efficiency plan and report
EESP	Energy efficiency service provider
EM&V	Evaluation, measurement, and verification
Entergy	Entergy Texas, Inc.
EPE	El Paso Electric Company
EUL	Estimated useful life
HTR	Hard-to-reach
kW	Kilowatt
kWh	Kilowatt-hour
LI	Low-income
LM	Load management
M&V	Measurement and verification
mcf	1,000 cubic feet
MTP	Market transformation program
NTG	Net-to-gross
PUCT	Public Utility Commission of Texas
PV	Photovoltaic
PY	Program year
QA/QC	Quality assurance/quality control
Recommissioning	RCx
RFP	Request for proposals
RSOP	Residential standard offer program
SOP	Standard offer program
SWEPCO	Southwestern Electric Power Company
TEESI	Texas Energy Engineering Services, Inc.
TNMP	Texas-New Mexico Power Company
TRM	Technical Reference Manual
Xcel Energy SPS	Xcel Energy Southwest Public Service, Inc.

1.0 EXECUTIVE SUMMARY

1.1 OVERVIEW

The Public Utility Commission of Texas (PUCT) oversees the energy efficiency programs delivered by the state's eight investor-owned electric utilities. Four of the utilities are fully deregulated and operate as part of the Electric Reliability Council of Texas (ERCOT): American Electric Power Texas, Inc. (AEP Texas), CenterPoint Energy Houston Electric, LLC (CenterPoint), Oncor Electric Delivery, LLC (Oncor) and Texas-New Mexico Power Company (TNMP). The other four utilities—Entergy Texas, Inc. (Entergy); El Paso Electric Company (El Paso Electric); Southwestern Electric Power Company (SWEPCO); and Southwestern Public Service Company (Xcel SPS)—are vertically-integrated and operate as part of the Midwest Independent System Operator or the Southwest Power Pool. The utilities' service territories are shown in Figure 1.

Figure 1. Territories of Investor-Owned Electric Utilities in Texas



The Texas electric utilities administer a variety of programs that improve the energy efficiency of residential and commercial customers' homes and businesses, reducing both peak demand on the electric grid and annual electric use. Standard offer programs (SOP) develop the infrastructure of service providers (e.g., contractors, distributors) and provide financial incentives to deliver higher efficiency products and services. Utilities select implementation firms to run market transformation programs (MTP). MTPs provide additional outreach, technical assistance, and education to customers in harder-to-serve markets (e.g., small business, education, health care, data centers, and local governments) or for select technologies (e.g., recommissioning, air conditioner (AC) tune-ups, pool pumps). All utilities provide energy efficiency offerings to low-income (LI) customers through hard-to-reach (HTR) programs that are delivered similarly to the residential SOPs. The ERCOT utilities also offer targeted LI programs that coordinate with the existing federal weatherization program. Finally, the utilities manage load management programs, which are designed to reduce peak demand for a specified amount of time (typically two to four hours) if needed for either grid or system reliability. Seven of the utilities offer summer load management programs and one utility offers both a winter and summer program as part of their energy efficiency portfolio.

1.2 PY2021 ENERGY EFFICIENCY SUMMARY RESULTS

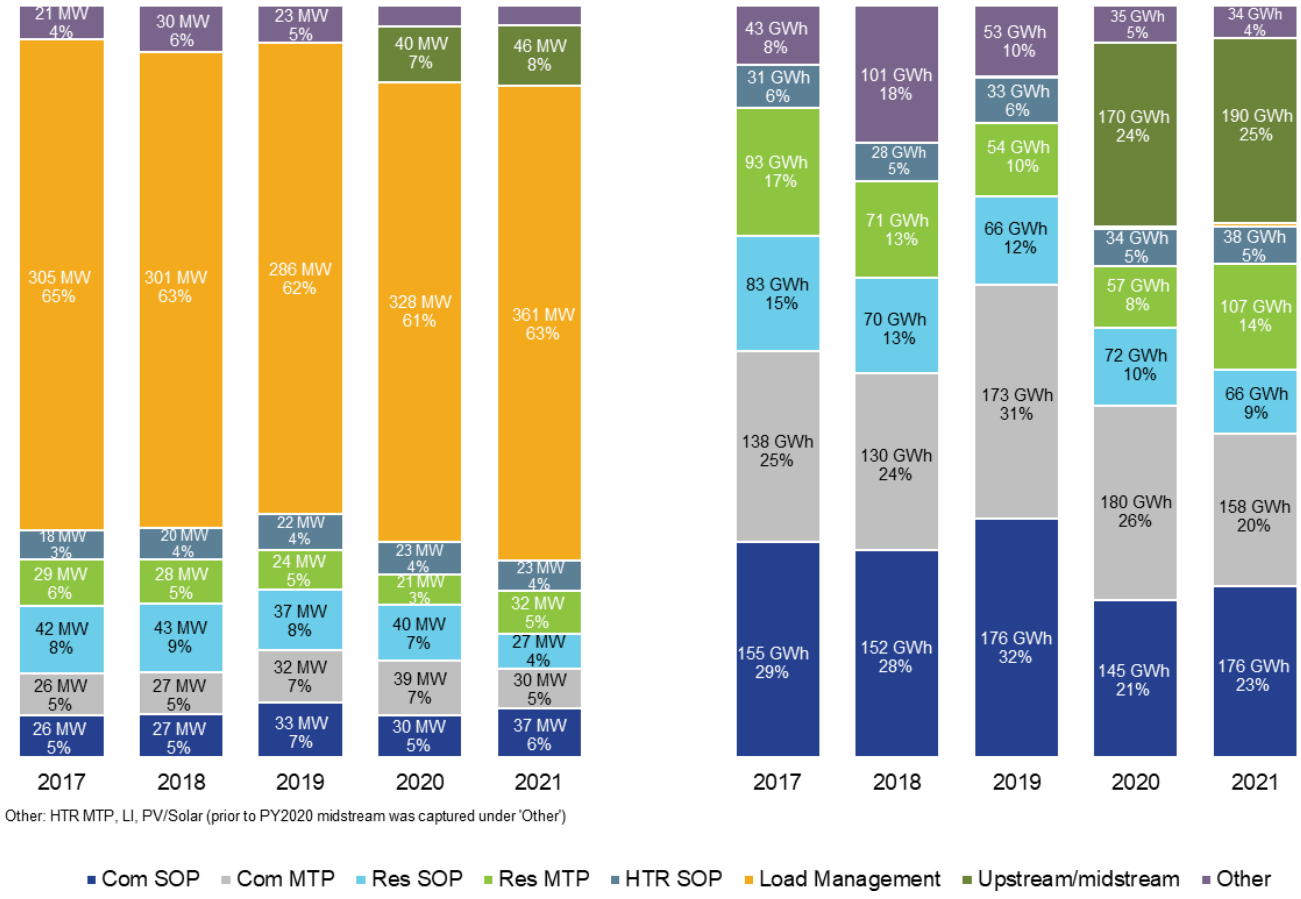
In program year (PY) 2021 (PY2021), the Texas electric utilities achieved statewide demand reductions of 571,164 kilowatts (kW) at a lifetime savings cost of $12.66 per kW. The utilities achieved statewide energy savings of 776,084,924 kilowatt-hours (kWh) at a lifetime savings cost of $0.016 per kWh[1].

1.2.1 Savings

As shown in Figure 2, load management programs consistently account for the majority of the statewide demand reductions (megawatts, MW). In the past, the 'Other' category included HTR MTP, LI, upstream/midstream, and photovoltaic (PV)/solar programs. Due to the growth in the upstream/midstream programs, we present it as a separate category beginning in PY2020, as it is now the second-largest contributor to statewide energy savings, slightly behind commercial MTPs and SOPs.

[1] This report presents evaluated saving results. Evaluated savings differ slightly from the utilities' claimed savings filed in their annual energy efficiency plans and reports. Evaluated savings include EM&V team adjustments to claimed savings. The ratio of claimed savings to evaluated savings is called a realization rate (see Figure 14, Section 2 of Volume 1 of this report). Applying realization rates to a utility's claimed savings account for the minor differences. The realization rate for each utility portfolio can be found in Volume 2 of this report.

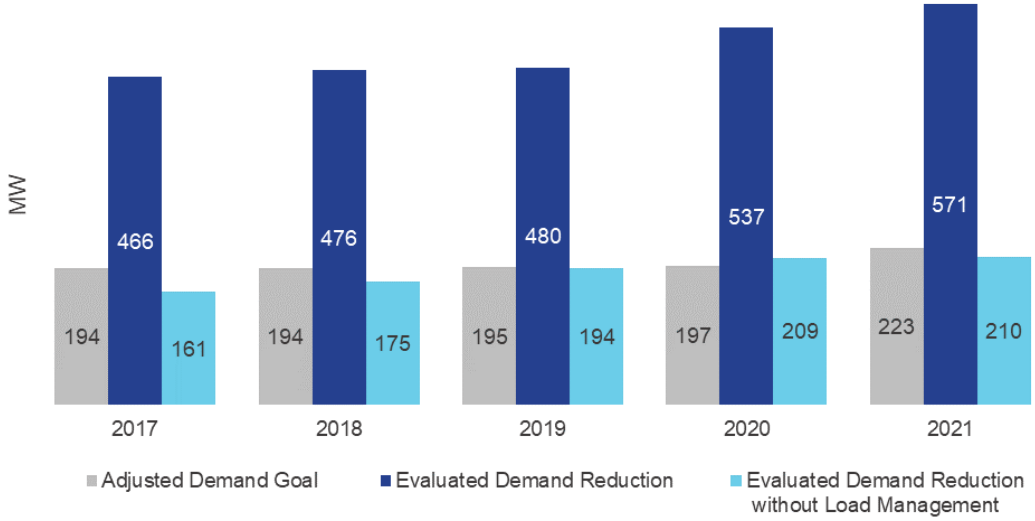
Figure 2. Evaluated Gross Demand Reduction and Energy Savings by Program Type[2]



As shown in Figure 3, the utilities continue to significantly exceed their legislated demand reduction goals; however, this is due primarily to the load management programs. As shown by the bar on the far right for each year, if demand reductions from load management programs were excluded, utilities only met the legislated demand goal once in the last five years (2020).

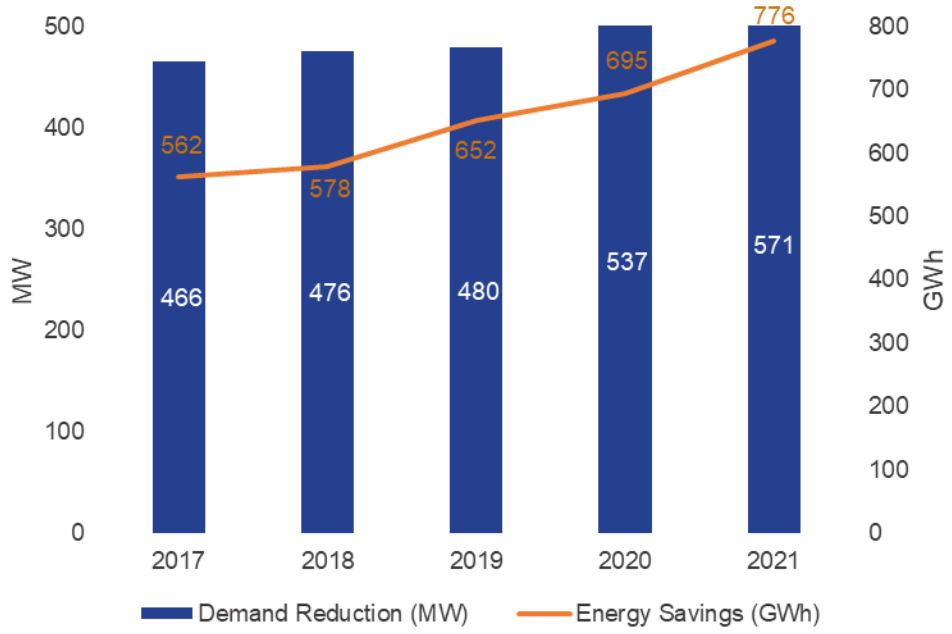
[2] Values less than four percent have been suppressed for visualization purposes.

Figure 3. PY2017–PY2021 Legislated Goals and Evaluated Demand Reduction



PY2021 saw the largest demand reductions and energy savings in the last five years (Figure 4).

Figure 4. Total Statewide Portfolio—Evaluated Gross Demand Reduction and Energy Savings by Program Year



Energy savings and demand reductions from the energy efficiency programs persist beyond the program year. The duration of savings is based on the type of energy efficiency improvement made and how long it typically lasts. The cumulative savings the utilities have achieved since PY2012—when the PUCT evaluation, measurement, and verification (EM&V) effort began—are shown in Figure 5 (demand reduction) and Figure 6 (energy savings). Demand reductions and energy savings are expected to continue through 2050.

Figure 5. PY2012–PY2050 Lifecycle Demand Reduction by Sector (MW)

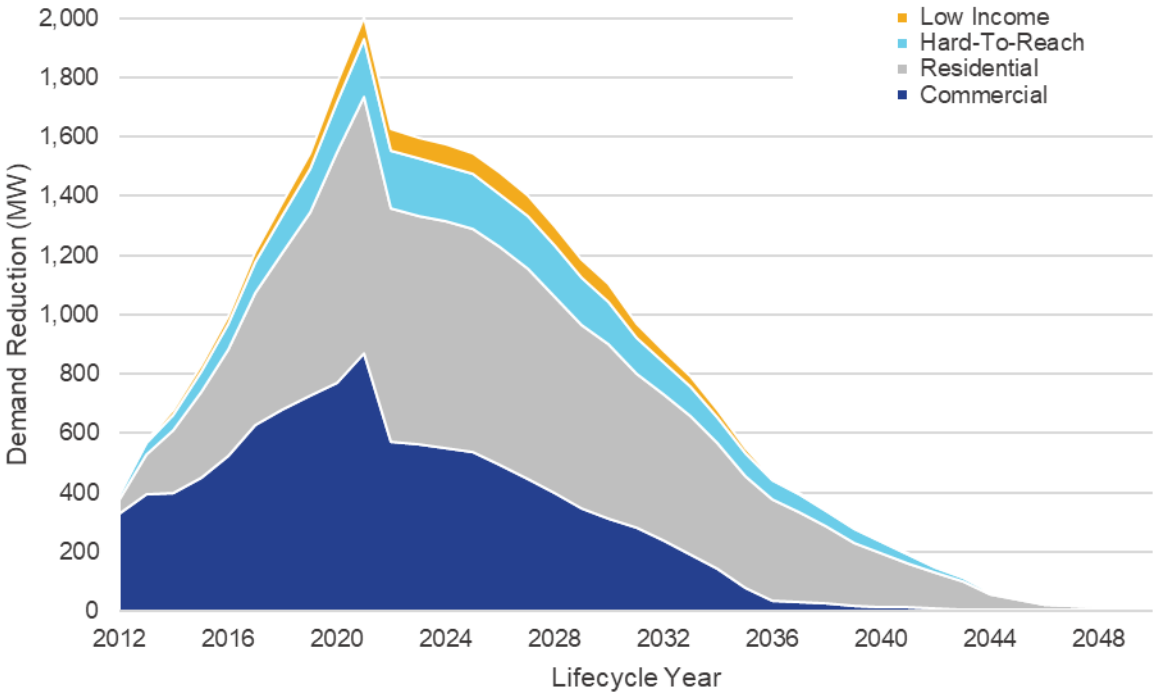


Figure 6. PY2012–PY2050 Lifecycle Energy Savings by Sector (GWh)

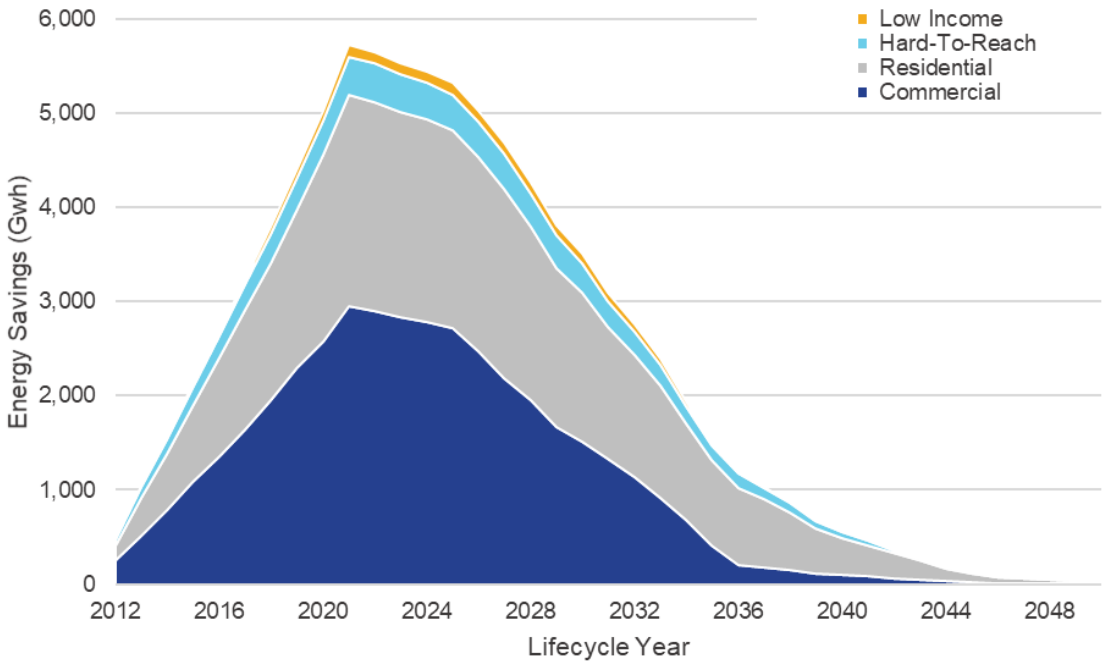


Figure 7 and Figure 8 show the types of measures installed through the programs and how they contribute to lifecycle savings. Lighting, HVAC, and building shell improvements continue to deliver the most savings over time. Load management delivers demand reductions only in the program year and accounts for the spike and drop-off after PY2021.

Figure 7. PY2012–PY2050 Lifecycle Demand Reduction by Measure Category (MW)

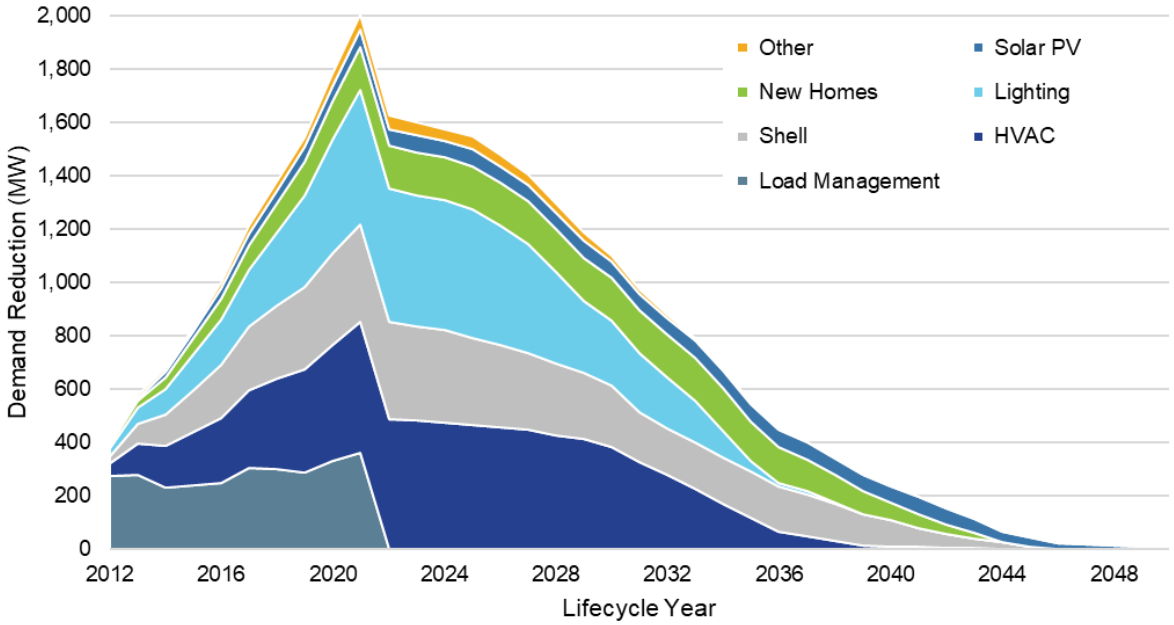
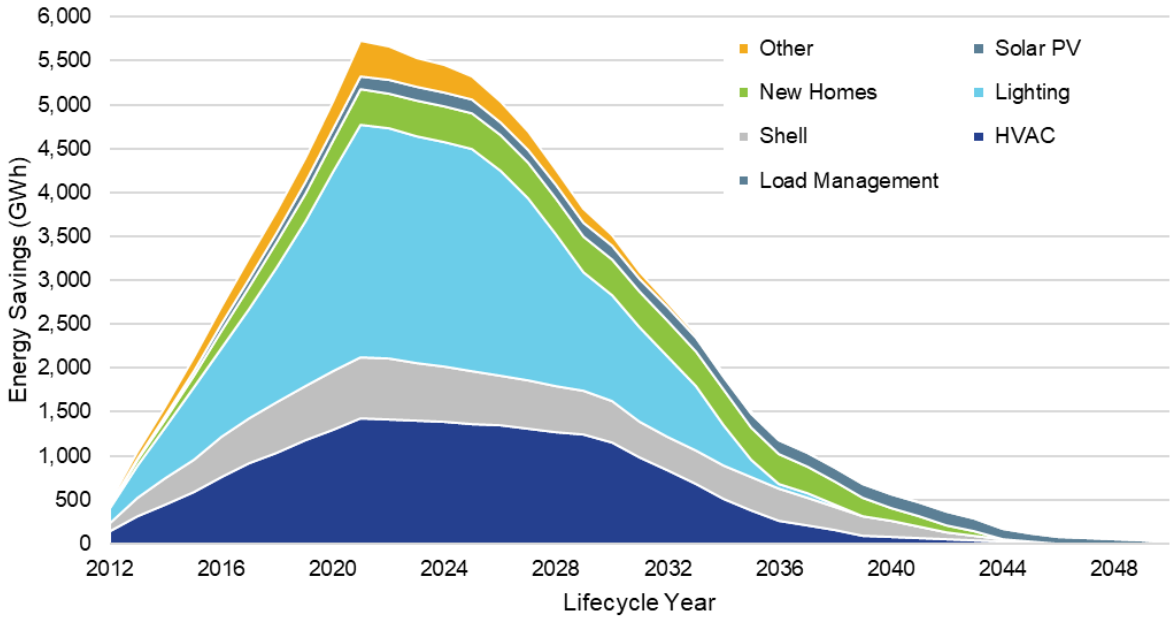


Figure 8. PY2012–PY2050 Lifecycle Energy Savings by Measure Category (GWh)



1.2.2 Cost-Effectiveness

Figure 9 overviews the avoided costs and statewide cost-effectiveness ratios over the last five years (PY2017 to PY2021). The statewide cost-effectiveness has consistently remained above the 2.0 ratio using the program administrator cost test (benefits divided by costs), jumping to 4.0 in PY2020 and then down slightly to 3.8 in PY2021. The high cost-effectiveness ratio is still largely due to the high avoided cost of energy compared to avoided costs prior to PY2020. The avoided cost in PY2021 was slightly lower than PY2020, accounting for a slight decrease in overall cost-effectiveness. Another driver of the slight decrease from PY2020 cost-effectiveness is the overall savings response to technical reference manual (TRM) changes that went into effect in PY2021.

Figure 9. Statewide Evaluated Gross Cost-Benefit Ratio and Avoided Cost by Program Year

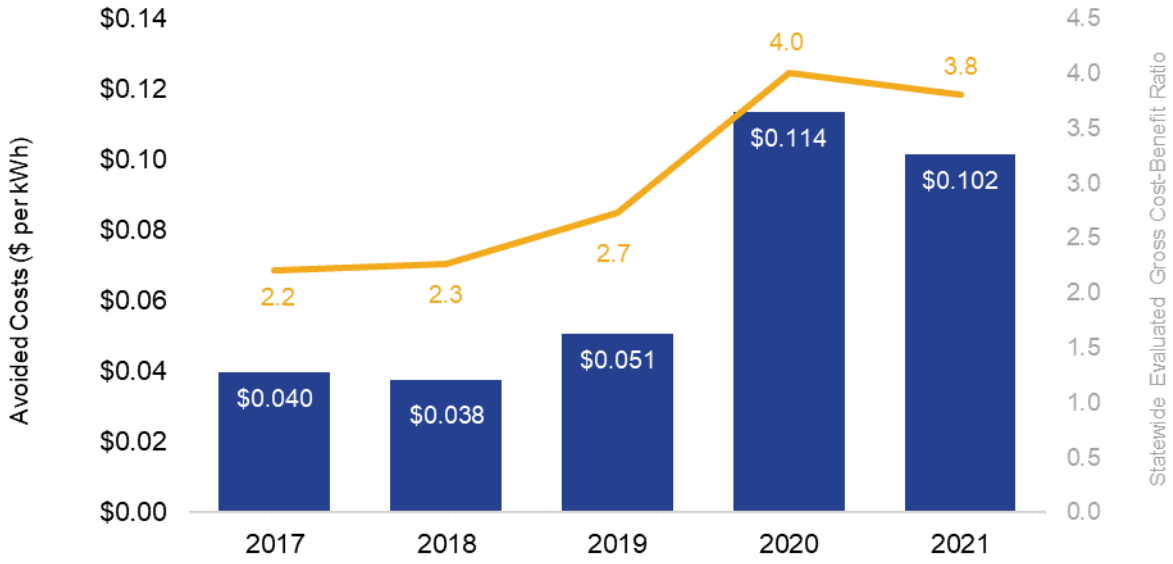
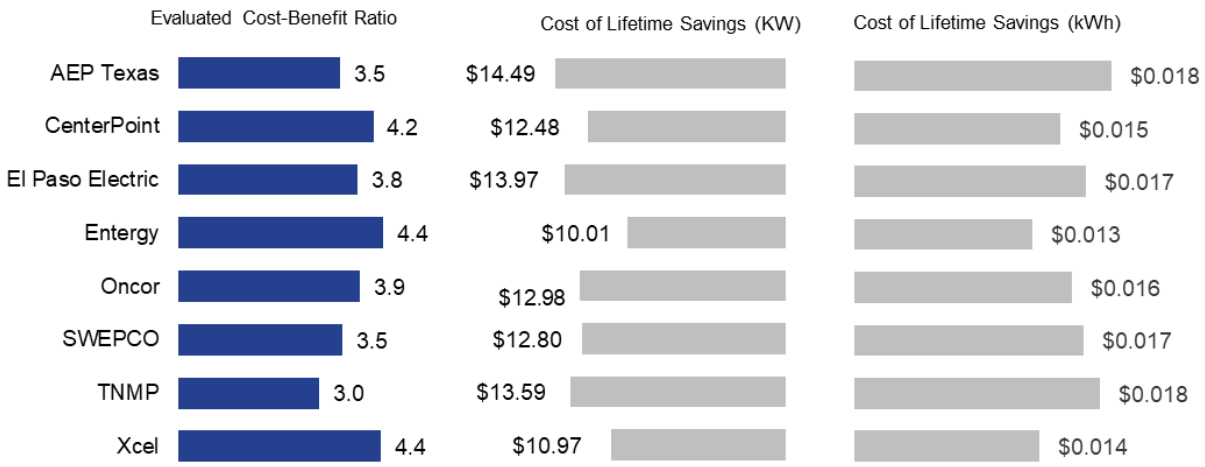


Figure 10 summarizes the cost-effectiveness of each utility's energy efficiency portfolio. All portfolios were cost-effective, with ratios ranging from 3.0 to 4.4. The lifetime cost per kW ranged from $10.01 to $14.49 across utility portfolios. The lifetime cost per kWh ranged from $0.013 to $0.018. These lifetime costs provide an alternate way of describing the cost-effectiveness of a portfolio of programs. Portfolios with a higher cost-effectiveness ratio will have a lower cost to acquire savings and vice versa.

Figure 10. PY2021 Evaluated Savings Cost-Benefit Ratio and Cost of Lifetime Savings



1.3 EVALUATION, MEASUREMENT, AND VERIFICATION OVERVIEW

In 2011, the Texas Legislature enacted Senate Bill (SB) 1125, which required the PUCT to develop an EM&V framework that promotes effective program design and consistent and streamlined reporting. The EM&V framework is embodied in the PUCT's substantive rule § 25.181, relating to the energy efficiency goal.

The PUCT selected an independent, third-party EM&V contractor for the PY2020–PY2023 programs through the Request for Proposals 473-20-0002, Project No. 51021. The selected EM&V team is led by Tetra Tech and includes Texas Energy Engineering Services, Inc. (TEESI) and Energy Bees.

The objectives of the EM&V effort are to:

- document gross and net energy and demand impacts of utilities' individual energy efficiency portfolios;
- determine program cost-effectiveness;
- provide feedback to the PUCT, utilities, and other stakeholders on program portfolio performance; and
- prepare and maintain a statewide technical reference manual (TRM).[3]

This Statewide Energy Efficiency Report presents the PY2021 EM&V findings and recommendations, looking across all eight electric utility portfolios. The report (1) addresses gross and net energy and demand impacts and program cost-effectiveness, and (2) provides feedback on program portfolio performance. The EM&V findings and recommendations inform annual updates to the TRM.

[3] The maintenance of the TRM is informed by the EM&V research and coordinated with the utilities and PUCT staff through the TRM Working Group. Public input prior to filing is solicited through the Energy Efficiency Implementation Project (EEIP) at multiple stages in the update process.

The PUCT's EM&V independently verifies utility claimed savings across all programs through program tracking data. Additional EM&V activities (engineering desk reviews, on-site measurement and verification (M&V), interval meter data analysis, consumption analysis, participant surveys, and in-depth interviews) are conducted based on an evaluation prioritization of *high*, *medium*, or *low* by program type. The PUCT staff and the EM&V team revisit the prioritization each year based on considerations such as magnitude and uncertainty of savings, stage of the program, importance to future portfolio performance, PUCT and Texas utilities' priorities, prior EM&V results, and changes in the markets in which the programs operate.

Figure 11. PY2021 Evaluation, Measurement, and Verification Activities

The utilities have demonstrated a willingness to work with PUCT staff and the EM&V team to improve the accuracy of claimed savings. This includes (1) adjusting claimed savings in response to EM&V findings, (2) requesting M&V reviews or additional technical assistance throughout the program year, and (3) implementing TRM or program changes. Utilities fully responded to all PY2021 EM&V recommended savings adjustments to claimed savings as identified in Table 1.

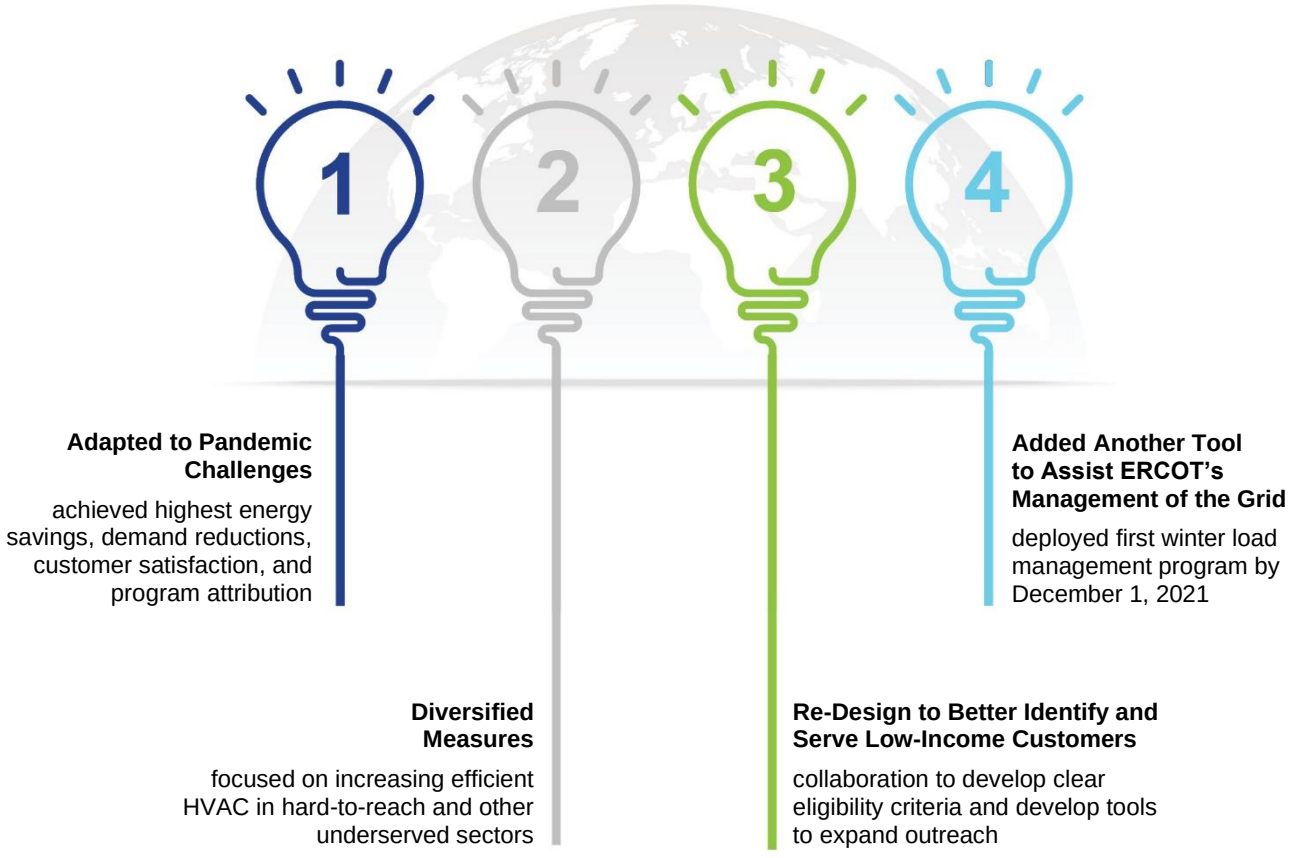
Table 1. PY2021 EM&V Savings Adjustments to Utility Claimed Savings

Utility	kW		kWh	
AEP Texas	↓	-86	↑	39,689
CenterPoint	↓	-282	↓	-1,531,571
El Paso Electric	↓	-702	↑	30,490
Entergy	↑	6	↑	58,348
Oncor	↑	11	↓	-11,246
SWEPCO	↑	15	↓	-17,838
TNMP	↓	-63	↓	-257,868
Xcel SPS	↑	2	↓	-16,631
Overall	↓	**-1,099**	↓	**-1,706,627**

1.4 KEY FINDINGS AND RECOMMENDATIONS

PY2021 saw many successes. Utilities continued their commitment to diversifying the types of measures delivered through the programs, with a specific focus on HVAC as a substantial peak-demand-reducing measure. For example, one utility launched a pilot that is gaining traction in installing efficient HVAC in multifamily buildings; another utility had considerable uptake on incentives for high-efficiency HVAC in new homes. Utilities also continued to expand the types of distribution channels used to reach customers, delivering energy-efficient products by working with retailers, distributors, and contractors, as well as adding online offerings. The utilities adapted to continuing challenges from the COVID-19 pandemic in PY2021, including customer health and safety considerations, supply chain issues, and contractor staff shortages. The utilities collaborated with PUCT staff and the EM&V team to re-design eligibility criteria for LI households in order to better serve this sector starting in PY2022, including the development of an online tool for contractors to use in the field. In response to Winter Storm Uri, ERCOT utilities worked to quickly roll out new winter load management programs, with Oncor first offering a winter load management pilot as part of its energy efficiency offerings on December 1, 2021. Commercial and residential participant surveys indicate high customer satisfaction with the programs, and the majority of claimed savings result because of the financial incentive and technical assistance provided.

Figure 12. PY2021 Energy Efficiency Accomplishments



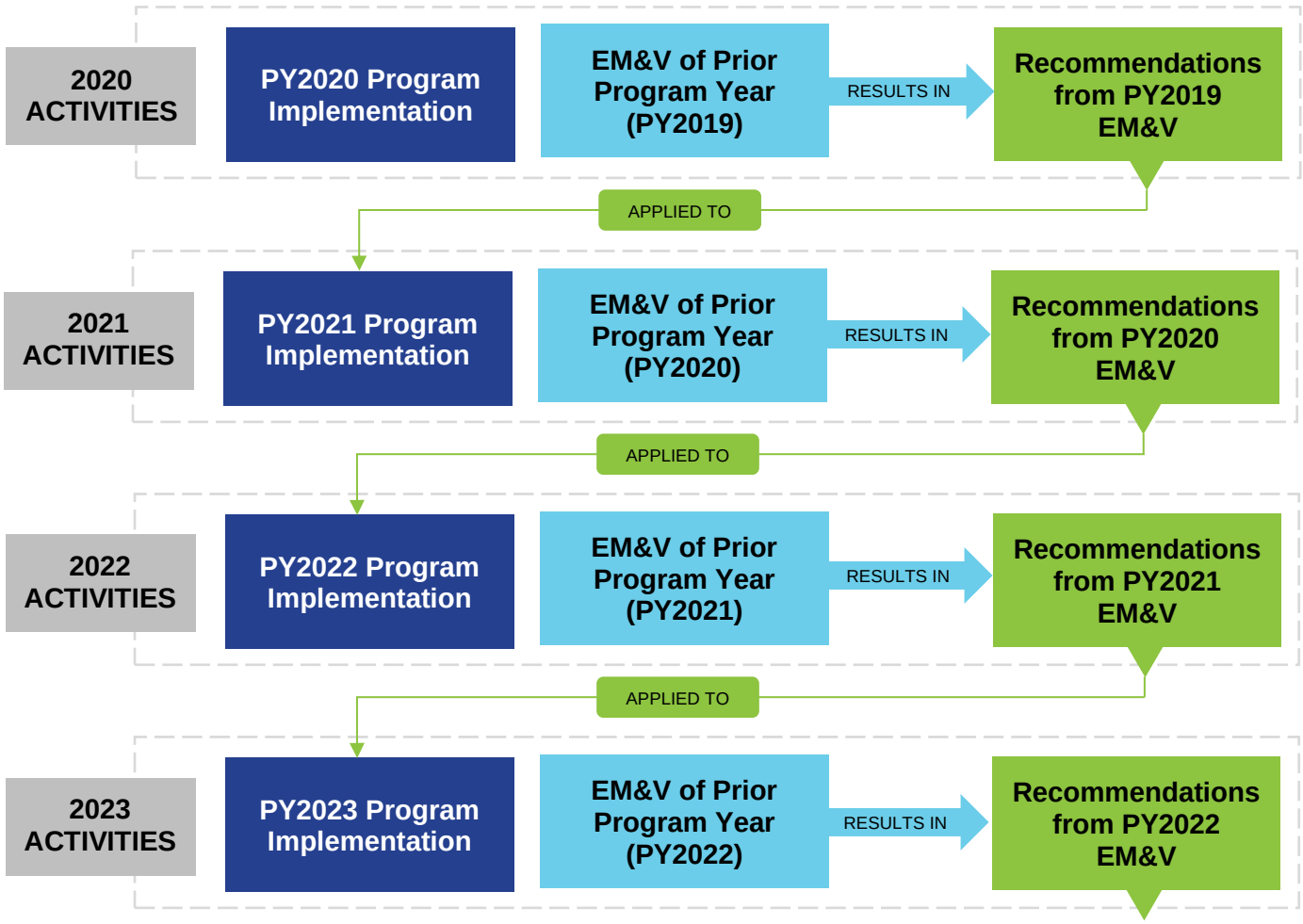
Within this context of progress, the EM&V team offers recommendations to foster continuous improvement in the programs. At the same time, the EM&V team notes new challenges are particularly on the horizon for PY2023 as new codes and standards, coupled with inflationary pressures, are predicted to result in increased costs for energy efficiency gains. Therefore, continued collaboration with stakeholders through the EEIP is also critical for the continuous improvement of the programs to serve Texans most effectively.

1.4.1 Recommendations

The PUCT's EM&V recommendations are to facilitate more accurate, transparent, and consistent savings calculations and program reporting across the Texas energy efficiency programs and provide feedback that can lead to improved program design and delivery.[4] PUCT staff and the EM&V team works with the utilities to agree on utilities' responses to recommendations; these are referred to as *action plans*. Action plans are also vetted with the EEIP (the statewide collaborative group). Utilities then use these action plans to respond to program savings, design, and implementation recommendations within the next program year, consistent with § 25.181(q)(9). Recommendations made based on PY2019 evaluation research, which was completed in 2020, were expected to be implemented in PY2021. Likewise, recommendations resulting from the PY2021 EM&V completed in 2022 are expected to be implemented in PY2023 (see Figure 13). First, we report on utility progress in meeting recommendations that were to be implemented in PY2021. Then we summarize recommendations from the PY2021 EM&V research to be implemented in PY2023.

[4] The EM&V team recognizes that there may be a trade-off between the objectives of the recommendations, program administration costs, and program participation barriers. The EM&V team strives to recognize these trade-offs by making feasible recommendations and working with the utilities to agree upon reasonable action plans in response to recommendations.

Figure 13. Recommendations Timeline



1.4.1.1 Prior EM&V Recommendations

Table 2 through Table 5 summarize the status of 30 PY2019 EM&V recommendations that utilities were to implement in PY2021.[5] While utilities have been responsive to recommendations—with over half of recommendations complete (17 out of 30)—there are still some areas for improvement in utility quality assurance/quality control (QA/QC), program tracking, and project documentation. A few recommendations are *in progress* as they will be assessed in future evaluation years as the applicable program was a *low* evaluation priority in PY2021 or because they reflect annual processes. Next, we review the status of prior EM&V recommendations for commercial, residential, and load management programs, followed by portfolio and cross-sector recommendations.

[5] The PY2019 Statewide Annual Energy Efficiency Portfolio Report had 35 recommendations; however, the COVID-19 response recommendations were collapsed for ease of reporting, resulting in 30 prior recommendations in this report.

Commercial recommendations addressed building type selection, major retrofits, lighting projects, HVAC projects, recommissioning programs, and small business programs (Table 2). Lighting wattage recommendations are noted as *in progress* since some minor discrepancies were found in the PY2021 EM&V. Small business occupancy sensors are noted as *in progress* since this will be assessed in the PY2023 EM&V when small business programs have a *high* priority again.

Table 2. Commercial Program Recommendations for PY2021 Implementation

Category	Recommendation	PY2021 implementation	Status
Building type selection	Commercial interior lighting and HVAC project analysis require proper *building type* selection as guided by the TRM. The *building type* selection should match the predominant indoor facility-use type based on the surface area. Also, the exterior area should not be considered when determining the facility use based on multiple kinds of square footage.	Utilities conducted QA/QC of the *building type* selection and asked the EM&V team for input as needed. Proper selection has improved from prior program years in SOP and commercial MTP programs. Small business programs continue to have evaluation adjustments.	 In progress
Major retrofits	Building renovations that change the *building type* are considered major retrofits. The TRM differentiates between new construction projects and retrofit projects for the baseline used in energy savings calculations.	The 2021 TRM included guidance on energy savings calculations for a major retrofit project with a *building type* change.	 Complete

Category	Recommendation	PY2021 implementation	Status
Lighting projects	Lighting calculations had a significant amount of wattage adjustments for installed lighting wattage. The two reasons were: (1) the LED lighting manufacturer wattages were used instead of the third-party tested wattage, and (2) half-watt denominations allowed by the TRM were not utilized. Utilities should update the calculation process to ensure the use of the third-party listed wattages for installed equipment and continue implementing half-watt increment rounding.	Utilities increased their QA/QC of lighting wattages; however, some evaluation adjustments were still made for incorrect wattages.	 In progress
	Lighting retrofit projects may install new fixtures in locations where fixtures were not previously located. Some projects can allow the existing lighting fixtures to remain in place without impacting the performance of the new lighting fixtures. When the replaced fixtures are not removed, these fixtures should be counted in the *post-install fixture* inventory.	The 2021 TRM stated that the existing lighting fixtures that remain after the lighting retrofits are complete are still considered installed and should be in the *post-install lighting* inventory.	 Complete
HVAC projects	Split systems require that a condenser and air handler be paired to determine cooling capacity and energy efficiency. The condenser unit is the key component and is typically listed with several air handling units on Air Conditioning, Heating, and Refrigeration Institute's (AHRI) listings. This efficiency and capacity should be used in the savings calculation.	The 2021 TRM provided more guidance for determining the efficiency of split systems.	 Complete

Category	Recommendation	PY2021 implementation	Status
Recommissioning programs	M&V methods provide a framework to provide high-quality verified savings for recommissioning projects that cannot be readily isolated through engineering equations or modeling and provide significant energy savings. The EM&V team offered several recommendations on the appropriate M&V.	The PY2021 TRM Recommissioning M&V Protocol was updated to increase the consistency of the calculation process and the accuracy of savings for M&V claimed energy savings. It is also considered a process to support continuous improvement. The EM&V team is providing technical assistance to support consistent implementation.	 Complete
Small business programs	The EM&V team was pleased to see an increase in *weather stripping* projects for small businesses. At the same time, it is crucial to recognize building envelope energy-efficiency measures, such as *weather stripping*, which are more dependent on the detail and quality of the installation compared to other equipment-based measures. The EM&V recommends TRM updates to ensure the proper installation of weather stripping.	The 2021 TRM updated the *non-residential entrance* and *exit door infiltration* measure guidance. Implementation of the measure typically lacked documentation specified in the TRM, resulting in a new recommendation from the PY2021 EM&V below.	 Complete
	The EM&V team noted that only a small percentage of sampled small business projects claimed *lighting controls* savings. There is an opportunity to increase per-project energy efficiency savings by five percent or more by focusing on increasing the number of wall-based occupancy sensors installed.	Utilities will continue to discuss the potential to increase the use of wall-based occupancy sensors with service providers.	 In progress

Residential recommendations are categorized by the four program types: HTR, LI, new homes, and upstream (Table 3). *Complete* recommendations include TRM updates, re-design of new homes to maximize net savings, and LED requirements. *In-progress* recommendations include integrating best practices into program design and delivery and increased training and education to improve measure implementation and savings.

Table 3. Residential Program Recommendations for PY2021 Implementation

Category	Recommendation	PY2021 implementation	Status
Residential retrofit programs	On average, across the ERCOT utilities, programs are reducing households' annual energy use by approximately eight percent. However, results ranged across utility programs from two percent to ten percent of annual consumption. Higher-performing programs are successfully including HVAC equipment.	Utilities considered best practices from the highest-saving residential programs, specifically ways to increase HVAC savings.	 In progress
	A comparison of the consumption analysis results at the measure level indicates the researched TRM deemed savings are overestimating actual savings. *Central air conditioning (CAC)* deemed savings are closest to actual savings. *Air infiltration* is the most overstated.	The PY2021 TRM included updates for *CAC*, *heat pumps (HP)*, *duct sealing*, *ceiling insulation*, and *air infiltration* measures.	 Complete
	The consumption analysis results demonstrating the TRM deemed savings systematically overestimates actual savings indicate that utility programs should address behavior; this includes both customer behavior such as *snapback* (consuming more energy when it is more efficient to do so) and service providers' implementation of measures.	Utilities should include education and training components for both customers and service providers as needed, considering if research and development (R&D) funds are necessary to support these efforts.	 In progress
Hard-to-reach programs	On average, HTR programs are saving five percent of participants' annual energy use, with fairly consistent results across utility programs ranging from five to seven percent. While not commonly implemented, *wall insulation* showed solid savings in the consumption analysis, and limited *HVAC* measures have been completed to date for this sector.	Utilities are working on strategies to increase energy savings opportunities for the HTR sector. One utility, in particular, has gained traction in delivering *HVAC measures* to this sector.	 In progress

Category	Recommendation	PY2021 implementation	Status
Low-income programs	LI programs are the highest savings residential program, with results across utilities ranging from 11 to 21 percent of participants' annual energy use.	Utilities should identify best practices from the highest performing LI program, which has employed unique approaches to serving this sector.	In progress
New homes programs	The TRM's new homes energy model approach does a good job estimating gross energy savings compared to the statewide code. A comparison with non-participant homes and results from interviews with builders and raters suggests some level of market transformation is occurring.	Utilities updated program designs to increase net savings, targeting specific end-uses (especially *HVAC*) and outreach to segments where the market is not transformed considering the current code.	Complete
Upstream programs	Interviews with participating upstream retailer stores, manufacturer sales data, and benchmarking from similar utility programs indicate some level of market transformation of *LEDs* as well as a continued role for the programs in the near term. The EM&V team recommends a net-to-gross (NTG) of 50 percent is used to assess the net savings of upstream lighting programs.	Utilities should assess the cost-effectiveness of upstream lighting programs based on net as well as gross savings to ensure they are cost-effective given some level of market transformation.	In progress
	The EM&V team found some incented lamps that were not ENERGY STAR®-qualified. For ease of implementation, utilities should consider requiring ENERGY STAR certification or third-party certifications for incentivized upstream lamps.	Utilities will monitor the LEDs promoted through the program to ensure they comply with TRM certification requirements.	Complete

The PY2019 EM&V had a few minor recommendations for calculating impacts, all of which are complete (see Table 4).

Table 4. Load Management Program Recommendations for PY2021 Implementation

Category	Recommendation	Future implementation	Status
Commercial programs	Utilities demonstrated strong capabilities in applying the TRM calculation method to savings. The EM&V team noted a minor discrepancy in one instance when selecting baseline days using the *high 5 of 10* method. Six days were chosen because of a tie between two days. The EM&V adjusted the savings calculation to use the five highest loads closest to the event as baseline days.	Utilities will keep active communications with the EM&V team to resolve minor discrepancies in savings calculations. In the case of a tie between the days used to calculate the baseline, utilities will follow the TRM guidance of selecting the five highest loads closest to the event.	 Complete
	The total program savings can be calculated by averaging the sum of sponsor-level savings or adding the average sponsor-level savings. While, in theory, there should be no difference, the points at which rounding occurs can drive minor differences in calculation results. The EM&V team recommends that rounding occurs at the sponsor level for each event.	The 2021 TRM updated the rounding guidance for commercial load management programs.	 Complete
Residential programs	Utilities demonstrated strong capabilities in applying the TRM *high 3 of 5 method*. Residential programs have a large number of participants, with the potential for rounding at the participant level driving substantial differences in savings at the event or program level. Continue rounding data only at the event level or program year level.	The 2021 TRM updated the rounding guidance for residential load management programs.	 Complete
	One utility applies a deemed savings value. While *participant* language was clarified in the 2020 TRM, additional clarification may be helpful. Furthermore, the event-level savings calculation for the deemed savings approach can be simplified to avoid minor rounding discrepancies.	The 2021 TRM language clarified the participant definition and rounding for the event-level savings calculations.	 Complete

Category	Recommendation	Future implementation	Status
	Utilities offering residential programs refer to them as *demand response* in program filings; *load management* is the term defined in the Energy Efficiency Rule 16 TAC § 25.181.	Utilities refer to applicable residential programs as *load management* instead of *demand response*, starting with 2020 filings.	 Complete

Portfolio and cross-sector recommendations included program tracking, project documentation, COVID-19 recommendations at the portfolio level, and measures that apply across sectors (*AC tune-ups*, *multifamily*). For program tracking and project documentation, two recommendations are noted as *complete,* and three have an *in-progress* status. For one *in progress,* it is an annual process, but for the other two, documentation improvements were still identified in the PY2021 EM&V. COVID-19 considerations are noted as *complete* as all utilities adopted best practices and again achieved goals in PY2021. *AC tune-ups* and *multifamily* are in progress as they will be looked at more in future evaluations.

Table 5. Portfolio and Cross-Sector Recommendations for PY2021 Implementation

Category	Recommendation	PY2021 implementation	Status
Program tracking	Some tracking data did not include the measure-level information required by the TRM measure, which resulted in the EM&V team being unable to verify savings for some measures due to insufficient data. The EM&V team recommends that all prescriptive measure tracking data includes the required fields outlined in the TRM.	While measure-level information has improved, there are still some areas for improvement, especially for new and revised measures and when a utility switches tracking system providers.	 In progress
	Tracking data for upstream lighting programs were inconsistent in structure and content. The EM&V team recommends that commercial and residential savings are clearly labeled and include retailer, quantity, and savings information.	The 2021 TRM clarified upstream lighting program requirements.	 Complete

Category	Recommendation	PY2021 implementation	Status
Project documentation	Across several utilities, the EM&V team found a decrease in program documentation scores due to missing or incomplete documentation. The EM&V team recommends that documentation, as specified in the TRM, is collected for each program.	Not all programs received *good* documentation scores; the EM&V team will ask utilities to discuss in results meetings how they will address programs that received less than a *good* program documentation score in PY2021.	 In progress
	An electronic TRM (eTRM) provides an integrated participant data management tool and energy savings calculator. Overall, this technology has the opportunity to enhance the accuracy and transparency of project savings calculations over traditional methods.	The utility using an eTRM provided the EM&V team with process documentation and supporting external documentation.	 Complete
	If a project was approved in a prior program year but not completed (*roll-over project*), the TRM version at project approval may be used for claimed and evaluated savings. However, program tracking data needs to indicate these projects.	Utilities will continue to inform the EM&V team of their program tracking indicator for *roll-over* projects approved under a prior TRM; this is noted as *in progress* since it is an annual occurrence.	 In progress
COVID-19 considerations	A number of strategies and best practices were recommended based on the process evaluation of utilities' response to the COVID-19 pandemic in 2020 and the first half of 2021.	Utilities continued to successfully meet program goals in 2021. As applicable, utilities employed recommended strategies and best practices such as a hybrid of remote/on-site QA/QC, follow-ups with customers regarding health and safety satisfaction, and using a variety of delivery channels. However, some program documentation recommendations for QA/QC were identified in the PY2021 EM&V, included below.	 Complete
AC tune-ups	The EM&V team identified some contractors with a high number of completed projects with much lower average test-in data than the rest of the population. Monitoring trade allies with potentially incorrect test-in results can help identify training opportunities.	Utilities should require their implementation contractors to monitor all trade allies' test-in data to identify and address abnormal trends from specific contractors; this will be assessed in the PY2022 EM&V and therefore is *in progress*.	 In progress

Category	Recommendation	PY2021 implementation	Status
	The EM&V team found that the efficiency loss factors used for the state of Texas were developed using M&V data from both Texas and New Mexico. The EM&V team recommends using only the M&V dataset from the state of Texas to determine efficiency loss values to avoid any influence from other outside regions and weather zones.	Utilities will require their implementation contractors to utilize only the M&V dataset from Texas to determine efficiency loss values; this will be assessed in the PY2022 EM&V and therefore is *in progress*.	 In progress
Multifamily buildings	While multifamily buildings receive incentives for a wide range of measures similar to single-family homes, the TRM does not currently differentiate between single-family and multifamily deemed savings. However, the consumption analysis found results varied considerably across the two.	The 2021 TRM began to address multifamily and single-family eligibility and treatment across residential measures. More updates may be needed, informed by the results of the PY2023 consumption analysis.	 In progress

1.4.1.2 PY2021 Key Findings and Recommendations

Based on findings from the PY2021 EM&V conducted across all the utilities, the EM&V team provides key findings and recommendations for the commercial, residential, and load management programs at the utility portfolio level. Action plans to respond to the EM&V recommendations are also presented. Unless otherwise noted, action plans refer to utilities; however, some action items are for the EM&V team, TRM Working Group, or a combination thereof and are noted as such.

1.4.1.2.1 Commercial Programs

Commercial key findings and recommendations are summarized in Table 6 using the following categories:

- lighting,
- new construction,
- M&V,
- SOPs
- Small business,
- consumption analysis, and
- program satisfaction and attribution.

Table 6. Commercial Program Recommendations and Action Plans

Category	Key finding and recommendation	Action plan
Lighting	Lighting calculation assumptions did not consistently match participant conditions or equipment detailed specifications. Utilities should reduce lighting savings calculation adjustments by completing a detailed review of the claimed savings calculations' individual line-item assumptions and specifications.	Increase QA/QC of the factors that led to adjustments; these include air conditioning type, refrigeration type, non-qualified lighting, lighting controls, and post-installation verification results.
	Lighting savings calculations did not provide consistent results from calculations for lighting equipment that remained in place and lighting equipment that was removed and not replaced.	Review the lighting savings calculations to confirm expected energy savings from lighting remaining in place and lighting removed and not replaced.
New construction	New construction projects in PY2021 have unpredictable timelines due to market conditions. The energy-efficient calculations did not consistently match the changing construction timelines. Most commonly, new construction projects were constructed in phases, and the energy efficiency calculations assumed the entire project was completed.	Verify new construction projects between the actual constructed components and the submitted calculations and documentation.
	New construction lighting projects require the participant to determine the baseline code compliance based upon a scale from *undeveloped* to *downtown area*. A conservative assumption to determine energy savings for new construction would be to select Zone 2; however, Zone 3 is typically picked.	The TRM Working Group will update the PY2023 TRM to clarify the selection of the new construction exterior lighting zones to detail the default.
M&V	The claimed peak demand calculation inconsistently uses the peak demand probability factor (PDPF) *top 20 hours* method for custom savings calculations. Last year's evaluation identified that the *top 20 hours* method was not consistently used.	Continue outreach to implementers and participants who complete custom calculations regarding the peak demand calculation method in the TRM.
	The ideal electric consumption billing data measurement frequency is at least hourly. Monthly consumption data is not able to capture the relationship between the electricity consumption and independent variables necessary to develop robust models to forecast energy savings.	The TRM Working Group will update the PY2023 TRM 10.0 Volume 4 to require hourly consumption data and create an alternative path for data with less frequency.
	The M&V savings process requires that the actual weather conditions at the site be used to develop consumption models based on weather conditions. The identification of historical weather data files and the normalized weather data files does not always match the site conditions.	The TRM Working Group will update the PY2023 TRM 10.0 Volume 4 to indicate the preferred historical weather data file acquisition process. It will also discuss updating the normalized weather data files.

Category	Key finding and recommendation	Action plan
SOPs	The EM&V team found calculation assumptions and documentation did not consistently match participant conditions or equipment specifications. In PY2021, this was expected to happen more frequently because equipment availability was an issue for constructability. It is understandable that the SOPs may not be given the adjusted as-built information when the invoice and purchase order were for other equipment; the claimed savings calculation should represent the as-built condition.	Complete a detailed review of the claimed savings calculations' individual line-item assumptions and specifications to reduce EM&V savings adjustments.
Small business	The documentation for small business programs is streamlined to allow for quick processing for smaller projects. However, the EM&V team found documentation discrepancies, including the wrong location, wrong name, and incorrectly-identified existing lighting fixtures. The streamlined nature must consistently collect the participant's name, location, and baseline equipment to maintain program integrity.	Collect data and documentation from service providers that are then accessible to support improved utility QA/QC reviews.
	The predominant building type is not consistently identified; two-thirds of the evaluated building type adjustments involved the use of the *service* building type.	Provide training to service providers to better determine building type for energy efficiency calculations.
	Entry and exit door seals continue to be implemented below the standards of other measures.	Improve the *entry and exit door seal* measure documentation to match the TRM requirements.
Consumption analysis	Lighting retrofit projects are providing significant savings in participants' facilities, and the TRM is reliability estimating these savings.	Continue to use the TRM to calculate claimed savings for lighting projects.
	The limited participant group size creates challenges in subdividing various analysis groups. Further complicating the analysis, participants' consumption patterns varied from the comparison group. Data availability is key to understanding the impacts of energy efficiency projects.	Utilities and the EM&V team should analyze opportunities to increase participant group sizes.
Program satisfaction and attribution	The programs are generating high satisfaction among participants (average satisfaction is 4.8 on a 5-point scale). In addition, satisfaction increased substantially from the last survey effort (66 percent in the PY2017 survey were very satisfied compared with 88 percent in PY2021).	Review the detailed participant survey results to be aware of areas of the programs working well and any opportunities for improvement.
	Program attribution, the percentage of claimed savings estimated to directly result from the programs, is high (99 percent for CSOP kW and 100 percent for CMTP kW). In other words, the majority of savings are happening because of the program as opposed to other external factors.	Monitor markets and change baselines to continue to maximize net savings.

1.4.1.2.2 Residential Programs

Residential key findings and recommendations are summarized in Table 7 using the following categories:

- energy Independence Security Act (EISA)
- deemed savings,
- HTR/LI programs process assessment, and
- program satisfaction and attribution.

Table 7. Residential Program Recommendations and Action Plans

Category	Key finding and recommendation	Action plan
EISA	New EISA standards will significantly decrease program lighting savings. Based on recent desk reviews and on-sites, a substantial number of halogen and incandescent lamps are currently operating in homes. The EM&V team recommends a delayed implementation of the new baseline to allow for the early retirement of existing incandescent and halogen lamps in programs with direct-install delivery.	The TRM Working Group will update the PY2023 TRM 10.0 Vol 2 to allow for early retirement of incandescent and halogen lamps baseline at the utility's discretion for LI programs with direct-install LED delivery.
	Financial enforcement for retailers of the EISA standard phases is between March 1 and August 1, 2023. Feedback indicates retailers are likely to discount inefficient lighting to move their inventory. Prematurely discontinuing or decreasing incentives for efficient bulbs during this transition period could result in increased inefficient bulbs in homes and businesses.	The TRM Working Group will discuss the pros and cons of a TRM mid-PY2023 implementation date for the EISA baseline change and present for Commission staff approval.
Deemed savings	The PY2021 TRM 8.0 includes a weighted methodology to calculate savings for measures with dual baselines. The EM&V team found that, in some cases, this methodology was not applied consistently.	Sum the heating and cooling savings values together prior to weighting rather than only weighting the cooling savings and adding the heating savings after the fact.
	The PY2021 TRM 8.0 includes an envelope measure allowance for customers participating in LI programs to claim reduced heating savings for homes cooled by one or more space heaters. The EM&V team found that, in some cases, this adjustment factor was not applied consistently.	The TRM Working Group will update the PY2023 TRM 10.0 Vol 2 to incorporate guidance to clarify how to apply the adjustment factors.

Category	Key finding and recommendation	Action plan
	The EM&V team found that, in some cases, summer demand savings were claimed for air conditioners where the full-load efficiency (EER) requirement of 12 was not met.	Demand savings should not be claimed for AC systems where the EER is less than the minimum standard. Only winter demand savings should be claimed for heat pump systems where the EER is less than the minimum standard.[6]
HTR/LI programs process assessment	Expanding the list of other qualifying LI programs and services that qualify for the energy efficiency HTR/LI programs could provide more opportunities for streamlined participation.	The list of qualifying programs and services in the PY2022 TRM HTR/LI program eligibility forms was expanded.
	Only individually-metered multifamily units have been eligible since master-metered units are in a commercial rate class. The programs can increase their reach to LI customers by including master-metered multifamily units with qualifying residents.	The individual meter requirement in the PY2022 TRM HTR/LI program eligibility forms was removed.
	Geographic location information from the Housing and Urban Development (HUD) LI-qualified census tracts provides streamlined participation and improves outreach to HTR/LI customers.	A *geographic location qualifier* category was added to the PY2022 TRM HTR/LI program eligibility forms.
	Many community action agencies and social services organizations throughout Texas are already experienced in qualifying LI households for programs and services.	A section for a community action agency or social service organization to verify program eligibility in the PY2022 TRM HTR/LI program eligibility forms was added.
	Without verification of self-reported income for those who chose to qualify for the program through this option, there is the potential for program services to go to non-LI customers.	Pilot processes verify income eligibility prior to participation for customers who use self-reported income in PY2022. This process can vary by utility, program, and customer type (single-family/multifamily).

[6] A new federal standard for air conditioners and heat pumps will take effect January 1, 2023, and the PY2023 TRM will be updated with the new minimum standard EER.

Category	Key finding and recommendation	Action plan
Program satisfaction and attribution	Most respondents said they were *satisfied* or *very satisfied* with the program overall (89 percent), with three-quarters of respondents being *very satisfied* (77 percent). While satisfaction is high, participants did offer some suggestions, with more energy education and program information at the top of the list.	Review the detailed participant survey results to be aware of areas of the programs working well and opportunities for improvement.
	Program attribution, the percentage of claimed savings that is estimated to result from the program intervention, is high (93 percent kw and 91 percent kwh NTG). In other words, the vast majority of savings are happening because of the program as opposed to other external factors.	Monitor markets and changing baselines to continue to maximize net savings.

1.4.1.2.3 Load Management Programs

Key findings and recommendations are presented in Table 8 for load management programs. Impact evaluation recommendations are minimal, given the processes are well-established. However, issues to address in the PY2022 process evaluation were identified.

Table 8. Load Management Program Recommendations and Action Plans

Category	Key finding and recommendation	Action plan
Commercial	Texas commercial load management programs continue to effectively increase commercial load participants and have maintained high levels of cooperation (about 90 percent) with curtailment events. Consider using the results of the annual test event to modify program-contract estimates of available demand reduction and the test and actual events to identify any non-performers that should not be future participants. The EM&V team will document in the PY2022 process evaluation how each utility manages its participant pool and any planned strategies for future management.	The EM&V team is conducting an in-depth process evaluation of the load management programs as part of the PY2022 evaluation. It will interview each utility to document how they manage their participant pool and any planned strategies for future management. The process evaluation will also include a review of available program information and any improvements to consider.
	There is considerable stakeholder interest in the utility load management programs. Utilities should provide online access to program manuals and update these manuals annually to foster a clear understanding of the program operations.	

Category	Key finding and recommendation	Action plan
Residential	Load management programs continue to effectively increase demand savings and participation. While a relatively low number of meters to date have had missing data, The TRM does not address how to handle missing data for baseline or event days.	The TRM Working Group will discuss TRM clarifications on how to handle missing data.
	TRM language related to the *deemed savings* method has been revised over the past few years, and there is now a mutual understanding of the approach; however, the participation documentation could be improved.	The utility using deemed savings will provide a file that identifies participating smart thermostat devices, including a description of the data fields and the calculation approach.
	For the *deemed savings* method, there was some confusion on how to claim savings for smart thermostat devices sold through the online marketplace and smart thermostat devices that were not enrolled in the residential load management program at the point of purchase. The TRM was updated to provide more guidance and enhance overall accuracy and transparency.	The utility using deemed savings should continue to claim savings for smart thermostat devices that did not enroll during the summer season through the smart thermostat or retail MTPs.

1.4.1.2.4 Portfolio-Level

Portfolio key findings and recommendations are summarized in Table 9 for the following:

- market trends,
- savings opportunities,
- program tracking data,
- meter data, and
- project documentation.

Table 9. Portfolio-Level Recommendations and Action Plans

Category	Key finding and recommendation	Action plan
Market trends	Energy efficiency gains are expected to be increasingly challenging and expensive to obtain. There are multiple reasons for this, including increased costs due to inflationary pressures, market saturation, code and standard changes, staffing shortages, supply chain issues, and economic uncertainty. Challenges are reported as pronounced in rural territories.	Build on best practices to reach underserved communities, including online offerings, community partnerships, installing multiple measures when on-site, and increased incentives.

Category	Key finding and recommendation	Action plan
	Utilities continued their commitment to diversifying the types of measures delivered through the existing programs as well as new pilots (i.e., installing efficient HVAC in multifamily and new homes and efficient commercial food service equipment). Utilities also continued to expand the types of distribution channels used to reach customers, delivering energy efficiency by working with retailers, distributors, and contractors, as well as adding online offerings.	Continue to adapt programs and measures based on marketplace dynamics and trends, needs of underserved communities, and changes in federal standards and codes.
Savings opportunities	The previously referenced EISA changes will decrease demand reductions (kilowatts) available through the programs by about 14 percent, with most of this in the residential sector. Utilities will need to pursue additional savings from other measures to address the impacts of the new regulations on overall savings and continue to meet goals. Identified measures include smart thermostats, lighting controls, heat pump water heaters, programs utilizing AMI data, mini-splits, recommissioning, and variable refrigerant flow.	Expand existing measure offerings and continue to explore potential new measures, engaging the EM&V team as needed.
Program tracking data	The EM&V team loads tracking data received from utilities each quarter by an automated process. Inconsistency in the data format or programs for which data is submitted from quarter to quarter resulted in custom programming for the data to be loaded.	Consider the development of a standard query that is re-run each quarter to capture updated data for the EM&V team; this will guarantee consistency between data request submittals.
	Mapping submitted program data to energy efficiency plans and reports (EEPRs) can be difficult. The differences in data are also likely to go undiscovered until after the last data submission when reconciliation happens. Earlier coordination between utilities and the EM&V team will ensure the accuracy of these mappings, reducing confusion at the end of the program year.	Utilities and the EM&V team should explicitly map all potential data names to EEPR names for the program year as part of the first data request.
	Similar to program mapping, identification of missing information within the data, such as estimated useful life (EUL) details or too-general roll-ups of measures, may go undiscovered until the end-of-year analysis.	Annual results meetings with the EM&V team will include discussions of any measures which potentially cause cost-effectiveness calculation issues.

Category	Key finding and recommendation	Action plan
Meter data	AMI meter data transfers can be more complicated than program tracking data transfers.	Expand the contact list for the meter data request to include a data professional.
Project documentation	The EM&V team found that, in many cases, the documentation verifying residential heating type, particularly electric resistance, was limited; this was an important recommendation from the PY2019 consumption analysis and was to be fully implemented in PY2021.	Educate service providers on TRM documentation requirements and check their compliance with heating type, specifically.
	Challenges for utility M&V inspections continued in PY2021. Commercial projects were less likely to have inspection notes documented, and when inspection notes were provided, the findings were not consistently incorporated into the final documentation and tracking system.	Develop a QA/QC process for inspections, including critical item verification and the incorporation of results into final savings.

2.0 INTRODUCTION AND PORTFOLIO RESULTS

This Statewide Energy Efficiency Report presents the PY2021 evaluation, measurement, and verification (EM&V) findings and recommendations, looking across all eight electric utilities' portfolios. The report addresses gross and net energy and demand impacts, program cost-effectiveness, and program portfolio performance feedback. It includes findings and recommendations to inform updates to the PY2023 Technical Reference Manual (TRM) and the PY2023 program design and delivery.

First, we overview the EM&V methodology in PY2021, followed by portfolio-level results related to program tracking and documentation. Section 3.0 through Section 5.0 present the commercial, residential, cross-sector, and load management program results. A separate Volume 2 of this report details PY2021 impact results for each utility's portfolio.

2.1 EVALUATION, MEASUREMENT, AND VERIFICATION METHODOLOGY

2.1.1 Overview

The EM&V methodology is based on the prioritization for the EM&V effort that includes both PY2021 and the four-year contract period. The EM&V team identified program types across utilities with similar program design, delivery, and target markets. We reviewed each program type and prioritized (*high*, *medium*, *low*) based on the following considerations:

- the magnitude of savings—the percentage of contribution to the portfolio of programs' impacts,
- level of relative uncertainty in estimated savings,
- stage of program or programmatic component (e.g., pilot, early implementation, mature),
- importance to future portfolio performance and PUCT and Texas utilities' priorities,
- prior EM&V results, and
- known and anticipated changes in the markets in which the programs operate.

We conduct a streamlined EM&V effort that couples broad due diligence verification of savings for all programs with targeted in-depth activities. These activities include engineering desk reviews, on-site measurement and verification (M&V), interval meter data analysis, benchmarking research and interviews, and consumption analyses based on the prioritization of the programs.

We carefully developed PY2020–PY2023 EM&V scopes across the four-year contract period that prioritize EM&V activities where they provide the greatest value. To continue the significant progress that the PUCT staff, utilities, and EM&V team have made while working together to improve programs and the TRM, we implement targeted in-depth impact evaluations for particular programs and end-uses, as summarized in Table 10 through Table 13. We couple this with tracking system verification of claimed savings across all programs. This approach maximizes both the cost-effectiveness and the value of the proposed EM&V activities. We have prioritized evaluation efforts regarding the level of effort they may receive as *high*, *medium*, or *low* for utility programs each year.

Residential. We have categorized the residential standard offer programs (RSOP), hard-to-reach (HTR), and low-income (LI) programs as *high* evaluation priorities in PY2021 and PY2023. These programs comprised a substantial percentage of overall statewide portfolio savings in the last five years and responded to TRM updates to the *heat pump* and *envelope* measures in PY2021. The programs were evaluated via desk reviews, on-sites, a targeted consumption analysis for PY2021, and a full consumption analysis in PY2023. We conduct RSOP participant surveys to update net-to-gross (NTG) information, collect key process information, and confirm measure installation in PY2021. The HTR and LI programs are implementing new eligibility processes in PY2022; therefore, these programs will also be a *high* priority in PY2022 to assess this process improvement. Residential new construction programs are a *high* evaluation priority in PY2023; a new statewide baseline code is expected, and these programs will need to continue to push the market in future program years. Residential upstream and midstream programs are expected to grow in utility portfolios and are given a *high* evaluation priority in PY2023 to update process and NTG information. In addition, high-impact measures (i.e., *air conditioners*, *heat pumps*) delivered through midstream programs may also be included in the PY2023 consumption analysis.

Commercial. Commercial standard offer programs (CSOP) and the largest savers of the commercial market transformation programs (CMTP) are at least a *medium* priority for each of the next four program years. These programs represent the largest percentage of statewide savings and plan to explore new customer segments and technologies. While prior EM&V generally found evaluated savings similar to the utilities' claimed savings, it also resulted in several recommendations for changes to reported claimed savings and recommendations. Therefore, we believe that at least a *medium* priority is justifiable for the next four program years due to the savings contributions, the heterogeneity of projects and customer types, and the associated levels of uncertainty in savings. For PY2020 and PY2021, we placed a *high* priority on the largest commercial savers to develop the foundation of annual commercial consumption analyses. The consumption analyses will gauge the effectiveness of the TRM for prioritized high-impact measures for key building types, starting with PY2021. Prioritized consumption analyses will then be repeated annually, expanding to include additional measures and building types. The CSOPs and largest CMTPs were also a *high* priority in PY2021 to update the NTG information and collect key information identified in the PY2020 consumption analysis through participant surveys. Small business programs are designated a *medium* priority twice in the next four-year sector (PY2021 and PY2023). While these programs are not large contributors to statewide savings, small businesses are recognized as an important sector to serve. This sector traditionally faces more barriers to energy efficiency program participation than other commercial sectors, and utilities have been trying to expand the range of measures offered.

Cross-Sector and Pilots. Load management programs are designated a *medium* priority in most years due to their significant contribution to capacity (kilowatt, kW) savings. In PY2022, the programs are designated as a *high* priority as the evaluation will include participant surveys to gather process information on the programs. Pilot programs in their second or third year of implementation are designated as a *medium* priority. We will provide feedback about whether pilots are viable options for full programs. AC tune-ups and photovoltaic (PV) programs are designated as a *medium* priority at least once in the next contract period as the last EM&V cycle established new M&V protocols for these measures in the TRM—which are being done correctly, with some opportunity for improvement. All other program types are *low* priorities for evaluation for three out of the four program years because they are small contributors to portfolio savings, have little uncertainty in savings, and have homogenous projects. However, each of these programs will be designated as a *medium* evaluation priority once in the four-year evaluation cycle.

2.1.2 Prioritization Tables

The tables below summarize prioritization and EM&V level of effort by program type over the four-year EM&V contract period.

Table 10. Evaluation Prioritization Summary—Commercial Sector

	Program type			
	Commercial SOP	Commercial MTPs, excluding small business	Small business MTPs	Other MTPs, pilots
Percentage of PY2019 savings statewide (kilowatt/kilowatt-hour)	7 percent of statewide demand reductions and 27 percent of statewide energy savings	6 percent of statewide demand reductions and 23 percent of statewide energy savings	1 percent of statewide demand reductions and 3 percent of statewide energy savings	Medium/TBD
PY2020 evaluation priority and activity	High: desk reviews, telephone verification of measures, process and NTG participant survey (delayed due to winter storms), targeted consumption analyses		Low: tracking system review and verification	
PY2021 evaluation priority and activity	High: desk reviews and on-site M&V, targeted consumption analyses, process and NTG participant surveys		Medium: desk reviews and on-site M&V	
PY2022 evaluation priority and activity	Medium: desk reviews and on-site M&V, targeted consumption analyses		Low: tracking system review and verification	
PY2023 evaluation priority and activity	Medium: desk reviews, on-site M&V, targeted consumption analyses		Medium: desk reviews and on-site M&V	

Table 11. Evaluation Prioritization Summary—Residential Sector

	Program type		
	Residential SOP	**HTR/LI**	**New homes MTP**
Percentage of PY2019 savings statewide (kilowatt/kilowatt-hour)	8 percent of statewide demand reductions and 10 percent of statewide energy savings	7 percent of statewide demand reductions and 8 percent of statewide energy savings	4 percent of statewide demand reductions and 6 percent of statewide energy savings
PY2020 evaluation priority and activity	Medium: telephone verification on measures, process and NTG participant surveys (delayed due to winter storms)	Low: tracking system review	Low: tracking system review
PY2021 evaluation priority and activity	High: desk reviews and on-site M&V, targeted consumption analyses of updated measures, residential participant surveys, LI/HTR process improvement		Low: tracking system review and verification
PY2022 evaluation priority and activity	Medium: desk reviews and on-site M&V	High: desk reviews and on-site M&V, LI/HTR process improvement interviews	Medium: desk reviews (statewide baseline code change being considered)
PY2023 evaluation priority and activity	High: consumption analyses[7] of updated measures		High: desk reviews, builder and rater interviews

Table 12. Evaluation Prioritization and Summary—Upstream, Midstream, Pilots, Other

	Program type	
	Upstream or midstream MTPs	**Other MTPs, pilots**
Percentage of PY2019 savings statewide (kilowatt/kilowatt-hour)	6 percent of statewide demand reductions and 16 percent of statewide energy savings	1 percent of statewide demand reductions and 1 percent of statewide energy savings
PY2020 evaluation priority and activity	Low: tracking system review	Low or medium/TBD
PY2021 evaluation priority and activity	Low: tracking system review	Low or medium/TBD
PY2022 evaluation priority and activity	Low: tracking system review	Low or medium/TBD
PY2023 evaluation priority and activity	High: in-depth interviews, benchmarking research, possible consumption analyses for high-impact measures	Low or medium/TBD

[7] The residential consumption analyses will include utilities with interval meter data given the importance of measuring kilowatt impacts. However, utilities that do not have interval meter data may be included in PY2023 if both the utility and PUCT staff determine there is sufficient value in doing so.

Table 13. Evaluation Prioritization and Summary—Load Management and Cross-Sector

	Program type		
	Load management programs (residential and nonresidential)	**AC tune-ups (residential and nonresidential)**	**Photovoltaic (PV)**
Percentage of PY2019 savings statewide (kilowatt/kilowatt-hour)	60 percent of statewide demand reductions and <1 percent of statewide energy savings	2 percent of statewide demand reductions and 3 percent of statewide energy savings	<1 percent of statewide demand reductions and 2 percent of statewide energy savings
PY2020 evaluation priority and activity	Medium: census interval meter-data analysis	Low: tracking system review and verification	Medium: a review of M&V calculations
PY2021 evaluation priority and activity	Medium: census interval meter-data analysis	Low: tracking system review and verification	Low: tracking system review
PY2022 evaluation priority and activity	High: census interval meter-data analysis, aggregator interviews, participant surveys (70 residential and 70 commercial)	Medium: census review of M&V data and desk reviews	Medium: a review of M&V data and desk reviews (PV storage change)
PY2023 evaluation priority and activity	Medium: census interval meter-data analysis	Low: tracking system review and verification	Low: tracking system review (assuming no issues from PY2022)

*Table 10 through Table 13 may not sum to 100 percent due to rounding.

2.1.3 PY2021 Activities

EM&V activities:

- confirm that the measures installed are consistent with those listed in the tracking system;
- verify that the claimed savings estimates in the tracking system are consistent with the savings calculated in the deemed calculation tools or tables in accordance with the PY2021 TRM 8.0 or M&V methods used to estimate project savings;
- review savings assumptions and, when available, utility M&V reports gathered through the supplemental data request for sampled projects and EM&V team on-site M&V;
- recommend updates to project-level claimed savings if EM&V results indicate a variation in savings of at least ±5 percent; and
- inform updates for the PY2023 TRM 10.0.

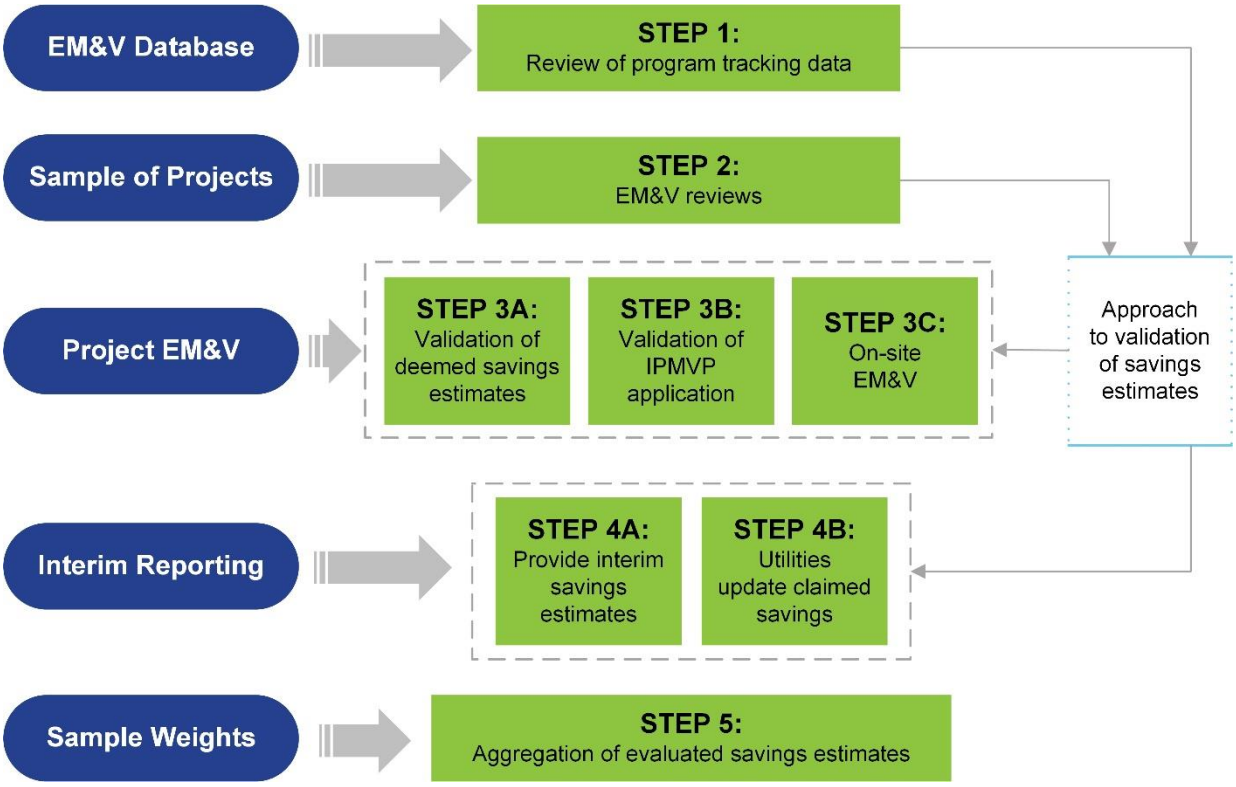
Table 14 shows the EM&V activities completed by program type and evaluation priority.

Table 14. PY2021 Evaluation, Measurement, and Verification Priorities and Activities

Program type	Evaluation priority	Claimed savings verification approach	Project desk reviews	On-sites	Participant surveys	Interval meter/ consumption data analysis
Commercial SOPs, Large commercial MTPs, retro-commissioning (RCx)	High	Sampled (see desk reviews)	156	78	385	Sampled business types for lighting participants and nonparticipants
Small business	Medium	Sampled (see desk reviews)	44	22	N/A	N/A
Commercial load management	Medium	Census	N/A	N/A	N/A	Census
Residential load management	Medium	Census	N/A	N/A	N/A	Census
Residential SOPs, HTR, LI	Medium	Sampled (see desk reviews)	98	31	223	Targeted consumption analyses for *air infiltration* measure
All other programs	Low	Census	N/A	N/A	N/A	N/A

The evaluated savings are based on project-level realization rate calculations weighted to represent program-, sector-, and portfolio-level realization rates. These realization rates incorporate any adjustments for the incorrect application of deemed savings values and any equipment details determined through the tracking system reviews, desk reviews, and primary data collected by the EM&V team. For example, baseline assumptions for hours of use may be corrected through the evaluation review and thus affect the realization rates. A flow chart of the realization rate calculations is illustrated in Figure 14. Realization rates for utility portfolios and utility programs can be found in Volume 2 of this report.

Figure 14. Realization Rate Flowchart



A complementary component of the realization rate is the sufficiency of program documentation provided to estimate evaluated savings—this was used to determine an overall program documentation score for each program with a *medium* or *high* evaluation priority in a utility's portfolio.

The EM&V team conducted cost-effectiveness testing using the program administrator cost test for claimed and evaluated results. LI programs were calculated using the savings-to-investment ratio.

2.2 PORTFOLIO TRENDS

This section presents a high-level overview of Texas utility portfolio trends over the last three years and provides a comparison to trends nationwide.

The research includes interviews with all eight Texas electric utility program design and delivery staff, quantitative trend analysis conducted from the EM&V database, and benchmarking research conducted looking at utilities nationwide. The research objective was to characterize how utility portfolios have changed over the last three years and future directions, successes, and challenges. It is important to note that the last three years provided a unique opportunity to track the latest emerging trends as rapid changes resulted from the COVID-19 pandemic. The analysis included pre-pandemic year 2019, pandemic year 2020, and pandemic/recovery year 2021.

Key Finding #1: Utilities with rural service territories face challenges recruiting energy efficiency service providers (EESP) to provide services to residential customers. These challenges are increasing with recent inflation and contractor staffing shortages.

All utilities interviewed providing service to rural populations discussed the challenges faced with reaching these customers. The biggest challenges discussed were distance to travel, ensuring EESPs can serve the area, customer trust of EESPs, and skepticism that the utility resources provided were real. This challenge only increases with general inflation, rising gas prices, and staffing shortages. The cost of the program sponsors to drive to these areas to provide services to an individual customer or install one measure may not make business sense for them, especially if they are short-staffed. Some utilities have even offered increased incentives to program sponsors to serve these areas but did not see increased participation. Faced with this ongoing and increasing challenge, utilities are exploring options to ensure they reach customers residing in rural areas. The Texas utilities interviewed discussed the following trends emerging to serve these populations:

Online Marketplace: Several utilities with rural services areas have either adopted or are investigating the adoption of an online marketplace. With rural communities gaining better access to quality high-speed internet, this offering may provide options for customers that do not live near retail stores; they can browse energy-efficient products that are pre-qualified and discounted. Common measures included in these types of programs are *LED lights*, *water savings products*, *smart thermostats*, and *advanced power strips* with options to keep adding items as new measures are vetted.

Multiple Measures Installed: Many utilities expressed the intention to recruit, train, and qualify EESPs who were willing and able to install multiple measures at one location during one trip. For instance, if a residential customer in a rural area is replacing a HVAC system, it makes sense to combine this with additional *insulation* or *duct sealing* measures. EESPs could take this further by installing a smart thermostat with offerings to participate in a residential load management program.

Community Partnerships and Relationships: Several utilities serving rural areas shared the importance of local community engagement through organizations such as soil conservation districts, community-based non-profits, municipalities, and chambers of commerce. Establishing and maintaining strong relationships with community entities can serve as a gateway to the recruitment of local EESPs, and aid in economic development and local job training programs while building trust and positive brand recognition through organizations that community members already trust.

National Perspective for Key Finding #1: Nationally, the barriers to serving rural communities with energy efficiency programs identified above were remarkably similar (geographical isolation, workforce availability, lack of awareness, and skepticism of existing resources); however, there also seems to be a focus on tackling the financial barriers as well such as high upfront costs of energy efficiency and overall higher energy burdens in rural areas nationwide.

On-bill programs are one option utilities serving rural areas are using to bridge the energy burden gap. Utilities with on-bill programs can provide their rural customers with free energy assessments, targeting multiple measures simultaneously, all while reducing the burden on the customer. In addition, On-Bill Tariff (OBT) and On-Bill Financing (OBF) models allow these same services to be provided to small businesses in rural communities. Table 15 defines three different on-bill program models.

Table 15. On-Bill Program Models[8]

Model	Description	Benefits
On-Bill Tariff (OBT)	OBT is a model where the investment in the energy performance of homes and buildings is recognized as a system reliability investment, and the utility utilizes tariffs for system investments to consumer bills as the collection mechanism.	The tariff charge on the bill is less than the estimated savings at an 80/20 split, so people save money from day one. The tariff charge is associated with the meter and survives homeownership/tenant changes. This model requires no personal debt obligation, no credit check, and no homeownership requirement.
On-Bill Financing (OBF)	OBF is a model where the investment is paid for in the form of a loan from the utility to the property owner. In this model, the utility is the capital provider and the underwriter of the loan to the customer.	The OBF model allows utility more flexibility in determining the creditworthiness of the customer. This model also allows broader access to capital to low-to-moderate income customers who have less access to credit through traditional lenders.
On-Bill Repayment (OBR)	OBR relies on capital provided by a third-party lender who provides underwriting services and qualifies the property owners based on traditional underwriting criteria.	The utility serves primarily as a marketing and payment collection partner. In the OBR model, the debt obligation is tied to the property owner.

Key Finding #2: Utilities interviewed are diversifying their portfolios' measure mix, and the trend data for measures are positive.

Like other utilities in the country, Texas utilities understand the importance of diversifying their portfolios' measure mix and providing comprehensive program offerings to all customer types. Texas utilities continued their commitment to diversifying the types of measures delivered through the programs and have new pilot programs installing efficient HVAC in multifamily and new homes and efficient commercial food service equipment in restaurants, schools, government, and hospital facilities. Utilities also continued to expand the types of distribution channels used to reach customers, delivering energy efficiency by working with retailers, distributors, and contractors, as well as adding online offerings. Texas utilities continue to adapt programs and measures based on such factors as marketplace dynamics and trends, needs of underserved communities, and changes in federal standards and codes.

Table 16 and Table 17 combine measure data for all Texas utilities interviewed and demonstrate the level of diversification in measures occurring from 2019 through 2021 between *lighting* and all other measures.

[8] Southeast Energy Efficiency Alliance

Table 16. Interviewed Texas Utilities Kilowatt Savings by Measure

Measure	2019 Kilowatts	2020 Kilowatts	2021 Kilowatts
Load management	59.56%	61.07%	63.23%
Lighting	15.22%	15.59%	13.89%
HVAC	12.34%	9.64%	10.40%
All other measures	12.88%	13.70%	12.48%

Table 17. Interviewed Texas Utilities Kilowatt-Hour Savings by Measure

Measure	2019 Kilowatt-hours	2020 Kilowatt-hours	2021 Kilowatt-hours
Lighting	53.25%	56.11%	48.70%
HVAC	25.32%	19.65%	19.39%
All other measures	21.43%	24.24%	31.91%

National Perspective for Key Finding #2: Nationally, utilities are diversifying their offerings beyond traditional energy efficiency program measures. The ACEEE 2020 Utility Energy Efficiency Scorecard (2020 Scorecard) identified the following national trends associated with utilities diversifying their portfolio:[9]

Innovating to meet the changing system needs: Utilities are incorporating more pilot programs to meet changing system needs, such as smart thermostats, online marketplaces, and distributed energy resources (DERs) such as demand response and storage systems. In addition, utilities are beginning to provide advanced metering infrastructure (AMI) feedback on energy usage to customers and deploying grid-interactive efficient buildings (GEB).

Energy usage data: Although there are many challenges to widespread data access and sharing of this data, incorporating energy usage data into programs such as virtual RCx and residential behavioral programs has been beneficial to utilities' diversification efforts. (see Key Finding #4 for additional information related to the use of AMI data.)

Electric vehicles: Utilities are adding a level of diversification by offering an incentive for electric vehicle charging equipment. Some utilities offer make-ready programs that allow organizations to deploy charging quickly, and other utilities use rate design to promote electric vehicle charge at off-peak times.

Key Finding #3: Although some Texas utilities offer incentives for heat pump water heaters (HPWH), widespread adoption has been slow.

According to PY2022 TRM Version 9.0 Volume 2, the residential *HPWH* measure involves the installation of an integrated, or "drop-in," ENERGY STAR® HPWH. The efficient condition is an HPWH certified by ENERGY STAR with a uniform energy factor greater than 2.3.

Although major efficiency improvements have been incorporated into HPWHs and have been available in the marketplace for over 40 years, they are still not widely used. In addition, the

[9] Relf, G., E. Cooper, R. Gold, A. Goyal, and C. Waters. 2020. *2020 Utility Energy Efficiency Scorecard.* Washington, DC: ACEEE. aceee.org/research-report/u2004

warmer Texas climate makes HPWHs a big opportunity for homeowners and Texas to save energy. The Texas utilities identified the following barriers that will need to be overcome before widespread adoption of HPWHs occurs in Texas:

Program Sponsor Education: When a water heater fails, and a contractor is called, it is common in the marketplace for customers to be sold a version of what they already have and know (rather than the contractor educating the customer on a more efficient replacement option available to them, such as HPWHs). Often, if the unit needing to be replaced is old to begin with, the newer replacement unit will be more efficient and pose the least path of resistance for the customer involved and the contractor installing the unit. These lost opportunities to educate customers on HPWHs are impacting the overall adoption rate of this measure.

Consumer Education and Marketing: Many customers have never heard of an HPWH or even realized this option exists; this results in a repeat purchase of conventional water heaters even though there is an opportunity to adopt a more efficient option. It will take better education and marketing to consumers on the value of this equipment if increased adoption rates are desired. Consumers and program sponsors need tools to compare choices, performance, and operating costs. The education and marketing must come from multiple sources, such as manufacturers, program sponsors, and utilities. Customer awareness of the products must first be increased; then, customers must be educated on how installing HPWHs can improve their comfort and reduce energy bills before they begin to ask program sponsors to quote a replacement option that includes the installation of HPWH.

Cost and Installation: HPWHs can cost three times more than traditional water heater options upfront; this poses a barrier for low- and moderate-income program participants. In addition, HPWHs may not be a cost-effective choice for homeowners replacing traditional water heaters with limited space for installation. HPWHs also require additional regular maintenance to continue to operate at maximum efficiency.

National Perspective for Key Finding #3: HPWHs are trending to be the next big savings measure beyond HVAC measures.

In the summer of 2021, the Department of Energy's (DOE) Building Technology Office (BTO) partnered with the Advanced Water Heating Initiative (AWHI) to "catalyze a rapid transition to high efficiency, grid-connected Heat Pump Water Heaters." The AWHI is a collaborative market transformation effort of over 50 organizations. Through this partnership, DOE will support manufacturers and utilities on best practices programs aimed at accelerating the adoption of HPWHs in American homes.[10]

According to D+R International research, the Southeast has tremendous potential to save energy and reduce water heating costs, with 9 of the top 12 states for electric water heating being south of the Mason-Dixon line and over 12.8 million inefficient, standard electric water heaters in operation. Table 17 table provides a summary of electric water heating potential by state.

[10] Department of Energy Nationwide Advanced Heating Deployment Initiative

Table 17. Electric Water Heating Potential by State[11]

Top 12 states	Single-family households with electric water heating (31+ gallons)
Florida	3,936,130
Texas	2,319,337
North Carolina	1,726,489
Pennsylvania	1,496,019
Georgia	1,271,430
Virginia	1,223,179
Tennessee	1,108,818
Washington	1,050,211
Maryland	983,431
Alabama	913,516
Kentucky	844,122
South Carolina	828,396

Key Finding #4: Utilities interviewed agree that AMI data is not being optimized in utility program portfolios due to privacy concerns.

Most utilities in Texas have AMI systems or have plans to install them soon. AMI (which combines smart meters, communication networks, and data management systems) measures electricity usage in short intervals (typically 15 minutes) and makes it available to consumers the next day. For those with smart meters in Texas, there are web portals where customers can sign up to access their AMI data.

In today's world of "big data," having AMI data may seem like an obvious choice to use and analyze for targeted energy efficiency and load management programs. Optimizing "big data" is a portfolio trend that is widely being discussed and will continue to grow. AMI data can be used to compare energy use by customer classes and target outreach for energy efficiency or load management programs to maximize grid operation and energy savings. Texas utilities are reluctant to optimize AMI data beyond customer billing, providing individual access, and providing access to the retail providers due to PURA § 39.107 (k).

[11] Booher, B. 2020. *Wholesale Channel Strategies for Heat Pump Water Heaters: 3 keys for successful midstream programs.* Maryland: D+R International. drintl.com

According to PURA § 39.107 (k): *The commission by rule shall prohibit an electric utility or transmission and distribution utility from selling, sharing, or disclosing information generated, provided, or otherwise collected from an advanced metering system or meter information network, including information used to calculate charges for service, historical load data, and any other customer information. The commission shall allow an electric utility or transmission and distribution utility to share information with an affiliated corporation, or other third-party entity, if the information is to be used only for the purpose of providing electric utility service to the customer or other customer-approved services.*

National Perspective for Key Finding #4: Nearly half of all meters in the US are smart meters and are a key element of grid modernization.[12] However, providing customers with access to AMI data alone generally does not result in energy savings. AMI data must be paired with engagement tools, pricing strategies, and programs with incentives and services that enable, motivate, and support customers to modify their energy use. ACEEE conducted a study that surveyed the top 52 electric utilities by sales and collected data on how they are leveraging AMI to save customers energy. Table 18 describes program measures leveraging AMI data to save customers energy; Table 19 shows which program measures described in Table 18 were included in the top 52 electric utilities' portfolios in PY2018.

Table 18. Program Measures Definitions Leveraging AMI Data to Save Energy[13]

Program measure	Description
Near-real-time energy use feedback to customers	Allows consumers to better understand their behavior and adjust their energy usage to increase savings and reduce their energy bills.
Behavior-based programs with customer feedback and insights	Reduces energy consumption through social science theories of behavior change by providing information to customers, leveraging interpersonal interactions, or providing consumer education.
Time-of-use (TOU) rates	Charges different prices for electricity during different times.
Programs using data disaggregation	Extracts end-use-level and/or appliance-level data from an aggregate or whole building energy signal to engage consumers and to target relevant programs to specific customers
Grid-interactive efficient buildings (GEBs)	Incentivizes buildings that reduce energy waste and carbon emissions while offering flexible building loads to the grid.

Table 19. Program Measures optimizing AMI Included in the Top 52 Electric Utilities' portfolios*

Utility	Near-real-time feedback to customers	Behavior-based feedback	TOU rates	GEBs	Data disaggregation
Portland General Electric	✓	✓	✓	✓	✓
Southern California Edison	✓	✓	✓	✓	✓

[12] Gold, R., C. Waters, and D. York. 2020. *Leveraging Advanced Metering Infrastructure to Save Energy.* Washington, DC: ACEEE aceee.org/researidrch-report/u2001

[13] Ibid

Utility	Near-real-time feedback to customers	Behavior-based feedback	TOU rates	GEBs	Data disaggregation
Commonwealth Edison	✓	✓	✓		✓
NV Energy		✓	✓	✓	✓
AEP Ohio (Ohio Power)	✓	✓	✓		✓
AZ Public Service	✓	✓	✓		✓
Baltimore Gas and Electric	✓	✓	✓		✓
Consumers Energy	✓	✓	✓	✓	
CPS Energy	✓	✓		✓	
DTE Energy	✓	✓	✓		✓
PECO Energy	✓	✓			✓
Salt River Project	✓	✓	✓		
Duke Energy Carolinas (NC)		✓	✓		
Georgia Power	✓	✓	✓		
San Diego Gas & Electric	✓	✓	✓		
WI Electric Power	✓	✓	✓		
Ameren IL		✓	✓		
Duke Energy OH		✓	✓		
Duke Energy SC		✓	✓		
PG&E		✓	✓		
PPL Electric Utilities		✓			
Alabama Power			✓		
Duke Energy IN		✓			
Florida Power & Light			✓		
OK Gas and Electric			✓		
West Penn Power			✓		
Total	**14**	**22**	**22**	**5**	**9**

*Information from PY2018.

2.3 NEW MEASURE ANALYSIS

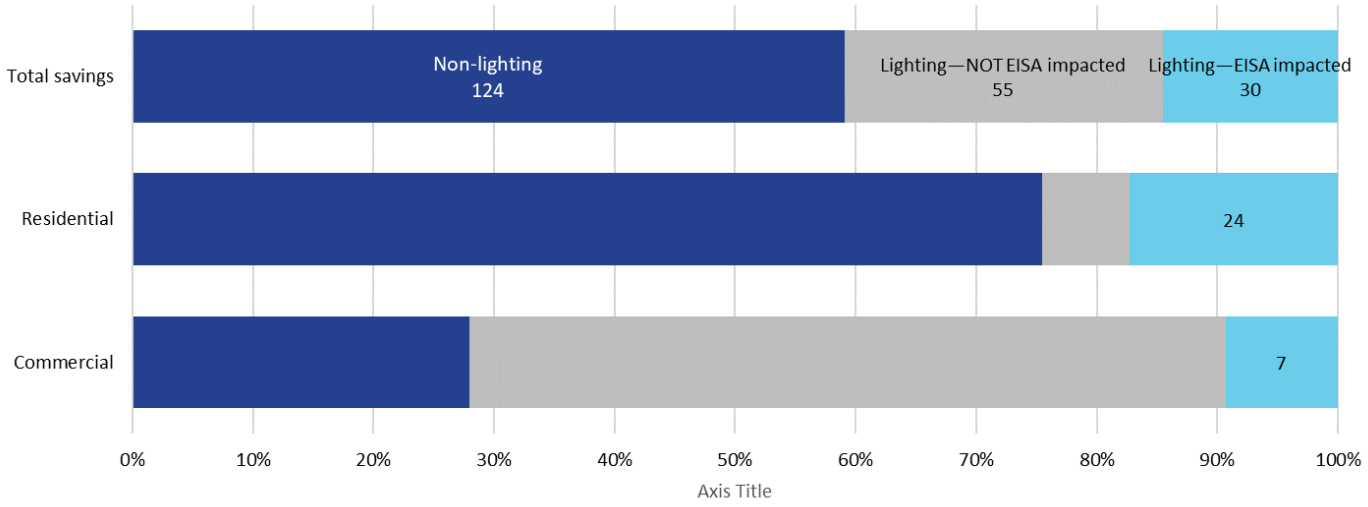
As introduced in the Executive Summary and further discussed in the Portfolio Trends Section above, new challenges are particularly on the horizon for PY2023 as new codes and standards coupled with inflationary pressures are predicted to result in increased costs for energy efficiency gains. This section first discusses the most substantial recent changes and their impacts on the energy efficiency programs as currently delivered. It then provides a preliminary analysis of possible new measures to support continued program success.

2.3.1 Codes and Standard Changes

The Department of Energy published two Final Rules related to general service lamps (GSL) in accordance with its responsibilities under the 2007 Energy Independence and Security Act (EISA).[14] One rule concerned an update to the definitions of GSLs and general service incandescent lamps (GSIL); the second rule updated the energy efficiency of GSLs to a 45 lumens-per-wattage requirement. The Final Rules will go into effect in 2022, with full compliance phased in during 2023.

The EISA standards will significantly decrease the lighting savings delivered through the energy efficiency programs, particularly for the residential sector. The preliminary analysis estimates that the EISA rule will impact approximately 30 MW of peak demand savings, most of which is from the residential sector (24 MW). These lighting savings account for 14 percent of total non-load management savings in 2021, as shown below.

Figure 15. PY2021 Energy Efficiency* Demand Reductions (MW)



*Demand reductions for load management programs have been removed.

[14] The Department of Energy published the two Final Rules on January 19, 2017, which were scheduled to go into effect on January 1, 2020. However, on September 5, 2019, the DOE withdrew both Final Rules. The Final Rules were restored in 2022, with the Federal General Service Lamp Definitions (87 FR 27461) and Backstop (87 FR 27439) going into effect on July 8 and July 25, 2022, respectively.

2.3.2 New Measure Opportunities

Utilities will need to pursue additional savings from other measures to address the impacts of the new regulations on overall savings and continue to meet energy savings goals. There are existing measures that utilities can pursue with high savings potential and high ease of implementation that can help ease the burden of new regulations, such as *smart thermostats* in the residential sector and *lighting controls* in the commercial sector. Table 18 and Table 19 provide a list of other existing residential and commercial measures that may help to ease the burden of new regulations on overall savings.

Table 18. Residential Savings Measures

Measure	Description	M&V considerations	Ease of implementation
Central and mini-split heat pumps	Replacing electric resistance furnaces and old air conditioning units with more efficient electric heat pumps results in savings in both heating and cooling demand.	Consideration for handing electric resistance backup during severe weather scenarios is underway. The new Federal Minimum Efficiency Standards will be enforced in PY2024.	High
Ceiling and wall insulation	Reducing air leakage from the ceilings and attics of residential homes to the ambient temperature during peak demand periods makes these measures very cost-effective. Wall insulation was also found to be a high-saving measure in the consumption analysis, but it is recognized as a costly retrofit.	Additional savings can be claimed for baseline insulation R values less than R-5, beginning with PY2022 TRM Version 9.0 Volume 2.	Medium* for *ceiling insulation*, low for *wall insulation* (*Ceiling insulation is noted as *medium* given supply shortages and cost increases; typically, it would be *high*.)
Smart thermostats	Smart thermostats allow customers to also participate in demand response programs, which reduce kilowatts during peak demand hours. The TRM also has a deemed energy savings methodology for direct-install, upstream, and midstream delivery methods.	The recent 2020 US EIA Residential Energy Consumption Survey (RECS) data shows low market penetration of smart thermostats, leading to considerable potential for savings.	High
Central and mini-split air conditioners	Replacing old air conditioning units with more efficient electric central and mini-split air conditioning units results in cooling electricity and demand savings.	New Federal Minimum Efficiency Standards will be enforced in PY2023.	Medium

Measure	Description	M&V considerations	Ease of implementation
Heat pump water heaters	Replacing conventional electric storage tank water heaters with heat pump water heaters results in savings in heating demand.	• Explore pathways to streamline implementation, such as midstream delivery. • Consider an early retirement baseline that creates an additional savings opportunity that could increase the cost-effectiveness of the measure.	Low

Table 19. Commercial Savings Measures

Measure	Description	M&V considerations	Ease of implementation
Lighting controls	Controls savings for retrofit projects will be unimpacted by EISA standards and are a simple way to supplement existing commercial lighting programs, which make up many commercial energy efficiency programs.	Established deemed savings methodology in PY2023 TRM 10.0 Volume 3; however, building code requirements limit applicability to new construction.	High
Commercial RCx	RCx involves assessing building energy systems (typically through a building energy audit) and identifying and implementing energy conservation measures (ECMs).	RCx projects are in TRM Volume 4 and must comply with IPMVP Option C. The projects require the preparation of an M&V report and regression model to determine savings.	Medium
Variable refrigerant flow (VRF) systems	Replacing conventional HVAC systems with VRF systems can lead to both summer and winter peak demand savings.	VRF systems are in TRM Volume 4 and require preparing an M&V plan and M&V report to determine savings. Savings estimates can be completed using calculations in the TRM.	Medium

Measure	Description	M&V considerations	Ease of implementation
Custom project	Custom projects are completed regularly by commercial and industrial customers. Programs can support the development of these projects and provide incentives to increase the energy efficiency of the new installation.	Each custom project requires increased customer interaction and QA/QC procedures to ensure energy savings calculations are realized. However, as the program develops, energy savings can increase significantly.	Low

Other emerging energy savings measures that Tetra Tech has worked with utilities to pursue in PY2021 and PY2022 include those outlined in Table 20.

Table 20. Residential Savings Measures

Measure	TX utility	Description	Status
Level 2 electric vehicle supply equipment	AEP Texas	Incentivizing Level 2 chargers over Level 1 chargers allows for additional energy savings from added efficiencies.	Data collection and analysis are underway; analysis results may be available for inclusion in the PY2023 TRM 10.0 Volume 2.
Battery storage	Oncor	Including battery storage in the Residential Solar program allows for additional savings.	Discussion in Volume 4 upgrades in PY2023 TRM 10.0 Volume 2.
LED night lights	Xcel	Replacing incandescent night lights with LED night lights allows for additional savings.	A guidance memo was issued for PY2022 program implementation and to be included in the PY2023 TRM 10.0 Volume 2.
Smart home energy management systems	CenterPoint	Installing connected measures, including smart power outlets, smart thermostats, smart switches, and motion sensors, with the potential for savings by automatically disconnecting specific connected loads depending on presence or room occupancy.	Data collection and analysis are underway; analysis results may be available for inclusion in the PY2023 TRM Volume 2.

Measure	TX utility	Description	Status
Codes and standards	Xcel	Statewide building code may not be applied consistently across jurisdictions; the measure supports local building code inspectors to increase adherence to the statewide building code.	Foundational research and data collection in the Xcel Energy territory are underway.
Deemed new homes approach	Oncor	Creating a pathway to implementation of new homes programs that use code-compliance HERS index metrics to map to deemed savings based on modeled savings from prior program participant data; will streamline the claimed savings and incentive calculation for an energy-efficient new home.	Historical data collected through the New Homes program energy models are being analyzed to determine if there is sufficient statistical integrity to deem energy savings based on a few variables.

Table 21. Commercial Savings Measures

Measure	TX utility	Description	Status
Additional commercial envelope measures (including motorized dampers)	Oncor, Entergy	Motorized dampers close automatically when an HVAC fan is turned off, saving energy by reducing infiltration.	This measure has been part of commercial RCx projects.
Luminaire level lighting controls	Oncor	Combine LEDs, controls, connectivity, and data for a flexible lighting product that can improve occupant comfort and space utilization.	This measure has been incorporated in *lighting controls* projects previously using TRM categories.
Additional appliances to commercial midstream programs	Oncor	Make appliances such as advanced power strips, ENERGY STAR air purifiers, ENERGY STAR clothes washers, and ENERGY STAR clothes dryers that are currently available only in residential programs also available in commercial programs	Commercial use of appliances varies by building type; other TRM approaches need to be reviewed prior to implementation.
Dedicated outdoor air system (DOAS) with heat recovery	AEP Texas	DOAS split conventional HVAC into two systems: one for providing dedicated outdoor air ventilation to the building and one for handling the internal heating/cooling loads.	This measure should be installed using the commercial RCx M&V process prior to the development of the TRM measure.

Measure	TX utility	Description	Status
Horticultural lighting	CenterPoint	Projects being received, including the use of LED lighting for indoor agricultural purposes; qualifications and savings calculation undefined.	Guidance on lighting qualification and savings calculations have been provided.
Liquid submersion cooling for data centers	Oncor	A method of cooling data center servers by submerging them in dielectric fluid, resulting in reduced energy use, peak demand, and infrastructure requirements compared with air cooling or liquid pipe-to-point cooling.	Projects have historically been completed using the custom calculation process for retrofit and new construction.
Smart building controls	Oncor	Smart buildings include efficient technologies with automated controls, networked sensors and meters, advanced building automation, data analytics software, energy management and information systems, and monitoring-based commissioning (MBCx).	Projects have historically been completed using the custom calculation process for retrofit and new construction. Commercial RCx M&V is also available to determine savings.

2.4 PROGRAM TRACKING

Tetra Tech collected, compiled, and reviewed program tracking data for all programs in PY2021. We used the data to support evaluation activities, including sampling, deemed savings reviews, and reporting. During these activities, we identified several issues relating to program tracking data. The PY2021 EM&V found the following key findings and resulting recommendations:

Key Finding #1: Tracking data received from utilities is loaded each quarter by an automated process. Inconsistency in the data format or programs submitted from quarter to quarter resulted in custom programming for the data to be loaded. Unnecessary extra formatting in the files also requires custom fixes before loading the data. Plain text (e.g., .csv) files are ideal; short of that, less formatting is preferable.

Recommendation #1: Utilities should consider the development of a standard query that is then re-run each quarter to capture updated data; this will guarantee consistency between data request submittals.

Key Finding #2: Mapping submitted program data to EEPR programs can be difficult. The differences are also likely to go undiscovered until after the last data submission when reconciliation happens. Earlier coordination between utilities and Tetra Tech staff to ensure the accuracy of these mappings would reduce end-of-program-year confusion.

Recommendation #2: Utilities and Tetra Tech staff should meet early in the year and explicitly map all potential program names to EEPRs programs for the program year.

Key Finding #3: Similar to program mapping, identification of issues with missing information within the data, such as estimated useful life (EUL) details or too-general roll-up of measures, may go undiscovered until the end-of-year analysis.

Recommendation #3: Utilities and Tetra Tech staff should meet early in the year and again quarterly if necessary and discuss any measures which will potentially cause cost-effectiveness calculation issues.

2.4.1 Meter Data

The consumption analysis requires interval meter data from AMI. Tetra Tech collected, compiled, and reviewed the readings similar to the program tracking data, although the source and volume of the information required a different process. The PY2021 EM&V commercial consumption analysis found the following key findings and resulting recommendations:

Key Finding #1: AMI meter data transfers can be more complicated than program tracking data transfers.

In PY2020, the meter consumption data request was completed through the same communication channels and data storage locations as the program tracking data request. However, the size and complexity of the data set may be best handled by utility meter data specialists from the utility and the EM&V team with support from the program tracking data contacts who understand the goals of the data request and programs. For example, direct communications between the EM&V team and utility meter data specialists could cover the structure and size of the data to more easily understand how to organize and store the data and quality assurance processes to ensure complete and secure data transmission. These types of communications are expected to unlock efficiencies in meter consumption data collection, transferring, and understanding.

Recommendation #1: Expand the contact list for the meter consumption data request to include a data professional from the EM&V team and the utilities.

Key Finding #2: Limited participant group size limited the scope and applicability of the consumption analysis.

In PY2021, many potential members of the participant group were removed due to a lack of interval meter data or less than 12 months pre- and post-implementation data. Ultimately, the size of the participant group was the limiting factor in the applicability of the consumption analysis.

Increasing the length of meter data available and perhaps requesting specific meters for the tracking participant group for consumption analysis will increase the potential size of the participant group; this will allow the analysis to better handle weather anomalies or other independent variables. The EM&V team understands that extra data requests create complexities for the utility meter data collection, creating an unnecessary burden for utility staff; however, doing so will increase the understanding of participant activity and the energy savings levels for individual measures.

Recommendation #2: Review the selection of meters and the data collection time period with program and data specialist contacts to discuss the potential to expand the meter data collected.

2.5 PROGRAM DOCUMENTATION

Tetra Tech collected and reviewed project documentation from individual sampled projects for programs with *high* and *medium* evaluation priorities in PY2021. The review is completed to review the completeness of documentation, identify discrepancies between the tracking system and the installed measure, and review the energy savings calculations for compliance with the TRM. Based on this work, the EM&V team offers the following key findings and recommendations:

Key Finding #1: The EM&V team found that, in many cases, the documentation verifying heating type, particularly electric resistance heating, was limited.

Based on the PY2019 consumption analysis that found overestimated savings for envelope and HVAC projects that had existing electric resistance heat, the PY2021 TRM 8.0 indicates that envelope and HVAC projects that additional documentation should be collected for projects with existing electric resistance heat type. This is due to the substantial increase in savings from electric resistance to heat pump heating types.

Recommendation #1: Utilities should educate contractors on documentation requirements outlined in the TRM and check their compliance with heating type, specifically.

Key Finding #2: Challenges for inspections continued in PY2021.

Inspections returned in PY2021 using a more standard process (compared to PY2020), which was impacted by COVID-19 restrictions. Although staffing constraints appeared to limit the inspections' impact on the overall QA/QC for implemented projects, the evaluation found that commercial program projects were less likely to have inspection notes documented. When inspection notes were provided, the findings were not always consistently incorporated into the final documentation and tracking system. In particular, rural projects appeared most impacted because program inspectors were less likely to use limited resources to access the locations.

Staff turnover with installers and program implementers also appeared to limit the impact of inspections. The commercial program evaluation found varied indications in programs throughout the inspection process. The evaluation found some inspections completed were missing details on project scope, changes in equipment specifications, and documentation of critical assumptions for calculations. In addition, there were several projects in which inspections documented adjustments that were not incorporated into the final calculations or were incorporated into final calculations, but the outputs were not incorporated into the tracking system.

Recommendation #2: Utilities and program implementers should develop QA/QC documentation to ensure all staff understands the inspection process, critical item verification, and follow-up to incorporate results into the final tracked program savings. In addition to the documentation of the inspection process, reviewing the opportunities for a hybrid inspection process that incorporates a combination of in-person inspection with technology-based tools for communication and virtual inspection will provide flexibility for staffing and can maintain a high level of data integrity.

3.0 COMMERCIAL ENERGY EFFICIENCY PROGRAMS

3.1 SUMMARY RESULTS

This section presents statewide summary results, followed by key findings and recommendations from all relevant evaluation, measurement, and verification (EM&V) activities.

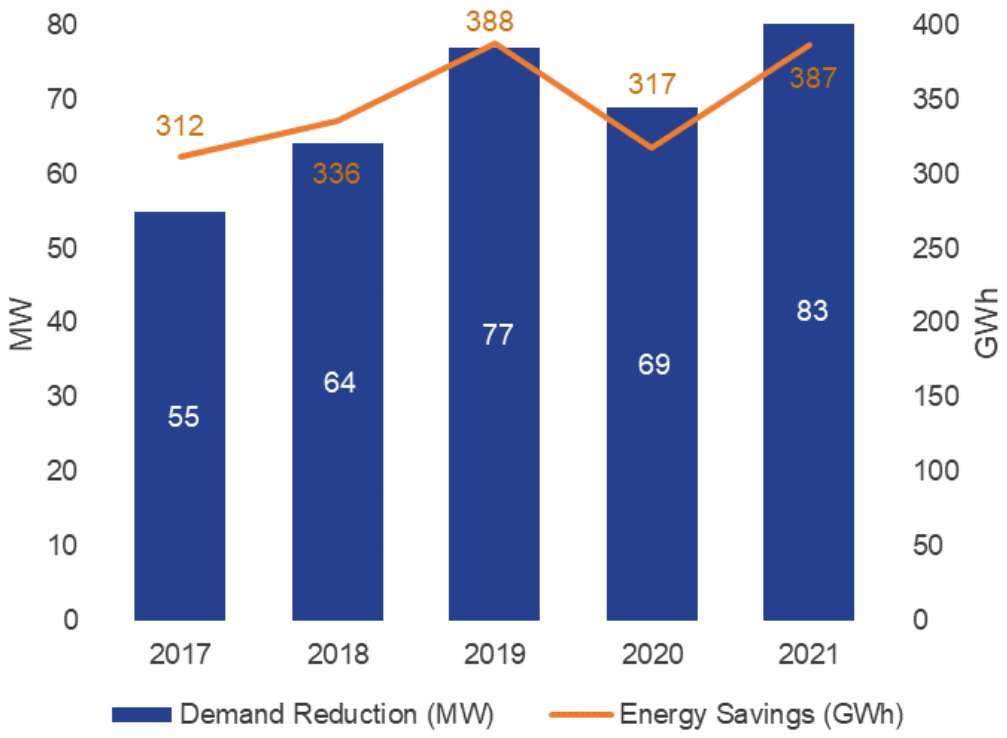
3.1.1 Savings

The statewide program year (PY) 2021 (PY2021) evaluated gross savings from commercial sector programs were:

- 83,313 kilowatts (kW) (demand reduction), and
- 387,008,857 kWh (energy savings).

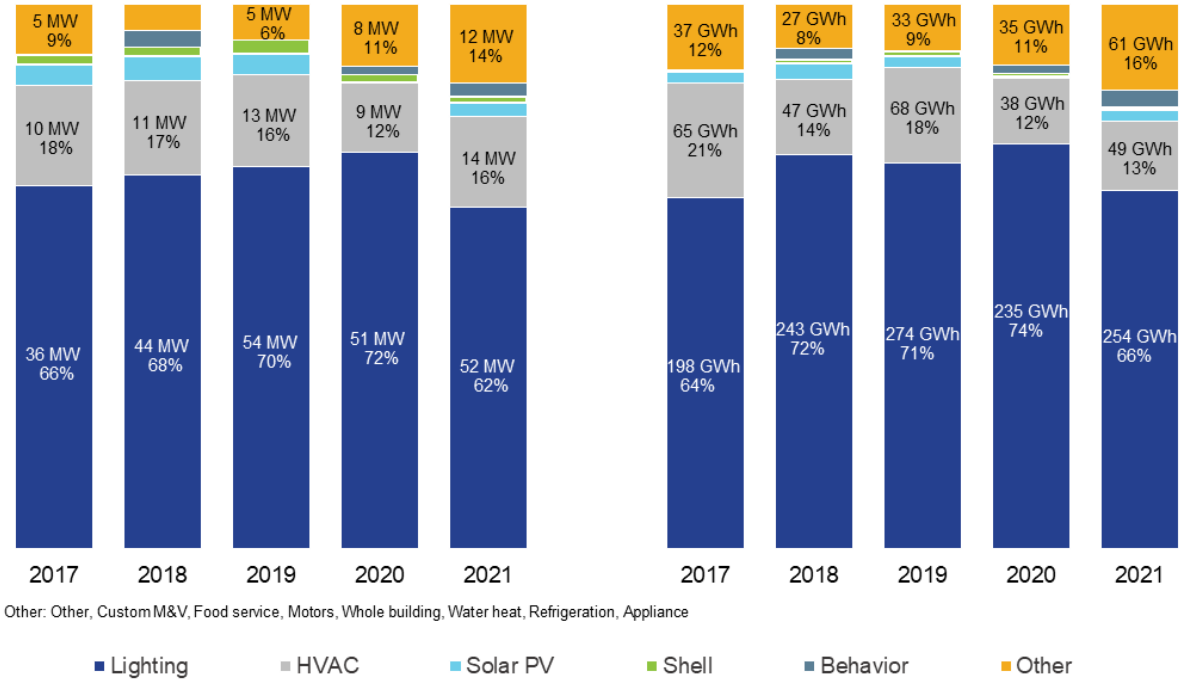
As shown in Figure 16, demand reduction results reflected a decrease from PY2019 to PY2020 (77 megawatts (MW) to 69 MW, respectively) but rebounded in PY2021 to 83 MW. Similar results occurred with energy savings; there was a decrease from PY2019 to PY2020 (388 GWh to 317 GWh, respectively) and an increase from PY2020 to PY2021 (317 GWh to 387 GWh, respectively).

Figure 16. Total Statewide Evaluated Demand Reduction and Energy Savings by Program Year—Commercial Programs PY2017–PY2021



As indicated in Figure 17, *lighting* measures still account for the majority of the energy savings (62 percent) and demand reduction (66 percent). PY2021 saw *HVAC* and *lighting* measures making up approximately 78 percent and 79 percent of demand reduction and energy savings, respectively.

Figure 17. Distribution of Statewide Evaluated Gross Demand Reduction and Evaluated Gross Energy Savings by Measure Category—Commercial Programs Excluding Load Management PY2017–PY2021[15]



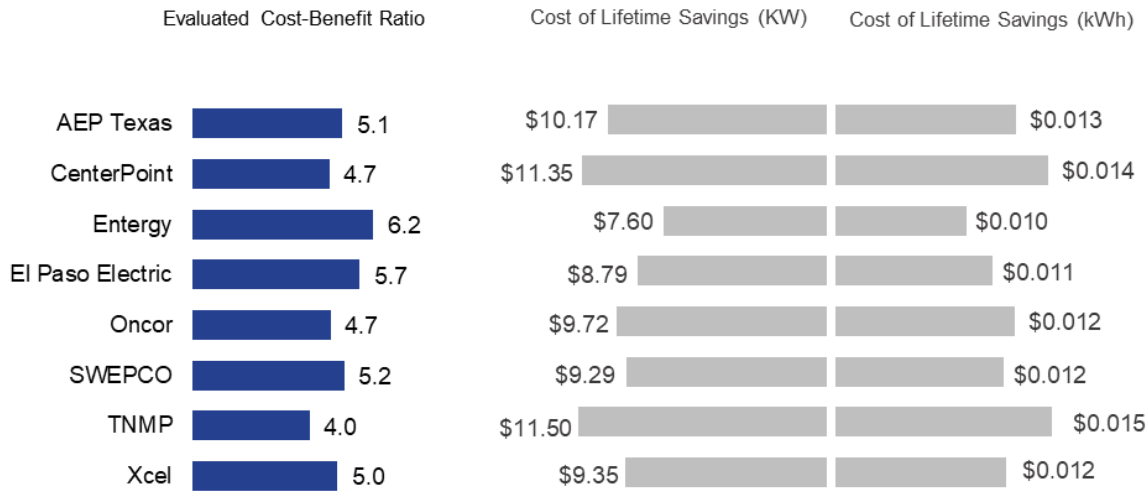
3.1.2 Cost-Effectiveness

Figure 18 summarizes the cost-effectiveness of each utility's commercial energy efficiency portfolio. Commercial sector programs were the most cost-effective, with overall cost-effectiveness of 5.1 statewide based on evaluated savings and 4.5 based on net savings. Utilities' results ranged from 4.0 to 6.2 based on evaluated gross savings and 3.6 to 5.4 based on evaluated net savings. There is variation in the utilities' results in the commercial sector because of the diversity of program designs offered by the utilities.

Figure 18 also summarizes the cost of lifetime kilowatt-hours and kilowatts for each utility's commercial sector programs. The cost per kilowatt-hour ranges from $0.010 to $0.015, and the cost per kilowatt ranges from $7.60 to $11.50. These costs provide an alternate way of describing the cost-effectiveness of a portfolio of commercial programs; portfolios with a higher cost-effectiveness ratio will have a lower cost to acquire savings and vice versa.

[15] Values less than four percent have been suppressed for visualization purposes.

Figure 18. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Commercial Programs PY2021



3.2 COMMERCIAL PROGRAMS

3.2.1 Program Overviews

This section summarizes the key findings and recommendations from the PY2021 evaluation of commercial energy efficiency projects. All commercial energy efficiency programs except midstream, solar photovoltaic (PV), and HVAC tune-up market transformation programs (MTP) were a *high* or *medium* evaluation priority in PY2021. The recommendations are to be considered by the utilities for PY2023 implementation and incorporated into the PY2023 Texas Technical Reference Manual (TRM) 10.0 as appropriate.

The EM&V team conducted a streamlined EM&V effort that couples broad due diligence verification of savings for the commercial programs with targeted in-depth activities, including engineering desk reviews, on-site verification, and interval meter data analysis based on the prioritization of the programs.

The EM&V team evaluated the commercial energy efficiency programs described below. There are two types of programs: standard offer programs (SOP) and MTP. An SOP is a program under which a utility administers standard offer contracts between the utility and energy efficiency service providers (EESP). These contracts specify standard payments based upon the amount of energy and peak demand savings achieved through energy efficiency measures, measurement and verification (M&V) protocols, and other terms and conditions. An MTP is a strategic program intended to induce lasting structural or behavioral changes in the market, resulting in increased adoption of energy-efficient technologies, services, and practices.[16] SOP and MTP programs continue to represent the most significant percentage of statewide savings.

[16] PUCT Order, Chapter 25: Substantive Rules Applicable to Electric Service Providers.

Commercial SOP: The Commercial SOP provides new construction and retrofit installation incentives for various measures that reduce demand and save energy in nonresidential facilities. Incentives are paid to EESPs (project sponsors) based on deemed savings or verified demand and energy savings at eligible commercial customers' facilities. The utility has a limited group of participating project sponsors, which are determined through a selection process. This selection process is based on meeting minimum eligibility criteria, complying with all program rules and procedures, submitting documentation describing their projects, and entering into a standard agreement with the investor-owned utility.

Commercial Solutions MTP: The Commercial Solutions MTP targets commercial customers that do not have the in-house expertise to (1) identify, evaluate, and undertake energy efficiency improvements; (2) properly evaluate energy efficiency proposals from vendors; or (3) understand how to leverage their energy savings to finance projects. Assistance from the program includes communications support and technical assistance to identify, assess, and implement energy efficiency measures. Financial incentives are provided for eligible energy efficiency measures installed in new or retrofit applications, resulting in verifiable demand and energy savings. Commercial Solutions MTPs can include midstream programs that offer incentives at the distribution point to installation contractors who intend to install the equipment for eligible commercial or industrial customers. Specialty midstream programs are implemented using the Commercial Solutions MTP framework but are operated separately within utilities.

SCORE MTP: The SCORE MTP helps educational facilities (public and private schools, K–12, and higher education) and local government institutions to lower their energy use; this is done by providing education and assistance with integrating energy efficiency into their short- and long-term planning, budgeting, and operational practices. Lowering energy use is also completed through energy master planning workshops; energy performance benchmarking; and identifying, assessing, and implementing energy efficiency measures. Energy efficiency improvements include capital-intensive projects and implementing operational and maintenance practices and procedures. Financial incentives are provided for energy efficiency measures that reduce peak electricity demand.

Recommissioning MTP: The Recommissioning MTP offers commercial customers the opportunity to make operational performance improvements in their facilities based on low-cost/no-cost measures identified by engineering analysis. Financial incentives are provided to facility owners and retro-commissioning (RCx) agents to implement energy efficiency measures and projects completed by approved project deadlines.

Small Business MTP: The Small Business MTP is sometimes referred to as the Open MTP by Texas utilities. It is designed to assist small business customers with identifying and implementing cost-effective energy efficiency solutions at their workplace. Small business customers are defined as business customers that do not have the in-house capacity or expertise to (1) identify, evaluate, and undertake energy efficiency improvements; (2) properly evaluate energy efficiency proposals from vendors; or (3) understand how to leverage their energy savings to finance projects.

3.2.2 Commercial Market Transformation Programs

This section presents the Commercial Solutions and SCORE program results that were a *high* evaluation priority and the Retro-Commissioning program that was a *medium* evaluation priority in PY2021.

3.2.2.1 EM&V Overview

The EM&V team conducted desk reviews and on-site verification visits for a sample of projects from the *high*- and *medium*-priority commercial MTP programs. For the desk reviews, the EM&V team applied the method prescribed in PY2021 TRM 8.0 to verify energy savings and demand reduction for each project sampled. Comparing the evaluated savings to the utility-claimed savings showed agreement in about half of the cases; this is much lower than previous evaluations. Some individual projects reviewed had extensive adjustments when evaluated but did not adjust the overall program realization rates. Table 22 presents the range of evaluated project-adjusted savings for MTP projects when comparing evaluated ex-post savings to ex-ante savings. The range identifies the variability in evaluated results for various MTP programs and provides additional context for the key findings and recommendations.

Table 22. Range of Evaluated Adjusted Savings for Market Transformation Program

Program	Evaluated adjusted savings comparison (kW)	Evaluated adjusted savings comparison (kWh)
Commercial Solutions MTP	13.7%–118.5%	48.2%–266.0%
SCORE MTP	0.0%–230.8%	54.2%–128.8%
Retro-Commissioning MTP	96.7%–132.6%	79.5%–120.0%

Based on the evaluation results, the EM&V team has outlined key findings and recommendations below.

3.2.2.2 Key Findings and Recommendations

All key findings and recommendations outlined for the commercial MTPs (Commercial Solutions and SCORE) are equally relevant to the SOP programs. The SOP programs include many of the same deemed and prescriptive calculations as the MTP programs; the SOP programs also use custom calculations and M&V methodology to claim savings for projects.

3.2.2.3 Commercial Market Transformation Programs (Commercial Solutions and SCORE)

Key Finding #1: The lighting calculation assumption did not consistently match participant conditions or equipment detailed specifications.

The lighting savings calculations continue to require small wattage adjustments for installed lighting equipment. However, the other calculation assumptions, which in past years have required minimal adjustments, required a significant increase in adjustments due to inconsistencies between the calculation and actual conditions. EM&V was able to identify the inconsistencies in both the documentation review and on-site verification. The following calculation assumptions increased the frequency of adjustments:

- *Air Conditioning Type:* The *air conditioning type* was commonly not adjusted per lighting equipment installed; this was most common in facilities with an air-conditioned office space and an unconditioned workspace.

- *Refrigeration Type:* Several projects did not adjust the space cooling type to *low* or *medium* refrigeration type from *air conditioned* type for refrigerated lighting locations. There were also projects with both *low* and *medium* refrigeration spaces that identified only one as the refrigeration temperature.
- *Non-Qualified Lighting:* Adjustments changing *qualified certification* to *non-qualified certification* continued at historical levels; however, there was an increase in the lighting equipment that was adjusted from *non-qualified* to *qualified* in the evaluation.
- *Lighting Controls:* Adjustments continued to be required to match the calculation to the lighting controls installed. Most commonly, the lighting controls were installed but not included in the calculation. However, there was an increase in the amount of *lighting control type* adjustments and removals of *lighting controls* from the calculations.
- *Post-Installation Verification:* Several projects required calculation adjustments identified during the post-installation verification. These adjustments were made in the final calculator, although the tracking system did not reflect the adjusted savings.

Recommendation #1: Reduce lighting savings calculation adjustments by completing a detailed review of the claimed savings calculations, individual line-item assumptions, and specifications.

Key Finding #2: New construction projects were completed in phases.

New construction projects should be verified between the actual constructed components and the submitted calculations and documentation.

New construction projects in PY2021 have unpredictable timelines due to market conditions. The energy-efficient calculations did not consistently match the changing construction timelines. Most commonly, new construction projects were constructed in phases, and the energy efficiency calculations assumed the entire project was completed. This condition identified significant adjustments to savings for PY2021 programs.

Recommendation #2: New construction projects should be verified between the actual constructed components and the submitted calculations and documentation.

Key Finding #3: New construction exterior lighting requires judgment to determine the proper baseline assumptions.

New construction lighting projects require the participant to determine the baseline code compliance based upon a scale from *undeveloped* to *downtown area*. Typically, the choice for new construction is either *Zone 2: Areas predominantly consisting of residential zoning, neighborhood business districts, lighting industrial with limited nighttime use, and residential mixed-use areas* or *Zone 3: All other areas*. A conservative assumption to determine energy savings for new construction would be to select Zone 2; however, Zone 3 is typically picked.

Recommendation #3: Update the TRM to clarify the selection of the new construction exterior lighting zones to detail the default to be more conservative (e.g., Zone 2) and allow for increased lighting allowances when applicable.

3.2.2.4 M&V Methodology Savings

The M&V methodology is used to claim energy savings for RCx, behavioral, operational, controls, or custom energy savings. The M&V methods provide a framework for providing high-quality verified savings for projects that cannot be readily isolated through engineering equations or modeling and provide significant energy savings. This process opens energy efficiency programs to identify and claim savings from more complicated projects where the interactive effects or operation protocols do not match those described in the TRM. Improvements in M&V equipment and techniques allow this energy efficiency claiming type to be used more frequently, creating more accurate claimed savings.

The projects include the M&V Plan and results to determine a normalized baseline from previous consumption records and an improved normalized consumption based on consumption records after the improvement. The protocol described in PY2020 TRM 8.0 Volume 4 requires comprehensive projects to comply with IPMVP Option C and expect savings greater than ten percent of energy use shown on the utility bill (or sub-meter). The analysis should have a coefficient of determination (R^2) equal to or above 75 percent. The process includes tools for the M&V expert to help manage the data to support a clean and relevant equation to develop a normalized energy consumption.

Key Finding #1: The claimed peak demand calculation inconsistently uses the peak demand probability factor (PDPF) *top 20 hours* method for custom savings calculations.

Last year's evaluation identified that the *top 20 hours* method was not consistently used. The PY2021 evaluation found that the use of the method increased in projects. Refer to the previous evaluation for a description of the improvement required.

Recommendation #1: Continue outreach to implementers and participants who complete custom calculations regarding the peak demand calculation method in the TRM.

Key Finding #2: M&V claimed savings modeling could be improved to enhance the accuracy of energy savings calculations.

The ideal electric consumption billing data measurement frequency is hourly or shorter to create a robust model to determine energy savings. Participants who only have consumption data available at the monthly frequency are not able to capture the relationship between the electricity consumption and independent variables necessary to develop robust models to forecast energy savings. The evaluation team has worked with the model developers to develop site-specific adjustments when the consumption data is not ideal. However, as AMI becomes more common, the M&V modeling should use hourly consumption data for pre-installation and post-installation models.

Recommendation #2: Update the PY2023 TRM 10.0 (Volume 4, Section 2.4, M&V Miscellaneous) to require hourly consumption data and create an alternative path for data with less frequency.

Key Finding #3: The historical weather and the normalized weather data files do not always match the site conditions.

The M&V savings process requires that the actual weather conditions at the site be used to develop consumption models based on weather conditions. Historical weather data files vary in detail and accuracy and may differ from actual site conditions.

The M&V savings process specified the normalized weather conditions for each of the five climate zones. This year, there were projects located inland in Climate Zone 4 which showed a significant difference between the specified normalized weather data file and the actual weather conditions at the site in peak temperature conditions. These significant differences resulted from the normalized weather data file specified being located on the coast while the sites were inland. The relative decrease in peak summer temperatures between the site's historical and normalized weather files created unrealistic calculated energy savings.

Recommendation #3A: Update the PY2023 TRM 10.0 Volume 4 to indicate the preferred historical weather-data-file acquisition process.

Recommendation #3B: Consider updating the normalized weather data files to make a differentiation between coastal areas and inland areas.

3.2.3 Commercial Standard Offer Program

This section presents the Commercial SOP program results that were a *high* evaluation priority in PY2021.

3.2.3.1 EM&V Overview

The EM&V team conducted desk reviews and on-site verification visits for a sample of projects from the *high*-priority Commercial SOP program. For the desk reviews, the EM&V team applied the method prescribed in PY2021 TRM 8.0 to verify energy savings and demand reduction for each project sampled. Comparing the evaluated savings to the utility-claimed savings showed agreement in about half of the cases; this is much lower than previous evaluations. Some individual measures reviewed had extensive adjustments, including one that reduced the savings to zero. Although, the adjustments do not adjust the overall program realization rates. The evaluated measures adjusted savings for the Commercial SOP projects between 71.4 percent and 125.9 percent, outside of the project that eliminated savings. The range of values identifies the variability in evaluated results for the Commercial SOP program and provides additional context for the key findings and recommendations.

The Commercial SOP key findings and recommendations do not restate the key findings and recommendations for other programs. However, since measures and program delivery occurs across the programs, the findings and recommendations from other commercial programs also apply to the Commercial SOP program.

3.2.3.2 Key Findings and Recommendations

Key Finding #1: Calculation assumption and documentation did not consistently match participant conditions or equipment specifications.

The lighting savings calculations in the Commercial SOP programs had many of the same adjustments identified in Commercial MTP Finding #1. In addition, Commercial SOP projects were found to have miscategorized *LED fixtures* as *LED tubes* and claimed portions of projects that were not completed at the time of the EM&V on-site inspection. One *HVAC* calculation found that the part-load efficiency and full-load efficiency were switched.

Outside of the adjustments above that are expected to be managed, there was equipment installed that did not meet the submitted specification and was not identified as *adjusted* in the final calculation. In PY2021, this was expected to happen more frequently because equipment availability was an issue for constructability. It is understandable that the Commercial SOP program may not have been given the adjusted as-built information when the invoice and purchase order were for other equipment. The claimed savings calculation should represent the as-built condition.

Recommendation #1: Reduce HVAC and lighting savings calculation adjustments by completing a detailed review of the claimed savings calculations, individual line-item assumptions, and specifications.

Key Finding #2. Lighting savings calculations did not provide consistent results from calculations for *lighting equipment that remained in place* and *lighting equipment that was removed and not replaced*.

The lighting savings calculations are organized to collect the existing and improved lighting types and wattages. There are some lighting retrofits where the existing lighting remains in place and continues to be used and some retrofits that remove equipment that is not replaced with new lighting equipment (delamping). The existing lighting that remains in place should be identified in both the *existing* and *improved* lighting inventories, so the calculation shows zero savings. For delamping, the improved lighting equipment should show a zero quantity of the predominant lighting equipment installed in the lighting retrofit; this will attribute the energy savings to the lighting retrofit equipment as opposed to the removed equipment.

In PY2021, the EM&V team identified lighting equipment that claimed savings for equipment remaining in place, claimed zero savings for *equipment removed and not replaced*, and categorized *lighting equipment removed and not replaced* as *lighting savings associated with the existing equipment (halogen)*.

Recommendation #2: Review the lighting savings calculations to confirm expected energy savings from *lighting remaining in place* and *lighting removed and not replaced* match expected results.

3.2.4 Small Business Market Transformation Programs (Small Business and Open)

This section presents the Small Business and Open program results that were a *medium* evaluation priority in PY2021.

3.2.4.1 EM&V Overview

The EM&V team conducted desk reviews and on-site verification visits for a sample of projects from the *medium*-priority Small Business MTP programs. For the desk reviews, the EM&V team applied the method prescribed in the PY2021 TRM 8.0 to verify energy savings and demand reduction for each project sampled. Comparing the evaluated savings to the utility-claimed savings showed agreement in about one-third of the cases; this is much lower than previous evaluations. Some individual measures reviewed had extensive adjustments, ranging from 70 percent to over 500 percent. The range of values identifies the variability in evaluated results for the Small Business MTPs programs and provides additional context for the key findings and recommendations.

The Small Business MTP programs' key findings and recommendations do not restate the key findings and recommendations for other programs. However, since measures and program delivery occurs across the programs, the findings and recommendations from other commercial programs also apply to the Small Business MTP programs.

Based on the evaluation results, the EM&V team has outlined key findings and recommendations described below.

3.2.4.2 Key Findings and Recommendations

Key Finding #1: Calculation assumption and documentation did not consistently match participant condition or equipment specifications.

The documentation of Small Business MTP programs is generally streamlined to allow for quick processing for the smaller projects. In PY2021, the evaluation identified adjustments in the small business calculations noted in Commercial MTP Section 3.2.2 and Commercial SOP Section 3.2.3. However, the Small Business MTP programs also included documentation discrepancies that recorded the wrong location or name of the business and incorrectly identified the existing lighting fixtures. The streamlined nature of the Small Business MTP program data collection must consistently collect the participant's name, location, and baseline equipment to maintain program quality.

The data may be collected through a third-party tool when delivering the Small Business MTP programs. The documentation should be accessible and collected in the utility tracking system to support improved quality assurance reviews.

Recommendation #1: Reduce small business savings calculations adjustments by completing a detailed review of the claimed savings calculations, individual line-item assumptions, and specifications.

Key Finding #2: The prescribed *building type* selected did not match predominant building operations.

The predominant *building type* is not consistently identified in small business projects. Two-thirds of the evaluated *building type* adjustments involved the use of the *service* building type, although there were two other adjustments from *manufacturing* to *retail* and *office* to *health care-outpatient*. Each adjustment made in the evaluation was able to identify the thought process of the implementer when determining the building type; however, each condition interpreted using the TRM guidance for *building type* should have identified a different *building type*.

Recommendation #2: Provide third-party data collection specialist training to determine *building type* for energy efficiency calculations.

Key Finding #3: The *door seal* measure was not implemented with the required documentation or detail.

Entry and exit door seals continue to be implemented below the standards of other measures in the small business programs. The *HVAC type* was not consistently documented, and the door dimensions were not consistently measured to the level of detail described in the TRM. In addition, the post-installation photos should show that the door seal has a full and clean seal on the wall and sides, and the seal shows no damage.

Recommendation #3: Improve the *entry and exit door seals* measure documentation to match the TRM requirements.

3.3 CONSUMPTION ANALYSIS

This section outlines the observation of the consumption analysis process completed on *lighting* measures for the SOP and MTP program measures. The consumption analysis limited the scope to *lighting* measures for select participant building types, including *food sales, outpatient healthcare, financial institutions, vehicle sales, and warehouses*. The detailed results and overview of the consumption activities will be included in the Technical Appendix.

Using the weather-normalized energy consumption, we implemented a series of meter-level fixed-effects models to estimate the energy savings and demand reduction resulting from the implementations. The participant group identified that completed lighting retrofit projects in PY2020 reduced energy consumption by 17 percent, as shown in
Table 23. This reduction percentage was consistent across the consumption sizes of the businesses, measured by the pre-retrofit annual normalized consumption.

Table 23. Consumption Model Results Compared to Pre-Treatment

Participant analysis group	n	Average normalized energy consumption, pre-treatment (kWh)	Average model savings (kWh)	Savings as a percentage of pre-treatment consumption
Under 100,000 kWh	13	45,728.30	6,734.85	14.73%
100,000 to 300,000 kWh	23	187,026.20	28,852.15	15.43%

Participant analysis group	n	Average normalized energy consumption, pre-treatment (kWh)	Average model savings (kWh)	Savings as a percentage of pre-treatment consumption
300,000 kWh to 1 million kWh	26	546,990.56	86,681.13	15.85%
Over 1 million kWh	17	1,608,498.97	297,399.47	18.49%
All groups total	**79**	**588,130.48**	**102,033.58**	**17.35%**

The claimed savings from these lighting retrofit projects are calculated based on the equipment removed and the upgraded equipment installed. The claimed savings normalize the energy savings and identify the reduction in the annual energy consumption. To compare the reduced consumption to the claimed energy savings, the participant group determined the average annual savings for each project from the combined energy modeling results and the combined claimed savings in the programs. The analysis found that the energy consumption model savings are lower than the claimed savings, as shown in Table 24; however, the confidence interval is large, and matching the claimed savings is possible.

Table 24. Consumption Model Results Compared to Claimed Savings

Analysis group	Average model savings (kWh)	Average claimed savings (kWh)	Model savings as a percentage of claimed savings	90% confidence interval
Participant	102,033.58	140,304.18	72.72%	72.7%

The EM&V team applied the peak demand methodology described in the TRM, the *PDPF top 20 hours method*. Table 25 shows the average modeled peak electric consumption and the savings as a percentage of the summer pre-install peak demand. The normalized summer peak demand of the pre-treatment period determines the participant analysis group and the savings percentage, although the model savings is determined by the maximum reduction in the winter or summer peak periods as defined by the TRM. Different than the annual consumption, the peak demand reduction modeled is a larger reduction as a percentage of pre-treatment demand than the modeled kilowatt-hours, and it follows the more traditional results of increased percentage reduction for smaller projects.

Table 25. Program-Level Consumption Model Peak Demand Reduction

Participant analysis group (Pre-Treatment Summer kW)	n	Average normalized peak energy demand		Average model savings (kW)	Savings as a percentage of summer pre-treatment
		Pre-treatment summer (kW)	Pre-treatment winter (kW)		
Under 20 kW	11	9.04	6.18	3.13	34.6%
20 kW to 200 kW	53	81.96	58.02	21.73	26.5%
Over 200 kW	8	389.71	207.53	82.66	21.2%
All groups total	**72**	**105.01**	**66.71**	**25.66**	**24.4%**

3.3.1 Observations

Observation #1: Lighting retrofit projects reduced energy consumption for program participants.

The program participants who completed a lighting retrofit project saved significant energy, as shown in the reduced energy consumption between the pre-installation and post-installation normalized consumption periods. The result is statistically near to the claimed savings and overall does not indicate significant adjustments are required for the TRM entries associated with calculating lighting savings.

Observation #2: Limited participant group size.

The tracking data request and data cleaning identified 1,732 potential meters for inclusion in the participant group. However, 140 participated in PY2020 and were eligible for the participant group, and 94 met the criteria for a lighting retrofit project. Although this is a significant number of participants to occur in a year, the limited participant group size creates challenges in subdividing the participant group into various analysis groups.

Observation #3: Data availability is key to understanding the impacts of energy efficiency projects.

The consumption analysis tracked participants that received an incentive in PY2017 through PY2019 (before the PY2020 participant period) and found that this group acted differently than the comparison group and more similar to the participant group. Additional historical data is required to understand the potential long-term impacts of lighting retrofit projects. The EM&V team and Commission staff will need to determine whether persistence is a research priority and if limited budget dollars should be allocated to persistence research.

3.4 PARTICIPANT SURVEYS

3.4.1 Overview

The EM&V team conducted a commercial participant telephone survey to inform the evaluation effort. The survey included participants' feedback from the Commercial Standard Offer program (CSOP) and Commercial Market Transformation program (CMTP).

While the survey's main objective was to assess measure persistence and collect information used to calculate net-to-gross (NTG), the survey also collected limited process information. The survey ran from June 13, 2022, to July 1, 2022. Table 26 shows the number of completed surveys by utility and program type.

Table 26. Commercial Surveys Completed by Utility and Program Type

Utility	CSOP	CMTP	Total
AEP Texas	16	81	97
CenterPoint	89	28	117
El Paso Electric	0	26	26
Entergy	0	21	21
Oncor	71	1	72

Utility	CSOP	CMTP	Total
SWEPCO	4	26	30
TNMP	0	11	11
Xcel Energy	10	1	11
Total	**190**	**195**	**385**

The following section summarizes key findings from the customer participant survey. The survey asked questions to inform installation and persistence rates, NTG ratios, and customer satisfaction, and it collected limited information about the participants' business.

3.4.2 Key Findings and Recommendations

Key Finding #1: The commercial programs generate high satisfaction among participants. CSOP and CMTP program participants rated their overall satisfaction on a 0–5 scale in the commercial survey, where 0 was equal to *very dissatisfied,* and 5 was equal to *very satisfied*. Mean satisfaction overall among commercial respondents was 4.8, as more than 95 percent of the overall respondents rated their satisfaction a 4 or 5. These high satisfaction levels suggested that the programs are being delivered according to customer expectations.

Recommendation #1: Continue delivering the program as-is.

Key Finding #2: The program participants' most commonly reported sources of awareness are their contractor or vendor and their utility. CSOP participants were more likely than participants in other program types to have heard from their EESP or contractor, while CMTP participants were more likely to have heard from their utility.

Recommendation #2: Continue program strategies that support an EESP infrastructure, effectively marketing energy efficient equipment through financial incentives and providing recommendations and information to customers regarding the energy efficient equipment.

Key Finding #3: Program attribution, the percentage of claimed savings estimated to directly result from the programs, remains high. Free-ridership based on program participant self-reporting decreased by 10 percent for the CSOP and about 15 percent for the CMTP compared to the last commercial survey conducted for PY2017. The EM&V team calculated the free-ridership rate for the CSOP at 23 percent for kilowatt-hour savings and 22 percent for kilowatt savings. For the CMTP, the free-ridership rate was 19 percent for kilowatt-hour savings and 20 percent for kilowatt savings.

Recommendation #3: Continue successfully maintaining industry-standard levels of program attribution for commercial programs.

3.4.3 Process Results

Detailed findings from the survey with commercial energy efficiency program participants are summarized below for firmographics, program awareness, program satisfaction, measure persistence, and program influence.

3.4.3.1 Firmographics

The survey included questions regarding the participating organization and the facility where the measure was implemented. The responses to the survey indicate that the programs are reaching a wide variety of business types, buildings, and projects. The most commonly-upgraded business types among CSOP survey respondents were *office*, *manufacturing*, *retail*, *service*, *warehouse*, and *food sales*. Given that some CMTPs target education and government facilities, these were the most commonly-upgraded business types among CMTP survey respondents. A wide variety of other types of facilities were represented, including *offices*, *retail*, *manufacturing*, *healthcare*, *services*, and *warehouses*. The facilities ranged widely in age, from about a century old to new construction projects.

The majority of participating facilities were upgraded directly by the owner (see Table 27); however, over 20 percent of surveyed CSOP projects were completed in a facility occupied by an organization other than the participant. This is important for commercial programs because leased facilities can prove to be a barrier; facility owners who control the building's equipment may not pay the energy bills, so they have a lower incentive to implement efficiency projects.

Table 27. Respondent Company's Role in Facility

Company's role	CSOP	CMTP	Total
Owns and occupies	70.4%	86.1%	87.3%
Rent or lease	21.1%	8.3%	14.7%
Owns but it is rented/leased to someone else	8.5%	5.6%	7.0%
Respondents (n)	**71**	**74**	**143**

Source: Question FIRM2, 2021 Commercial Participant Survey.

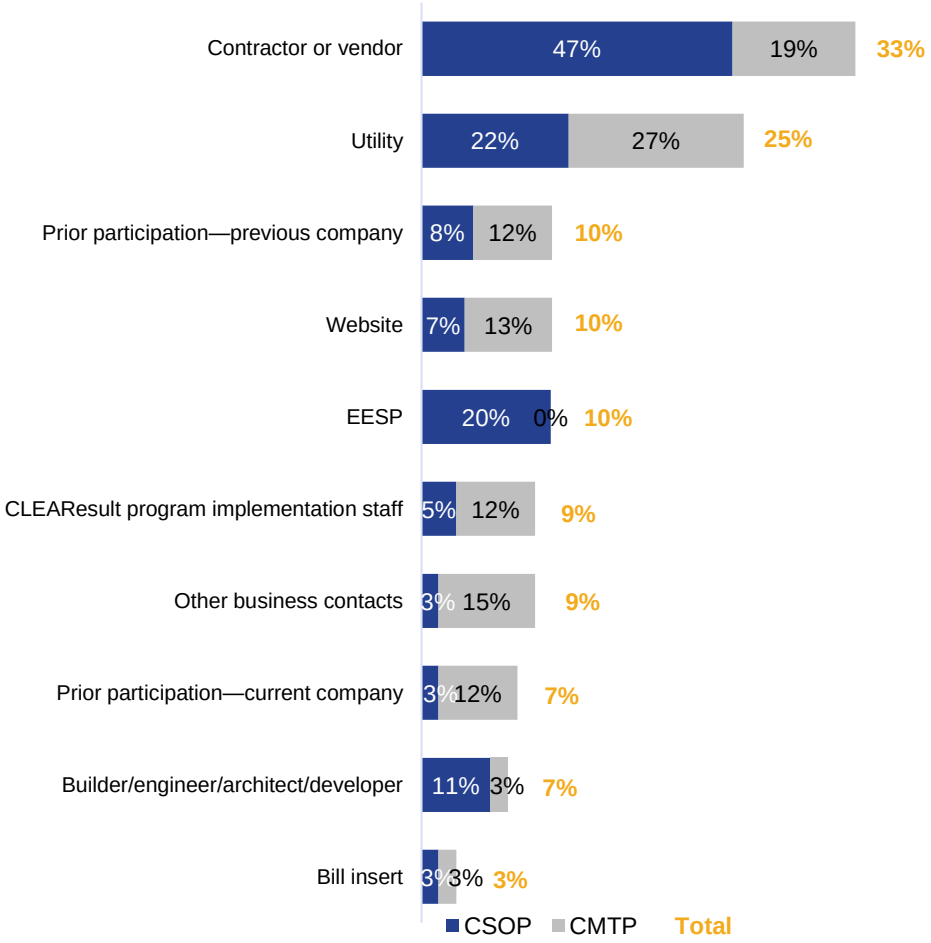
Don't know, *refused*, and multiples were excluded from this analysis.

3.4.3.2 Program Awareness

CSOP and CMTP program participants were asked how they first heard about the energy efficiency program. Participant responses are slightly different by program and are displayed in Figure 19. Participants could report more than one answer.

CSOP participants were more likely than other program types to have heard from their EESP or contractor, while CMTP participants were more likely to have heard from their utility. CSOP participants most commonly reported hearing about the program through their *contractor or vendor* (47 percent). Still, the *utility* was also reported by 22 percent of the CSOP respondents, followed by *EESP vendor* (20 percent). CMTP respondents most frequently reported that they heard about their program through their *utility* (27 percent), while another 19 percent reported that their *contractor or vendor* was their source of program awareness. Thirteen percent of CMTP respondents reported hearing about the program through a *website* (either the utility's website or Google). These main sources of awareness align with those resulting from the Commercial Participant Survey conducted for PY2017.

Figure 19. Top Ten Sources of Program Awareness



Source: Question A1, 2021 Commercial Participant Survey.
The figure shows the top ten sources of program awareness. *Don't know*, *refused*, and multiples were excluded.

The survey also asked participants if they were aware that the program services were coordinated by their utility. The majority of participants responded that they did know that the utility was involved. About 20 percent of all respondents were unaware; this was higher for CSOP participants than CMTP participants, as outlined in Table 28.

Table 28. Awareness with Utility Involvement in Energy Efficiency Program

Awareness (Y/N)	CSOP	CMTP	Total
Yes	75.0%	87.8%	81.5%
No	25.0%	12.2%	18.5%
Respondents (n)	**72**	**74**	**146**

Source: Question INC0, 2021 Commercial Participant Survey.
Don't know, *refused*, and multiples were excluded from this analysis.

3.4.3.3 Program Satisfaction

The survey included a short series of questions to gauge customer satisfaction with their participation experience. The programs are generating high satisfaction among participants (see Table 29). Survey respondents were asked to rate their overall satisfaction on a 0–5 scale, where 0 was equal to *very dissatisfied,* and 5 was equal to *very satisfied*. Mean satisfaction across CSOP and CMTP respondents was 4.8. Eighty-eight percent of overall respondents reported their satisfaction at a 5, or indicated they were *very satisfied* with the program—a substantial increase from the PY2017 survey where 66 percent indicated that they were *very satisfied* with the program. More than 95 percent of the overall respondents rated their satisfaction a 4 or 5. Looking at satisfaction by program, 87 percent of CSOP respondents rated their satisfaction a 5; 89 percent of CMTP respondents rated their satisfaction at similar levels.

Table 29. Satisfaction with CSOP and CMTP Programs

Satisfaction rating	CSOP	CMTP	Total
0—Very dissatisfied	0.0%	0.0%	0.0%
1	1.4%	1.3%	1.3%
2	0.0%	0.0%	0.0%
3	2.7%	2.7%	2.7%
4	9.5%	6.7%	8.1%
5—Very satisfied	86.5%	89.3%	87.9%
Mean	**4.8**	**4.8**	**4.8**
Respondents (n)	**74**	**75**	**149**

Source: Question SA2, 2021 Commercial Participant Survey.

Totals may not sum to 100 percent due to rounding. *Don't know*, *refused*, and multiples were excluded from this analysis.

The highly-satisfied customers brought up a wide range of subjects resulting in their satisfaction, including customer service and communication, financial benefits (rebates and energy bill reductions), positive experience with contractors, and quality or performance of new equipment. Of the less-than-satisfied respondents who rated satisfaction a 3 or lower (n=6), some mentioned that the paperwork was time-consuming, and others noted that the incentives or financial benefits were low.

Satisfaction was also high with the safety precautions and cleanliness of the contractor. When asked to rate their satisfaction on a 0–5 scale, where 0 was equal to *very dissatisfied,* and 5 was equal to *very satisfied*, 89 percent of CSOP respondents and 92 percent of CMTP respondents rated their satisfaction with the safety and cleanliness of the contractor at a 5, or indicated they were *very satisfied*.

Participants were also asked if they would change any aspects of the energy efficiency program services or equipment based on their experiences. Most of the respondents said “nothing” (82 percent), and only 18 percent of the respondents provided some suggestions. Most of the suggestions were related to either increasing the program incentives and budget (n=7), streamlining the application process and required paperwork (n=7), expanding the equipment qualified for the program (n=4), or providing more information about the incentive calculation approach (n=2).

When asked if they recommended the energy efficiency program to others, the percentage of customers that did was higher for CMTP participants, as outlined in Table 30.

Table 30. Recommendation of the Energy Efficiency Program to Others

Recommendation (Y/N)	CSOP	CMTP	Total
Yes	36.5%	55.4%	45.9%
No	63.5%	44.6%	54.1%
Respondents (n)	**74**	**74**	**148**

Source: Question SA5, 2021 Commercial Participant Survey.
Don’t know, *refused*, and multiples were excluded from this analysis.

3.4.3.4 Measure Persistence

All of the measures implemented through the program are still installed and operating.

3.4.3.5 Program Influence

We reviewed the participant responses to key program influence indicators. The results presented below indicate *moderate* to *high* program influence.

When asked about the importance of 12 different factors in influencing their decision to purchase or implement energy efficiency upgrades, the highest rated factor among all respondents was *payback on investment.* The lowest rated factor was *information from a training course or seminar offered by a service provider*. These results are consistent with results from the PY2017 Commercial Participant Survey.

Table 31 includes the average rating for each of the 12 factors (for each program type) on a scale from 0–10, where 0 means *not at all important* and 10 means *very important*. Compared to PY2017, *previous experience with a utility energy efficiency project* ranked higher, while *recommendations from a vendor or supplier* ranked slightly lower. One outlier *was information provided through a study, energy assessment, or other technical assistance* that received a lower rating among CMTP respondents (average rating of 5.7 compared to 7.8 in PY2017).

Table 31. Rating of Importance of Factors that Influenced Customers' Energy Efficiency Upgrades

Factor	CSOP		CMTP	
	Average rating	Number of respondents	Average rating	Number of respondents
Payback on investment	8.3	157	8.2	180
Information provided through a study, energy assessment, or other technical assistance	8.1	42	5.7	95
Availability of the markdown or financial assistance	8.1	79	8.0	134
Previous experience with contractor or a utility energy efficiency project	7.7	144	8.3	171
General concerns about the environment	7.6	158	6.3	182
Standard practice or corporate policy regarding equipment installation	7.5	101	6.4	180
Information or recommendations provided by program staff or contractor	7.3	144	6.7	173
The age or condition of the old equipment	7.3	150	8.3	131
Recommendation from a vendor or supplier	6.7	149	6.0	155
Information from utility program informational materials	5.8	148	6.6	164
Financial assistance or rebate from another organization	4.5	74	6.4	87
Information from a training course or seminar offered by a service provider	4.5	87	4.5	125

Source: Question N3, 2021 Commercial Participant Survey.

Don't know and *not applicable* responses were excluded from this analysis.

Participants were also asked to rate the likelihood that they would have purchased or implemented the program-qualifying equipment in the absence of the program incentive on a 0–10 scale, where 0 is *not at all likely* and 10 is *very likely*. As shown in Table 32, the average ranking among CSOP respondents was 4.8 and 5.3 among CMTP respondents, which is a lower average ranking compared to PY2017, where the average rating was 6.6 for CSOP and 6.2 for CMTP.

Table 32. Likelihood that Consumers Would Have Bought and Sold Energy Efficient Equipment in the Absence of the Program

Scale	CSOP participant responses	CMTP participant responses
0—Not at all likely	31	57
1	0	1
2	1	2
3	6	1
4	58	7
5	2	30
6	11	2
7	11	7
8	9	12
9	6	9
10—Very likely	22	53
Mean	**4.8**	**5.3**
Respondents (n)	**157**	**181**

Source: Question N5a, 2021 Commercial Participant Survey.

Don't know, *refused*, and multiples were excluded from this analysis.

3.4.4 Net-to-Gross Results

This section presents the methodology and key findings from the commercial NTG research. The EM&V team used surveys to calculate free-ridership, spillover, and NTG ratios for both CSOP and CMTPs, where primary data collection was used to estimate NTG. Table 33 presents the number of customer surveys completed for NTG analysis within the commercial sector. Customer survey counts are shown by utility and program type.

Table 33. Commercial NTG Research Primary Data Collection Completes by Program Type and Utility

Utility	CSOP	CMTP
Commercial completes	**156**	**176**
AEP Texas	7	77
CenterPoint	87	25
El Paso Electric	NA	24
Entergy	NA	17
Oncor	48	1
SWEPCO	4	20
TNMP	NA	11
Xcel Energy	10	1

The CSOP and CMTP analyses used input from customer surveys that were sampled from participants of the Commercial Standard Offer, Commercial Solutions, Large Commercial and Industrial, SCORE/CitySmart, and Retro-Commissioning programs to calculate the recommended NTG ratio.

To develop overall program estimates of free-ridership and spillover, the individual customer free-ridership and spillover estimates were weighted by the respective respondent's share of claimed savings. Therefore, a free-ridership value associated with a large project will have more influence on the overall rate of free-ridership than a small one. Next, the utility-level estimates of free-ridership and spillover were weighted by each utility's share of claimed savings before being summed to produce the overall program estimates of free-ridership and spillover.

3.4.4.1 Free-Ridership

Free-ridership analyses attempt to estimate the proportion of savings that stem from customer actions that would have happened in the absence of the program. Customers who would have completed the same project at the same time without the program's intervention are considered free riders. For PY2021, free-ridership was calculated using the participants' self-report surveys.

The surveys resulted in free-ridership of 23 percent for CSOP kilowatt-hours, 22 percent for CSOP kilowatts, 19 percent for CMTP kilowatt-hours, and 20 percent for CMTP kilowatts, all weighted by savings; this is a 10 percent reduction for CSOP and about a 15 percent reduction for CMTP from PY2017.

Table 34 reports the program level kilowatt-hour and kilowatt free-ridership rates by program type, respectively, along with the relative precision associated with each estimate.

Table 34. Free-Ridership Results for CSOP and CMTP

Program type	Customer kWh free-ridership rate	Customer kWh precision at a 90% confidence interval	Customer kW free-ridership rate	Customer kW precision at a 90% confidence interval
CSOP (n=156)	23%	2%	22%	2%
CMTP (n=176)	19%	2%	20%	2%

3.4.4.2 Spillover

Spillover refers to additional energy-saving equipment that was installed in the utilities' service areas without receiving an incentive or direct intervention from the utility. For PY2021 reporting, the EM&V team used spillover rates from PY2017.

For PY2017, the EM&V team calculated the spillover rate for CSOP at 24 percent for kilowatt-hour savings and 21 percent for kilowatt savings; this was higher than the spillover rates in our PY2013 evaluation, which came in at 7 percent for kilowatt-hours and 19 percent for kilowatts, respectively. The level of precision at 90 percent confidence is 19 percent for kilowatt-hours and 19 percent for kilowatts. Only *lighting* (n=48) had a sufficient sample to report spillover rates by measure category. The kilowatt-hour and kilowatt weighted spillover rates for *lighting* were both 21 percent.

The EM&V team calculated the spillover rate for CMTP at 22 percent for kilowatt-hour savings and 32 percent for kilowatt savings. These spillover levels also trended slightly higher than the values within our PY2013 for MTPs. The level of precision at 90 percent confidence is 36 percent for kilowatt-hours and 36 percent for kilowatts.

3.4.4.3 Net-to-Gross Ratio

The NTG ratio was calculated using the following formula; the resulting ratio can be applied to the population to determine the final net savings value.

NTG Ratio = (1– Free-ridership Rate) + Spillover Rate

The final CSOP NTG ratio, accounting for free-ridership and spillover, is 100 percent for kilowatt-hours (up from 91 percent in PY2017) and 99 percent for kilowatts (up from 89 percent in PY2017). The final CMTP NTG ratio, accounting for free-ridership and spillover, is 100 percent for kilowatt-hours (up from 86 percent in PY2017) and 100 percent for kilowatts (up from 99 percent in PY2017). Table 35 shows the CSOP and CMTP statewide free-ridership rate, spillover rate, and NTG ratios.

Table 35. Final Commercial Statewide NTG Ratios by Program Type

Program type	Savings type/weighting	Free-ridership	Spillover	NTG ratio
CSOP	kWh	23%	24%	100%
	kW	22%	21%	99%
CMTP	kWh	19%	22%	100%
	kW	20%	32%	100%

4.0 RESIDENTIAL ENERGY EFFICIENCY PROGRAMS

4.1 SUMMARY RESULTS

This section presents statewide summary results, followed by key findings and recommendations from all relevant evaluation, measurement, and verification (EM&V) activities.

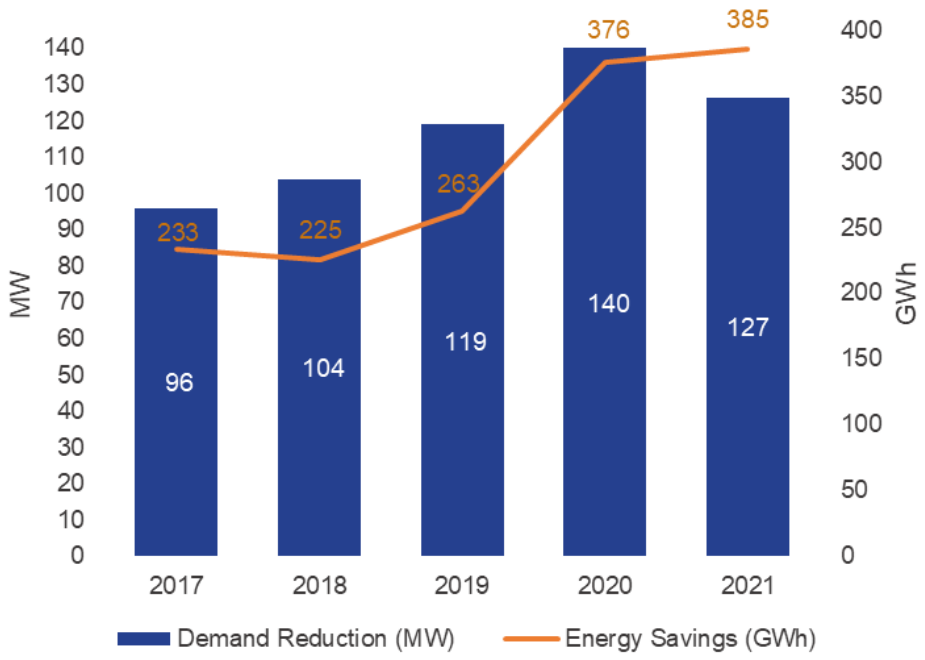
4.1.1 Savings

The statewide program year (PY) 2021 (PY2021) evaluated gross savings from residential sector programs (excluding load management) were:

- 126,698 kilowatts (kW) (demand reduction); and
- 384,956,785 kWh (energy savings).

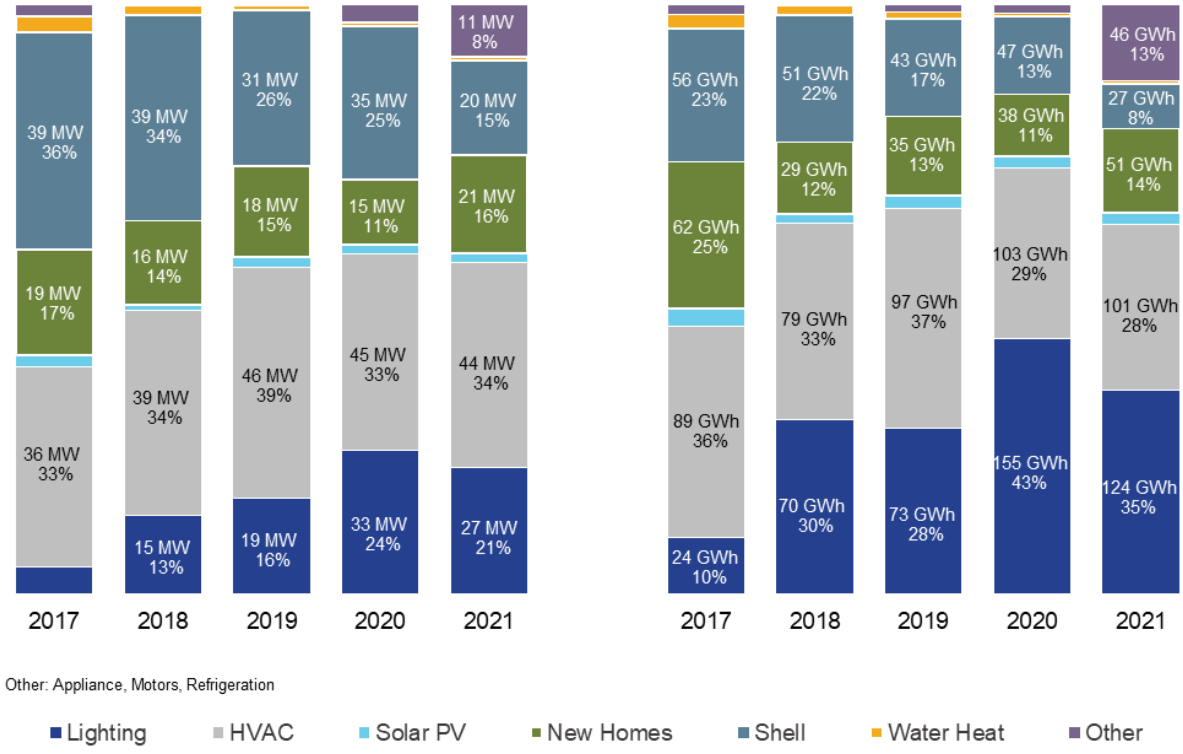
As seen in Figure 20, the demand reduction achieved in PY2021 saw its first decrease in five years, going from 140 megawatts (MW) to 127 MW. Energy savings continue to increase yearly, primarily driven by upstream lighting increases.

Figure 20. Total Statewide Evaluated Gross Demand Reduction and Energy Savings by Program Year—Residential Programs PY2017–PY2021



For PY2021, most residential demand savings (excluding load management) were derived from *lighting* and *HVAC* measures. Figure 21 presents the breakdown of savings by measure category and demonstrates that the utilities have successfully diversified their measure mix for residential savings.

Figure 21. Distribution of Statewide Evaluated Gross Demand Reduction and Gross Energy Savings by Measure Category—Residential Programs PY2017–PY2021[17]



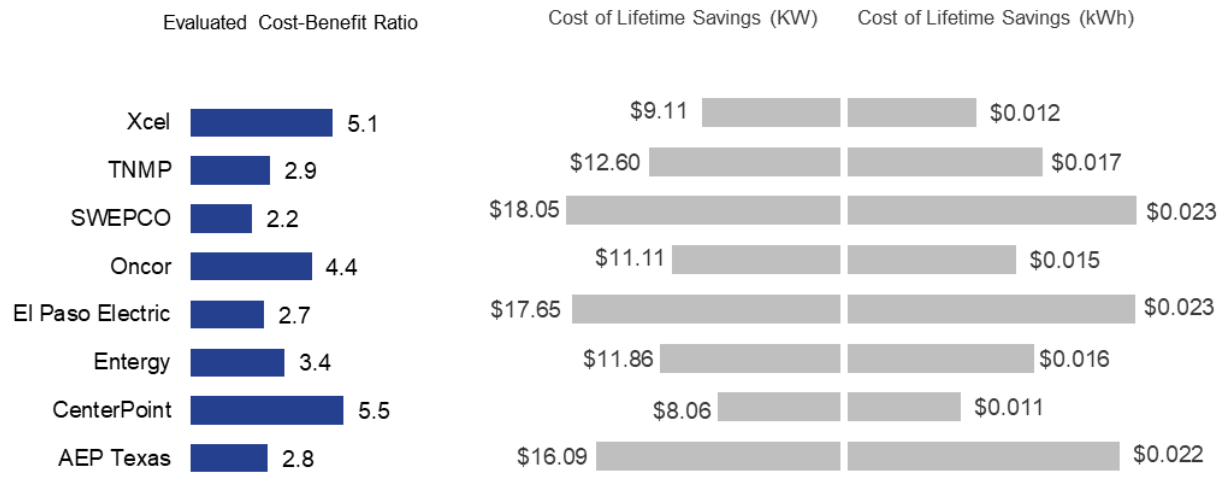
4.1.2 Cost-Effectiveness

Residential sector programs' cost-effectiveness statewide is 3.6 based on evaluated gross savings and 2.9 based on evaluated net savings. Like the commercial sector, the residential sector's cost-effectiveness varied among utilities, with evaluated gross savings results ranging from 2.2 to 5.5 and evaluated net savings results ranging from 2.1 to 3.8. As with the commercial sector, this is partly due to the differences in the types of programs offered by different utilities.

Figure 22 summarizes the cost-effectiveness of each utility's residential energy efficiency portfolio and the cost of lifetime kilowatt-hours and kilowatts for each utility's residential sector programs. The cost per kilowatt-hour ranges from $0.011 to $0.023, and the cost per kilowatt ranges from $8.06 to $18.05. These costs provide an alternative way of describing the cost-effectiveness of a portfolio of residential programs. Those portfolios with a higher cost-effectiveness ratio will have a lower cost to acquire savings and vice versa.

[17] Values less than four percent have been suppressed for visualization purposes.

Figure 22. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Residential Programs PY2021



4.2 PROGRAM OVERVIEWS

This section summarizes the key findings and recommendations from the PY2021 evaluation of residential energy efficiency projects. The residential standard offer programs (RSOP), hard-to-reach (HTR), and low-income (LI) programs were *high* evaluation priorities. The recommendations are to be considered by the utilities for PY2023 implementation and will also be incorporated into the PY2023 Texas Technical Reference Manual (TRM) 10.0 as appropriate.

The EM&V team evaluated the residential energy efficiency programs described below. Like the commercial energy efficiency programs, there are RSOPs and market transformation programs (MTP). The RSOPs provided by the Texas utilities offer standard incentives for a wide range of measures that are bundled together as a project to reduce system peak demand, energy consumption, and energy costs. The residential MTPs offered in Texas are designed as a strategic effort to make lasting changes in the market that result in increased adoption of energy-efficient technologies, services, and practices. MTPs are designed to overcome specific market barriers that prevent energy-efficient technologies from being accepted. HTR and LI programs are also offered to provide comprehensive energy efficiency retrofits for single-family and multifamily customers who meet the program's income guidelines on the residential side.

Residential SOP: The Residential SOP provides incentives to project sponsors for a wide range of retrofit measures that reduce demand and save energy, targeting retrofit measures for residential customers in single-family and multifamily buildings. Incentives are paid to project sponsors for qualifying measures that provide verifiable demand and energy savings. The program is open to all qualifying energy efficiency measures, including but not limited to *air conditioning*, *duct sealing*, *weatherization*, *ceiling insulation*, *water-saving* measures, and ENERGY STAR® windows.

Hard-to-Reach SOP: The Hard-to-Reach SOP provides incentives to project sponsors for a wide range of retrofit measures that reduce demand and save energy in residential buildings. This program is available to customers whose annual total household income is at or below 200 percent of current federal poverty guidelines. Incentives are paid to project sponsors for qualifying installed measures such as *air conditioning*, *air conditioner tune-ups*, *duct sealing*, *weatherization*, *ceiling insulation*, *water-saving* measures, and ENERGY STAR windows.

Residential Solutions MTP: The Residential Solutions MTP provides incentives to customers—through participating contractors—for a wide range of retrofit and new construction measures that reduce demand and save energy in residential buildings. The program also provides technical assistance and education on energy efficiency measures. This program is operated by one utility and is included in this section as it operates similarly to a RSOP.

Residential New Construction MTP: The Residential New Construction MTP provides incentives to builders to increase the efficiency of new homes above minimum code efficiency. The programs partner with raters, who inspect homes and provide energy models to describe the program-sponsored homes. The utilities compare these energy models with code to estimate energy savings.

Residential Upstream/Midstream MTP: The Upstream and Midstream MTPs provide incentives to residential and small commercial customers through in-store discounts at participating retailers and distributors or through an online marketplace for qualifying high-efficacy LED lighting, smart thermostats, energy-efficient appliances, and other efficient equipment. Measure offerings and delivery vary by utility.

Hard-to-Reach Solutions MTP: The Hard-to-Reach Solutions MTP provides incentives to customers—through participating contractors—whose annual total household income is at or below 200 percent of current federal poverty guidelines. Incentives are provided for a wide range of retrofit and new construction measures that reduce demand and save energy in residential buildings. The program also provides technical assistance and education on energy efficiency measures. This program is operated by one utility and is included in this section as it operates similarly to an HTR SOP.

Targeted Low-Income Solutions: The Targeted Low-Income Solutions program offers an energy audit to qualified LI residents of Texas. Alternatively, the program offers a review of the home's energy efficiency and installation of weatherization measures to increase the energy efficiency of their home. A household qualifies if the income is at or below 200 percent of the federal poverty guidelines, and their home must be able to benefit from being weatherized. Then, after the audit is completed, the program gives financial and installation assistance to improve the home's energy efficiency.

4.2.1 Residential Standard Offer, Hard-to-Reach, and Low-Income Programs

4.2.1.1 Impact Key Findings and Recommendations

Key Finding #1: PY2021 TRM 8.0 includes a weighted methodology to calculate savings for measures with dual baselines. This methodology is applied by weighting the sum of heating and cooling early retirement savings for the remaining useful life of the equipment, and the sum of heating and cooling replace on burnout savings for the difference between the estimated useful life and the remaining useful life. The EM&V team found that, in some cases, this methodology was not applied consistently.

Recommendation #1: Utilities should sum the heating and cooling savings values together prior to weighting rather than only weighting the cooling savings and adding the heating savings after the fact.

Key Finding #2: The PY2021 TRM 8.0 includes an *envelope* measure allowance for customers participating in HTR or LI programs to claim reduced heating savings for homes cooled by one or more space heaters. This allowance is made by applying an adjustment to deemed savings specified for homes with electric resistance heat. The EM&V team found that, in some cases, this adjustment factor was not applied consistently.

Recommendation #2: Update the PY2023 TRM 10.0 to incorporate guidance to clarify how to apply the adjustment factors.

Key Finding #3: Although there is no full-load efficiency (EER) requirement specified in the current federal standard for air conditioners and heat pumps, the intent of the programs is only to incentivize high-efficiency equipment. Therefore a minimum EER of 12 is set forth in the TRM based on the Consortium for Energy Efficiency minimum requirements. However, the programs may allow systems that comply with *Seasonal Energy Efficiency Ratio* (SEER) and *Heating Seasonal Performance Factor* (HSPF) requirements but do not comply with the *Energy Efficiency Ratio* (EER) requirements to claim heating and cooling energy savings and winter demand savings but not summer demand. The EM&V team found that, in some cases, summer demand savings were claimed for air conditioners where the EER fell below 12.

Recommendation #3: Demand savings should not be claimed for air conditioner systems where the EER is less than the minimum standard EER. Additionally, only winter demand savings should be claimed for heat pump systems where the EER is less than the minimum standard EER[18].

Key Finding #4: The Department of Energy (DOE) has implemented the Energy Independence and Security Act (EISA) 2020 backstop requiring general service lamps (GSL) to meet 45 lumens-per-wattage efficacy, making incandescent and halogen lamps non-compliant for manufacturing and retail sales. Enforcement of the standard at the retail level will begin on January 1, 2023. However, the EM&V team understands there are a substantial number of halogen and incandescent lamps currently operating in LI and HTR homes.

Recommendation #4: Update the PY2023 TRM 10.0 to allow for early retirement of incandescent and halogen lamps baseline, at the utility's discretion, for LI and HTR programs with direct-install-LED-delivery, given documentation requirements are met.

4.2.2 Low-Income Verification Process Assessment

Starting in 2020, the EM&V team, PUCT staff, and utilities began collaborating to improve the verification process for the LI programs. This work culminated as part of the PY2021 EM&V effort to start implementation in PY2022. It was agreed that the objective of the process assessment was to "*Revise low-income/hard-to-reach eligibility verification to increase the confidence program services are going to intended customers, improve program outreach, address participation barriers, and develop efficient administration processes*." This objective was presented at the March 2021 EEIP meeting, and resulting TRM changes were presented at the October 2021 EEIP meeting. This section summarizes the process assessment

[18] A new federal standard for air conditioners and heat pumps will take effect January 1, 2023 and the PY2023 TRM 10.0 will be updated with the new minimum standard EER.

recommendations, which utilities began implementing in PY2022. The PY2022 EM&V effort will provide feedback on lessons learned from the first year.

4.2.2.1 Background

Texas utilities provide energy efficiency services to LI customers through a combination of HTR and LI programs as specified in 16 Tex. Admin. Code (TAC) § 25.181, relating to the energy efficiency goal. All regulated Texas electric utilities are required to achieve no less than five percent of their total demand reduction goal through programs serving HTR customers (16 TAC § 25.181(e)(3)(F)). In addition, the Electric Reliability Council of Texas (ERCOT) utilities are required to spend no less than 10 percent of each program year's energy efficiency budget on a targeted low-income efficiency program (16 TAC § 25.181(r)). The qualifying income level of 200 percent of the federal poverty level is the same for HTR and LI programs though the programs are implemented differently.

The utilities use program-eligibility certification forms maintained by the PUCT on their website. The forms differ for single-family and multifamily, but both include a way to qualify for the programs through other LI programs and services (Category 1) as well as through self-reported income (Category 2). The multifamily form requires documentation for qualifying programs under Category 1, but this documentation requirement is not included in the single-family form Category 1 instructions. On both forms, Category 2 self-reported income is signed by the customer under penalty of perjury and is subject to a PUCT audit.

The PUCT has revised the income eligibility annually based on updated federal poverty level information, but the forms have not had major changes for over a decade. Due to the importance of these forms in determining program eligibility, PUCT staff and the EM&V team agreed to incorporate the forms into Volume 5 of the PY2022 TRM 9.0. As part of integrating the eligibility certification forms into the TRM, PUCT staff and the EM&V team worked with the utilities to perform an in-depth review of the forms and certification processes. The research and recommendations in this section are part of this in-depth review that informed the TRM additions.

4.2.2.2 Key Findings and Recommendations

Interviews with the utilities, comparisons of current practices with other LI programs, and a study commissioned by Oncor and conducted by the Texas Energy Poverty Research Institute (TEPRI) indicated an opportunity to increase the confidence level that the program services are going to the intended LI recipients. These activities also identified that verification requirements should be as streamlined as possible to avoid negatively affecting participation.

Key Finding #1: Revising the income-eligible verification forms with additional qualifying programs and services for Category 1 would provide more options to qualify for the program. These could include additional program options already part of the PUCT Lifeline program and other programs identified by the utilities or other stakeholders for single-family households, for example.

Recommendation #1: Expand Category 1 qualifying programs and services.

Key Finding #2: Only individually-metered multifamily units have been eligible for HTR and LI programs since master-metered multifamily units are included in the commercial rate class. All parties agree that the programs can increase their reach to LI customers by revising the income-eligible verification forms to include all multifamily units with qualifying residents regardless of whether they are individually- or master-metered. Costs and benefits of master-metered projects would accrue to the commercial sector but can be applied to applicable LI and HTR goals.

Recommendation #2: Revise multifamily individual-meter-eligibility criteria to allow master-metered projects to count toward LI and HTR goals.

Key Finding #3: An option to streamline participation requirements would be to allow participants to qualify via geographic location through US Housing and Urban Development (HUD) LI information.

Recommendation #3: Include geographic qualification in the TRM.

Key Finding #4: Many community action agencies and social services organizations throughout Texas are already qualifying LI programs for other services. These third parties could verify they have checked eligibility in compliance with Texas Administrative Code, TEXAS DEPARTMENT OF HOUSING AND COMMUNITY AFFAIRS, CHAPTER 6, COMMUNITY AFFAIRS PROGRAMS, SUBCHAPTER A GENERAL PROVISIONS, RULE § 6.4 Income Determination.

Recommendation #4: Add an option for community action agency or other social service agency certification.

Key Finding #5: Without verification of self-reported income for those participating through Category 2, there is the potential for program services to go to non-LI customers. Each utility is encouraged to develop a process that verifies income eligibility documentation, similar to the Lifeline program. The verification can be done individually by the utilities or through a hired third-party vendor. The process for single-family and multifamily may vary; for example, in property manager interviews, we found that landlords typically complete and store income documentation on-site and could be audited. Non-ERCOT utilities may have additional options to verify customer eligibility internally if they already qualify customers for LI rates or receive energy assistance payments for customers. ERCOT utilities do not have access to this information, but there may be a possibility of coordinating with retail electric providers to identify and qualify LI customers.

Recommendation #5: Verify Category 2 self-reported income before program approval.

4.3 PARTICIPANT SURVEYS

4.3.1 Overview

The EM&V team conducted a residential participant telephone survey to inform the evaluation effort. A list of PY2020 participating Residential SOP and Residential Solutions participants was obtained from the eight utility companies who received measures in the following measure categories: HVAC equipment, air infiltration services, and insulation. The team targeted 205 completed surveys from a total number of 26,707 participants. A total of 223 surveys were completed, as shown in Table 36 below. The estimated length of the telephone survey was 15 minutes.

Table 36. Texas PY2020 Residential Study Response Rate

	AEP Texas	Center Point	El Paso Electric	Entergy	Oncor	SWEPCO	TNMP	Xcel Energy	Overall
Sample	**225**	**125**	**100**	**150**	**200**	**100**	**96**	**100**	**1,096**
Business line	0	0	0	0	0	0	0	0	0
Affiliated with utility	0	0	0	0	0	0	0	0	0
Eligible sample	**225**	**125**	**100**	**150**	**200**	**100**	**96**	**100**	**1,096**
Does not recall participating	8	9	5	5	4	5	5	11	52
Ineligible—Other1	0	0	0	0	0	0	0	0	0
Ineligible—Other2	2	2	1	2	3	0	1	1	12
Refusal	2	10	5	6	9	5	2	4	43
Incompletes (partial surveys)	0	0	0	1	0	0	0	0	1
Language barrier	7	7	1	2	0	2	5	5	29
Bad number	12	7	5	6	3	7	6	5	51
Called out	0	0	0	0	0	0	0	0	0
Not completed	156	72	63	97	130	58	54	55	685
Completed	**38**	**18**	**20**	**31**	**51**	**23**	**23**	**19**	**223**
Response rate									
Response rate (completed/eligible sample)	16.9%	14.4%	20.0%	20.7%	25.5%	23.0%	24.0%	19.0%	20.3%

The EM&V team designed the survey around key researchable topics aimed at measure verification, customer awareness and experiences, and customer decision-making. An advance notification letter was mailed to customers on October 22, 2021. All phone surveys were then completed in Tetra Tech's in-house Survey Research Center (SRC) beginning on October 28, 2021, with all surveys completed by November 16, 2021.

4.3.2 Key Findings and Recommendations

Key Finding #1: Customer satisfaction with the program is high.

Most respondents said they were *satisfied* or v*ery satisfied* with the program overall (89 percent). Out of 181 respondents, 77 percent said they were *very satisfied* with their project(s). There were no responses of respondents being *very dissatisfied*.

Recommendation #1: Continue implementing the program as-is.

Key Finding #2: Although residential customers are *satisfied* with the program, the majority of program improvement feedback pointed to a need for additional advertising, education, and awareness directly from the utility.

Sixty-one percent of all respondents indicated they would change nothing about the program. Of those that did provide feedback, more program marketing and receiving more information and education during participation were the most mentioned. Having more types of eligible equipment, increased quality control, and increased incentive amounts were next. A few other suggestions included having a checklist the participant can use to follow as the contractor explains each step, faster rebate processing, and one mentioned more stringent leakage requirements.

Recommendation #2: Review marketing materials and handouts to identify potential areas for additional information.

Key Finding #3: The customers' most popular source of awareness is through their energy efficiency service provider (EESP)/contractor and word of mouth.

Over one-half of respondents (54 percent) said they learned of the program through their contractor or someone they know; social media followed. Bill inserts and brochures were two of the least mentioned sources.

Recommendation #3: Continue to utilize EESPs to market the program.

4.3.3 Process Results

Detailed findings from the process surveys completed with PY2020 Residential SOP and Residential Solutions participants who received HVAC measures and infiltration and insulation services are summarized below for firmographics, demographics, program awareness, program satisfaction, and program influence.

4.3.3.1 Firmographics

Figure 23 shows the number of measure-level survey responses by utility.[19] Oncor represents the largest percentage of respondents, making up 19 percent of the survey responses, with Entergy at 18 percent and AEP TCC at 16 percent.

[19] AEP TCC and AEP TCN shown separately in all PY2020 Residential survey result graphics. Starting in PY2021, the two divisons are consolidated and represented as AEP Texas.

Figure 23. Total Number of Measure Responses Represented by Utility Company (n=280)

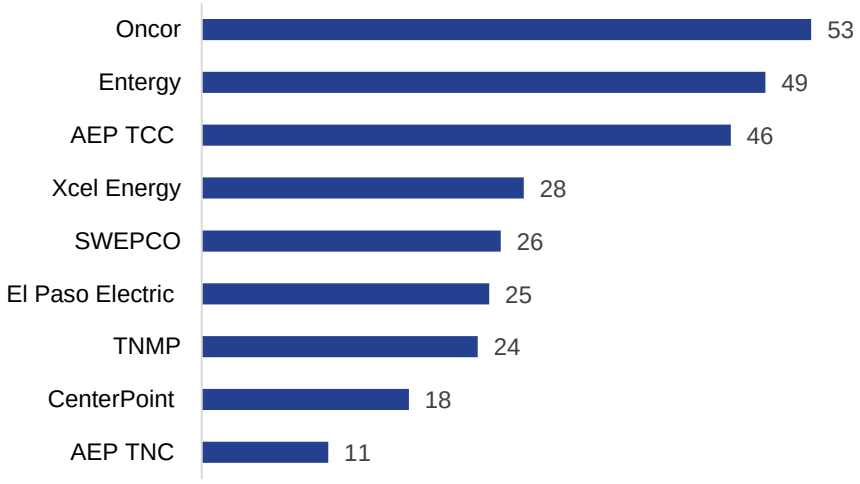
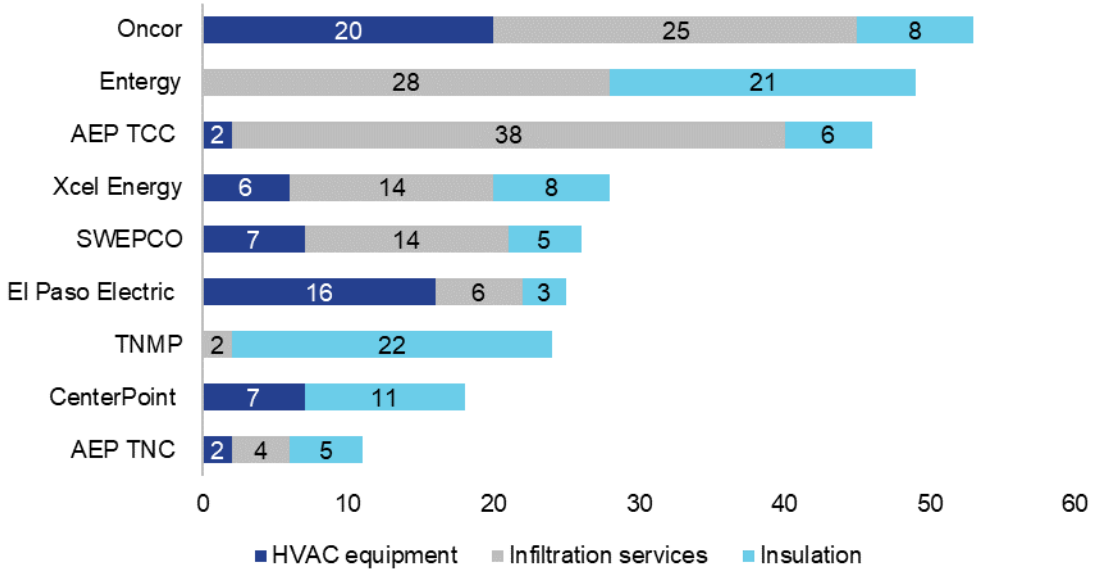


Figure 24 below represents the total energy efficient measures and services installed by the eight Texas utility companies[20], broken out by the three measure categories: HVAC equipment, infiltration services, and insulation.

Figure 24. Energy Efficient Measures and Services by Measure Category Reported by Utility Company (n=280)

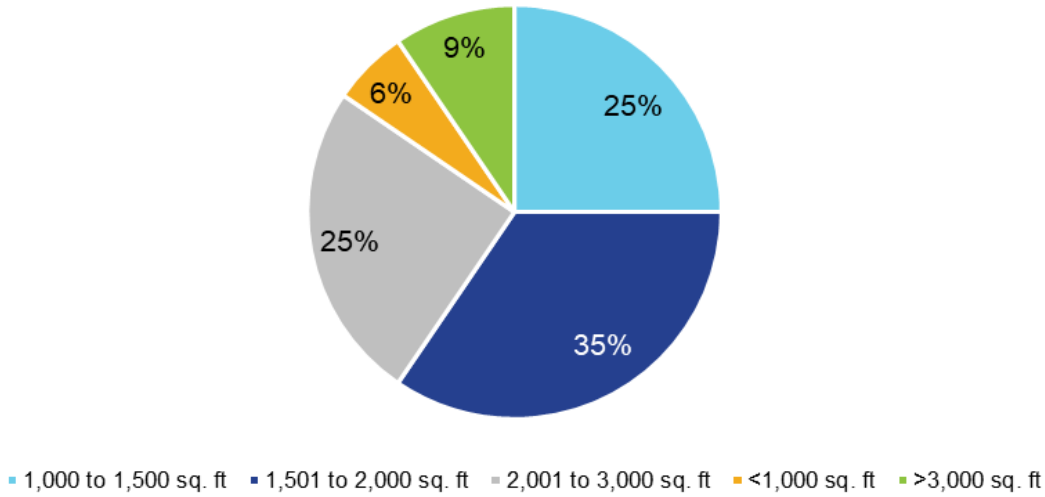


[20] Ibid

4.3.3.2 Demographics

Most of the respondents lived in homes with square footage between 1,000 square feet and 3,000 square feet (85 percent). Homes sized between 1,501 square feet and 2,000 square feet were the most mentioned (35 percent). Figure 25 shows the breakout in housing square footage.

Figure 25. Housing Square Footage of Residential Respondent Dwelling (n=168)



*Source: SOP/Res Solution Survey Question D1. *Don't Know* or *Skipped Question* responses have been excluded

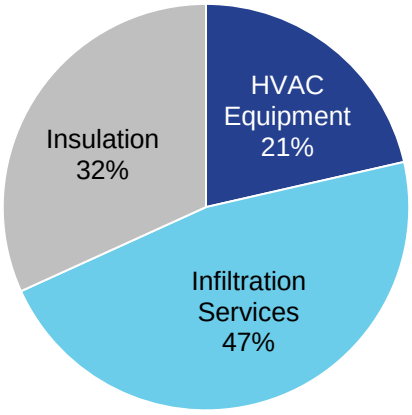
As shown in Table 37, most respondents reported owning their homes (85 percent); 9 percent indicated they were either a landlord or property manager at the participating location. Of the 227 respondents, only five (two percent) have sold their properties since participating in the programs.

Table 37. Home Ownership Status of Respondents

Respondent status	Count	Percentage
I own my home or apartment	192	85%
I am a landlord at this location	12	5%
I rent my home or apartment	10	4%
I am a property manager at this location	8	4%
Sold property	5	2%
Grand total	**227**	**100%**

Figure 26 shows that, overall, the *infiltration services* measure makes up about one-half (47 percent) of the energy-efficient measures and services implemented; *insulation* is 32 percent, and *HVAC equipment* is 21 percent.

Figure 26. Overall EE Measure Categories Represented by Respondents

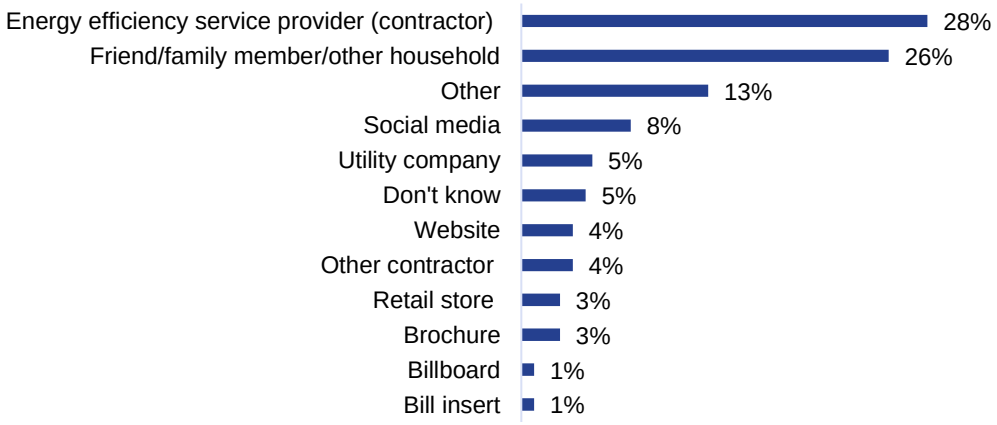


Within the three measure categories, survey questions focused on six high-efficiency equipment and/or services, including *energy-efficient air conditioners*, *energy-efficient heat pumps*, *ceiling insulation*, *evaporative coolers*, *duct sealing*, and *air infiltration services*.

4.3.3.3 Program Awareness

Survey respondents were asked how they became aware of the energy savings program. Respondents were able to indicate multiple sources (see Figure 27); the most popular source of awareness was through an *energy efficiency service provider (EESP)/contractor* (28 percent) and through word of mouth (*friend/family member/other household*) (26 percent). Thirteen percent of respondents indicated *other*, with the most specified responses being through their realtor, door-to-door salesperson, or participation in another program.

Figure 27. Respondent Source of Awareness (n=222)

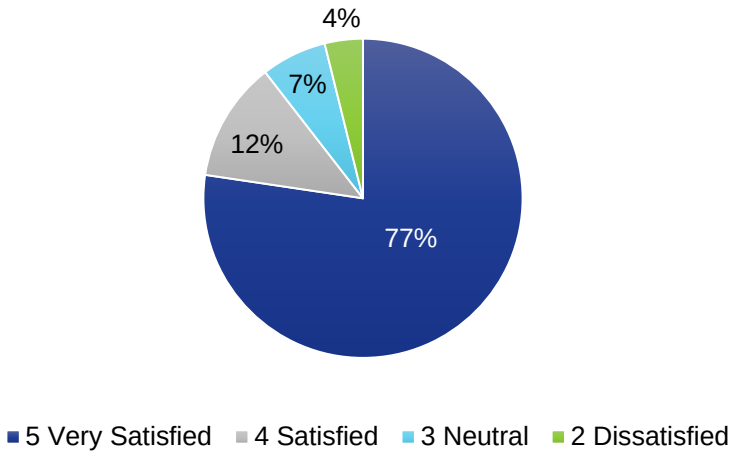


* Source: SOP/Res Solution Survey Question P1. *Skipped* responses are not included. Respondents were able to indicate all that applied.

4.3.3.4 Program Satisfaction

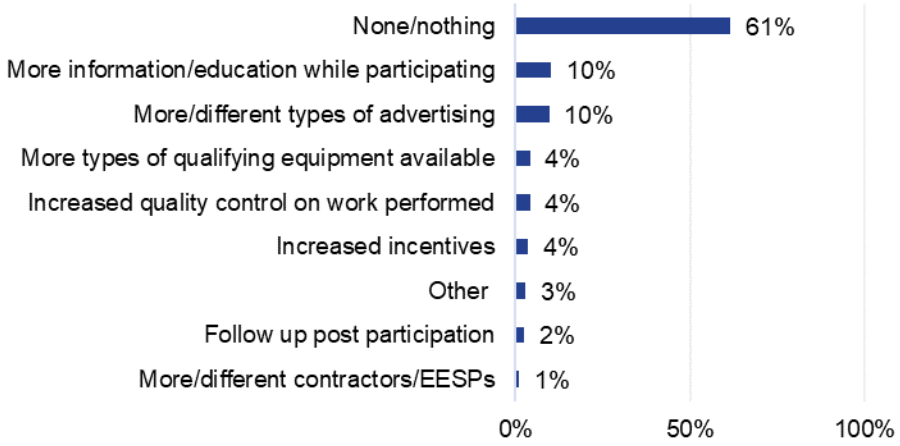
Respondents were asked to rate their project satisfaction using a 1–5 scale, with *1* being *very dissatisfied* and *5* being *very satisfied*. Out of 181 respondents, 77 percent said they were *very satisfied* with their project(s); none of the respondents indicated they were *very dissatisfied,* as shown in Figure 28.

Figure 28. Overall Project Satisfaction Results



In addition to rating their satisfaction with the program, customers were also asked what they would change about the program. Sixty-one percent of respondents indicated they would change nothing about the program. More program marketing and receiving more information and education during participation were the most mentioned suggestions (both ten percent). Having more types of eligible equipment, increased quality control, and increased incentive amounts followed at four percent each, as shown in Figure 29 below. A few other suggestions included having a checklist the participant can use to follow along as the contractor explains each step, faster rebate processing, and one mentioned more stringent leakage requirements. They felt the amount of leakage they had that was deemed acceptable was too high.

Figure 29. Suggestions for Program Changes



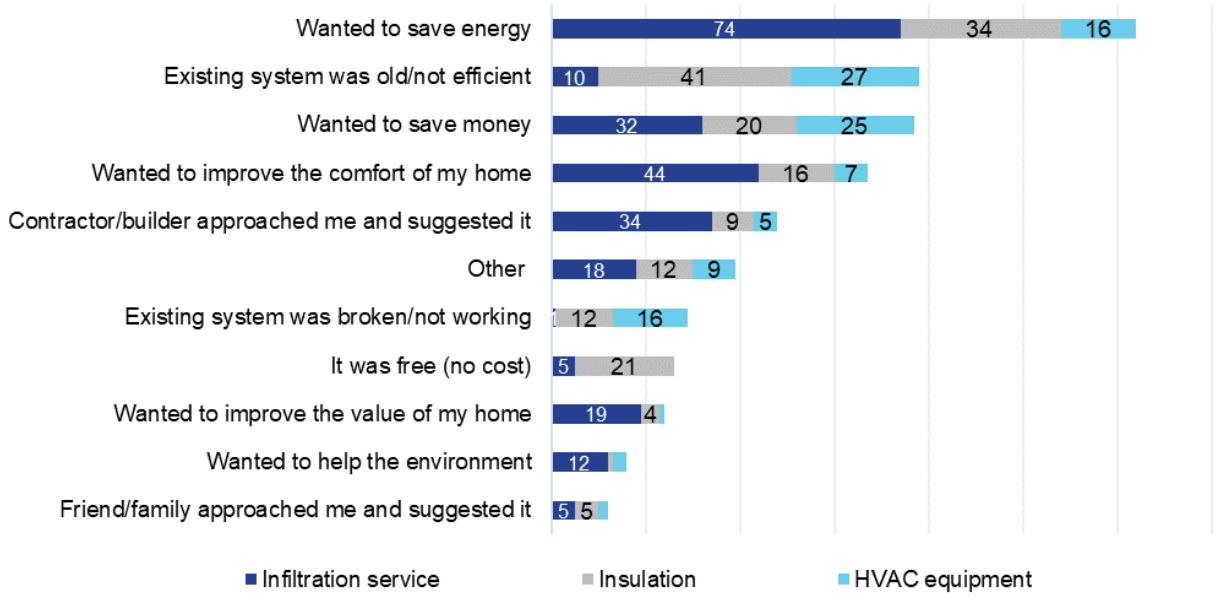
* Source: SOP/Res Solution Survey Question SAT2.

Given the COVID-19 pandemic of 2020, it is worth noting that, in addition to asking about general program satisfaction, surveyors asked if customers were satisfied with their EESP/contractor's safety precautions and cleanliness, using the same satisfaction scale. Almost all (98 percent) of respondents said they were *satisfied* or *very satisfied*. Of the remaining two percent, only one respondent said they were *very dissatisfied,* with no indication as to what could have been done differently.

4.3.3.5 Program Influence

Respondents were asked why they decided to install the energy efficiency measures and/or services; most indicated multiple motivations, which is reflected in the total number of responses. *Wanting to save energy* was the most mentioned reason for participation (124 responses, or 23 percent), with *old/not efficient equipment* and *wanting to save money* as the next two most-mentioned motivators. Figure 30 below shows the number of responses by reason and measure.

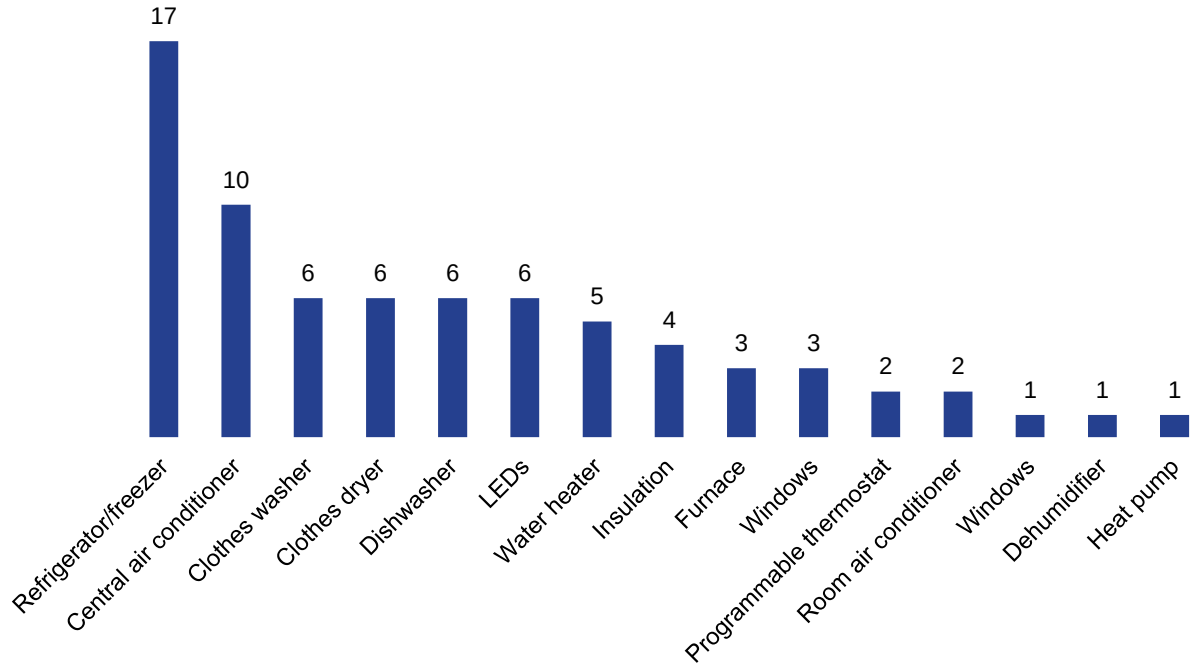
Figure 30. Customer Motivation (n=540)



*Source: SOP/Res Solution Survey Question M2. *Don't Know and Refused* responses have been excluded

Customers were asked if they have purchased any other type of energy efficient or ENERGY STAR-rated equipment since implementing their energy efficiency project through the program. Of the 223 respondents, 54 respondents (24 percent) indicated they had purchased additional energy-efficient equipment. Figure 31 shows the equipment they have purchased. Energy-efficient *refrigerators/freezers* were the most mentioned purchases, 17 respondents (23 percent), followed by *central air conditioners*, 10 respondents (14 percent). Customers were also asked to indicate how they knew the equipment was energy efficient. The most-mentioned answer was that *the appliance was ENERGY STAR-rated and had a large yellow sticker on it*.

Figure 31. Additional Energy Efficient or ENERGY STAR-Rated Equipment Purchased (n=73)



*Source: SOP/Res Solution Survey Question SPA2. *Skipped* responses have been excluded

4.3.4 Net-to-Gross Results

This section presents a summary of the methodology and key findings from the Residential SOP net-to-gross (NTG) research.

The EM&V team used a self-report approach (SRA) implemented through customer surveys to collect responses for use in calculating free-ridership and spillover, the components of NTG. The NTG results in this report used both PY2020 program participants—primarily because, in PY2021, the pandemic introduced an atypical environment—and interviews with EESPs in PY2018 to better inform the HVAC free-ridership.

The self-report survey sample was designed to meet the industry standard of ±10 percent precision at 90 percent confidence. Table 38 documents the number of customer surveys used for calculating the Residential SOP NTG ratio. Note that free-ridership was only asked for one measure to limit respondent burden. Cases are also weighted by the measure's demand reduction (kilowatt) and energy savings (kilowatt-hour) to account for differences in the size of projects represented in the survey.

Table 38. RSOP NTG Research Primary Data Collection Completes

Utility	Number of measure completes[21]
AEP Texas	32
Center-Point	12
El Paso Electric	10
Entergy	28
Oncor	38
SWEPCO	17
TNMP	23
Xcel Energy	8
Total	**170**

4.3.4.1 Free-Ridership

Free-ridership analyses attempt to estimate the proportion of savings that stem from customer actions that would have happened in the absence of the program. Customers who would have completed the same project at the same time without the program's intervention are considered free riders. Typically, free-ridership is calculated using the self-report surveys; however, because residential customers do not fully understand the efficiency levels of HVAC equipment to know what they would have done absent the program, we use results from interviews with EESPs in place of the participants. For PY2021, the HVAC free-ridership results from PY2018 were used in place of PY2020 participant self-reports. The EM&V team will conduct another round of EESP interviews in PY2022 and update the NTG. In PY2018, the EM&V team spoke with 63 EESPs who participated in one or more utilities' RSOPs. The EESP responses were weighted by the kilowatt-hour and kilowatt contributions from measures installed by that EESP to account for different levels of participation by different EESPs.

The PY2020 participant self-report surveys for non-HVAC equipment resulted in free-ridership of 10 percent kilowatt and 11 percent kilowatt-hour, with both weighted by savings; this is a reduction from PY2018, 17 percent kilowatts and 16 percent kilowatt-hours. The PY2018 EESP interviews resulted in free-ridership of 24 percent kilowatt and 25 percent kilowatt-hour, weighted. Combined, the residential SOP free-ridership is 17 percent kilowatt and 19 percent kilowatt-hour.

[21] The number of completes used to calculate NTG does not equal the total number of completed surveys in the participant survey effort because not all surveys obtained the data necessary to calculate NTG.

4.3.4.2 Spillover

Spillover refers to additional energy-saving equipment that was installed in the utilities' service areas without receiving an incentive or direct intervention from the utility. For PY2021 reporting, the EM&V team used deemed spillover savings from the PY2018 evaluation[22] for *HVAC* measures and used PY2021 program tracking data for *non-HVAC* measures. The spillover results for non-HVAC equipment were <1 percent kilowatt and 1 percent kilowatt-hour. The EESP spillover results from PY2018 used for HVAC is 19 percent for both kilowatt and kilowatt-hour. The weighting did not result in different spillover estimates by savings type. Combined, the statewide spillover for RSOP is ten percent kilowatt and ten percent kilowatt-hour.

The spillover result is reasonable for two reasons. First, EESPs are in a better position to understand the influence of the utilities' programs on the overall HVAC market and can speak to the programs' effect on overall efficient HVAC sales. Second, the spillover result reflects that EESPs have changed their sales practices due to program influence, even in cases where the utility does not directly incentivize a project.

4.3.4.3 Net-to-Gross Ratio

The NTG ratio was calculated using the following formula; the resulting ratio can be applied to the population to determine the final net savings value:

$$NTG\ Ratio = (1 - Free\text{-}ridership\ Rate) + Spillover\ Rate$$

The final NTG ratio, accounting for free-ridership and spillover, is 93 percent weighted by kW (up from 89 percent in PY2018) and 91 percent weighted by kWh (a slight decrease from 93 percent in PY2018). Table 39 shows the RSOP statewide free-ridership rate, spillover rate, and NTG ratio.

Table 39. PY2021 RSOP Statewide NTG Ratio

Savings type		Free-ridership	Spillover	NTG ratio
Non-HVAC	kW	10%	0%	90%
	kWh	11%	1%	90%
HVAC	kW	24%	19%	95%
	kWh	25%	19%	94%
Total	kW	17%	10%	93%
	kWh	19%	10%	91%

[22] NTG will be updated again in PY2022 using results from a new round of EESP interviews.

5.0 LOAD MANAGEMENT PROGRAMS

5.1 SUMMARY RESULTS

This section summarizes the key findings and recommendations from the program year (PY) 2021 (PY2021) evaluation of commercial and residential load management programs. Load management programs were designated as *medium* evaluation priorities in PY2021 due to their significant contribution to capacity (kilowatt, kW) savings. The recommendations are to be considered by the utilities for PY2023 implementation and will also be incorporated into the PY2023 Texas Technical Reference Manual (TRM) 10.0 as appropriate.

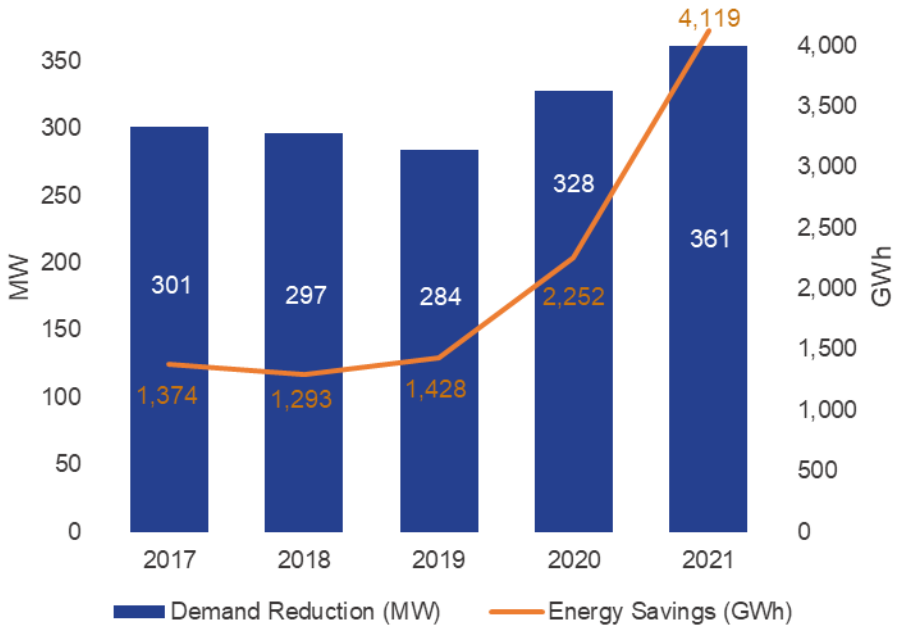
5.1.1 Savings

The total evaluated gross savings of the programs were:

- 361,152 kW (demand reduction), and
- 4,119,283 kilowatt-hours (kWh) (energy savings).

These results show a significant increase compared to PY2020, by roughly 33 megawatts (MW). Figure 32 summarizes the evaluated megawatt and megawatt-hour savings of all load management programs from PY2017 to PY2021.

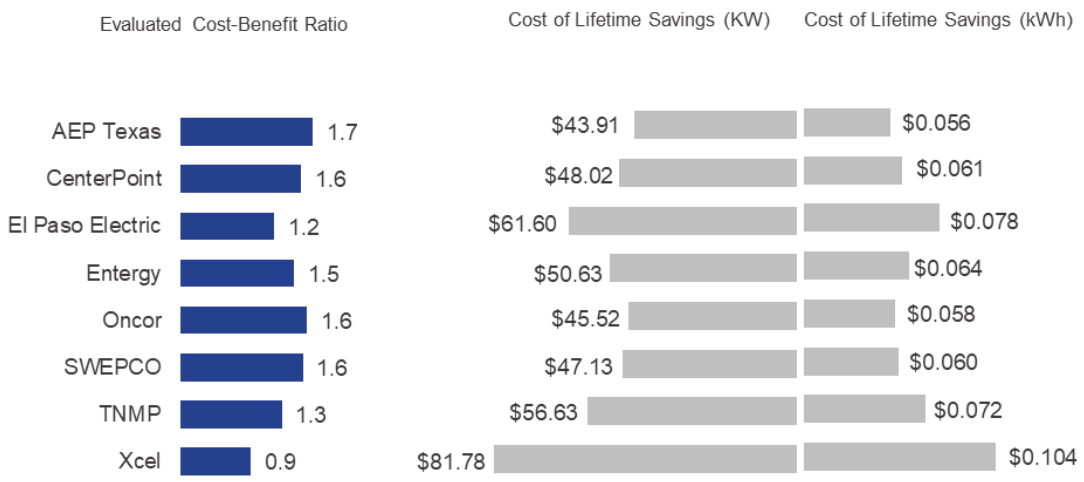
Figure 32. Total Statewide Evaluated Gross Demand Reduction and Energy Savings by Program Year—Load Management Programs PY2017–PY2021



5.1.2 Cost-Effectiveness

Figure 33 summarizes the cost-effectiveness of each utility's energy efficiency portfolio based on evaluated savings of all load management programs in PY2021. Most portfolios were cost-effective, ranging from 0.9 to 1.7. The cost per kilowatt ranged from $43.91 to $81.78, and the cost per kilowatt-hour ranged from $0.056 to $0.104. These costs provide an alternate way of describing the cost-effectiveness of a portfolio of programs. Those portfolios with a higher cost-effectiveness ratio will have a lower cost to acquire savings and vice versa.

Figure 33. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Load Management Programs PY2021



5.2 COMMERCIAL LOAD MANAGEMENT

This section summarizes the key findings and recommendations from the PY2021 evaluation of the commercial load management programs offered by the eight Texas utilities.

The EM&V team applied the savings calculation methodology prescribed in PY2021 TRM 8.0 on a census of records to calculate energy savings and demand reductions from interval meter data.

5.2.1 Programs Overview

Commercial load management programs are designed to manage kilowatt usage during summer peak demand periods. These periods are defined in most utility programs as 1:00 p.m. to 7:00 p.m., weekdays, June through September. These programs are based on performance and offer incentive payments to participating customers for voluntarily curtailing electrical load on notice.

While each utility operates a unique load management program, there are many similarities among them. In general, a dispatch event may be called at the utility's discretion 30 to 60 minutes in advance of a curtailment event, which generally lasts one to four hours. In most cases, the utility reserves the right to call a certain number of curtailment events per season, ranging from 5 to 15, based on the utility. Customers must meet several eligibility requirements,

including but not limited to (1) taking service at the distribution level, (2) meeting minimum demand requirements, and (3) being equipped with interval data recorder metering. Customers cannot participate in other load management programs using the same curtailable loads simultaneously (i.e., *double-dipping*).

Participants can either curtail their contracted load during a load control event or opt-out if they wish not to participate. Participants receive an incentive based on the kilowatts they curtail during the event. Savings for kilowatts and kilowatt-hours are calculated by following the methodology described in PY2021 TRM 8.0, and an incentive is given to a participant based on the amount of kilowatts saved. This incentive amount is specified in an agreement with the utility when enrolling in the program and ranges from $15 to $50 per kilowatt saved.

5.2.2 Key Findings and Recommendations

Key Finding #1: Texas commercial load management programs continue to increase commercial load participants effectively and have maintained high levels of cooperation (about 90 percent) with curtailment events.

As measured by the number of customers, participation has fluctuated annually in years prior to PY2018 but remained relatively stable, with about 600 commercial participants. Participation has been steadily increasing since PY2018, reaching 825 participants in PY2021, thus, resulting in higher savings. Of these participants, the majority (about 90 percent) curtailed load when requested for a curtailment event (739 of the 825 participants). The ratio of enrolled participants compared to participants that were able to curtail was comparable to pre-pandemic levels.

Recommendation #1a: Continue to assess the role of commercial load management programs as part of the utility's overall energy efficiency portfolio.

Recommendation #1b: Consider using the results of the annual test event to modify program-contract estimates of available demand reduction and the test and actual events to identify any non-performers that should not be future participants.

Key Finding #2: There is considerable stakeholder interest in utility load management programs; information on the programs and participants could be improved for easier public consumption.

Not all utilities have program manuals detailing the program processes on their websites, and not all program manuals are updated annually.

Recommendation #2: To foster a clear understanding of the program operations, provide easy online access to program manuals and update these manuals annually and consider a summary of key metrics**.**

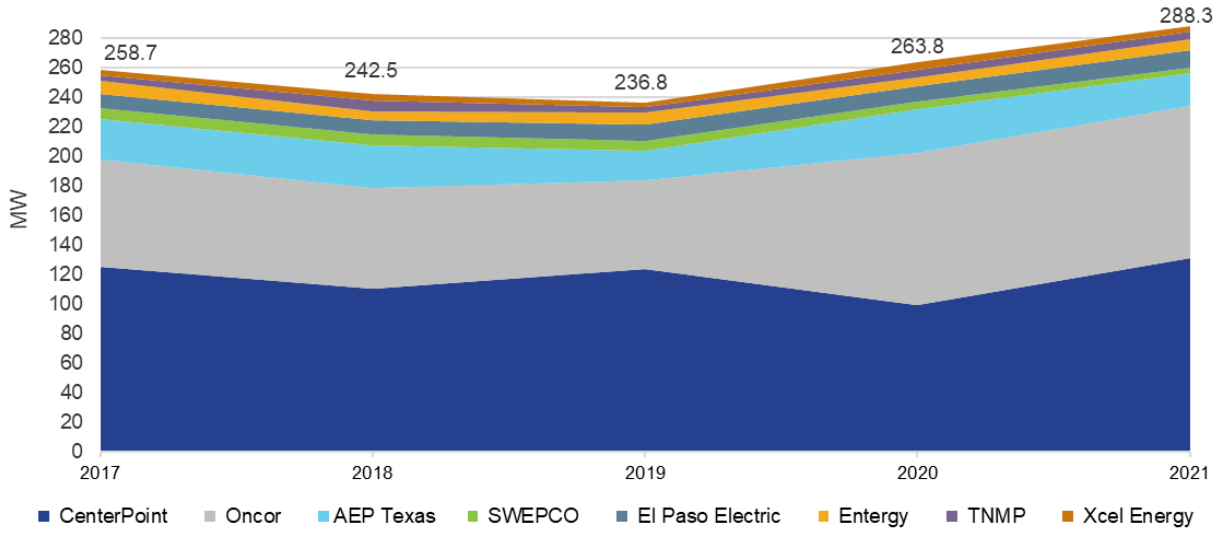
5.2.3 Impact Results

The total PY2021 evaluated savings of all eight commercial load management programs were:

- 288,304 kW (demand reduction), and
- 1,220,194 kWh (energy savings).

The PY2021 evaluated savings show a continued increase from PY2020 by roughly 25 MW. CenterPoint has the most significant savings among the utilities' commercial load management programs, followed by Oncor. Figure 34 shows total kilowatt savings from commercial load management programs by program year.

Figure 34. Evaluated Demand Savings of Commercial Load Management Programs PY2017–2021



Demand savings calculations from each utility were mainly calculated the same as the evaluation calculations. There were no cases in which adjustments had to be made to individual meter savings calculations; this result supports the fact that both the EM&V team, the implementer, and utilities follow the TRM algorithm for savings calculation similarly. While all utilities followed the TRM methodology correctly, the realization rates for commercial load management programs were not 100 percent in PY2020. The reason for this discrepancy is that, when comparing individual meter savings for one of the commercial load management programs, it was found that the utility was following a conservative approach by not setting savings to zero in cases where the calculation methodology produced negative savings. Per PY2019 TRM 6.0, in cases where the savings algorithm produces negative savings, the negative savings can be set to zero. As a result, commercial load management programs received a realization rate of 100.2 percent for kilowatts and 100.1 percent for kilowatt-hours.

5.2.4 Winter Load Management Results

Oncor launched its winter load management pilot on December 1, 2021, which was open through February 2022; the results of this pilot will be included in the PY2022 EM&V report. The EM&V team conducted three in-depth interviews with participants in this pilot; interviews are informing a participant survey for all PY2022 load management programs. However, one key finding from the interviews is that those using backup generation are concerned that a program test-event outside of the allowable window could make them in non-compliance with the Texas Commission on Environmental Quality (TCEQ) Rule §117.2030[23].

5.3 RESIDENTIAL LOAD MANAGEMENT

This section summarizes the key findings and recommendations from the PY2021 evaluation of three Texas utilities' residential load management programs (Oncor, CenterPoint Energy, and El Paso Electric). Other utilities did not offer a residential load management program.

Two utilities calculated savings using interval meter data following the *high 3 of 5* method; the third utility used *deemed savings* method from PY2021 TRM 8.0.

5.3.1 Program Overviews

Residential load management programs are designed to manage kilowatt usage during summer peak demand periods. Three of the eight Texas utilities offer their customers a residential demand response program. Of the three, two programs utilize a smart thermostat control strategy, and the other utilizes direct load control devices. Incentives for these programs differ by whether the utility's service territory is part of the Electric Reliability Council of Texas (ERCOT) market or not. Utilities in the ERCOT market receive an incentive based on the evaluated kilowatt savings achieved during the load control season; in contrast, non-ERCOT utilities pay a flat enrollment incentive and a flat incentive per program year. Participants are allowed to opt out of a load control event.

Participants in two of the three residential programs are evaluated individually with the *high 3 of 5* method described in PY2020 TRM 7.0. In contrast, the other is evaluated using the new deemed savings value for residential demand response smart thermostat programs. The availability of advanced metering infrastructure meters dictates a utility's methodology to calculate savings.

All utilities define their control seasons as June 1 to September 30, with possible load control events happening within the window of 1:00 to 7:00 p.m. on non-holiday weekdays for ERCOT utilities and 2:00 to 8:00 p.m. on non-holiday weekdays for non-ERCOT utilities.

Residential programs in Texas have seen dramatic increases in evaluated kilowatt savings over the past few years as participation has steadily increased. This increase in participation and savings can be attributed to the adoption and successful marketing of programs that utilize smart thermostats.

[23] Texas Administrative Code (state.tx.us)https://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=117&rl=2030.

5.3.2 Key Findings and Recommendations

Key Finding #1: Texas residential load management programs continue to increase demand savings and participation effectively. While a relatively low number of meters to date have had missing data, The TRM does not provide a detailed approach to handling missing data for baseline or event days.

Two different approaches are used to deal with missing data: (1) the average for each provider or (2) zeroing out those days. To date, the difference has not impacted the evaluation because only a few devices with small savings had this issue; however, it is worth discussing further and clarifying language in the TRM if these programs continue to grow or if they expand to other devices like water heater controls.

Recommendation #1: Discuss updates to the TRM that clarify how to handle missing data.

Key Finding #2: TRM language related to the *deemed savings* method has been worked through in the past few years, and there is now a mutual understanding of the approach. The utility, implementer, and EM&V team agreed on final demand savings calculations, although documentation for participating thermostat devices may be improved.

Due to the unique aspect of the *deemed savings* method (using runtime data and a deemed savings value instead of interval data), the approach used to identify participating devices is critical. Providing ample documentation of the calculation approach supported by a clear definition of each data field for each smart thermostat manufacturer would be helpful.

Recommendation #2: The files provided to identify participating smart thermostat devices for the *deemed savings* method should include a description of the data fields and the calculation approach. A calculation approach should also be provided for the devices enrolled through the online marketplace.

Key Finding #3: For the *deemed savings* method, there was some confusion in PY2020 on how to claim savings for smart thermostat devices sold through the online marketplace and enrolled in the residential load management program at the point of purchase. The TRM was updated to provide more guidance and enhance overall accuracy and transparency.

In general, customers that receive incentives for purchasing a thermostat device through an energy efficiency program may be able to enroll in the load management program offered by the utility at the point of purchase. Deemed demand savings can only be claimed for those customers if they enroll and participate during the summer season. Otherwise, these devices are only eligible for the deemed energy efficiency savings.

Recommendation #3: Continue to claim savings for smart thermostat devices that did not enroll during the summer season through the smart thermostat or retail MTPs.

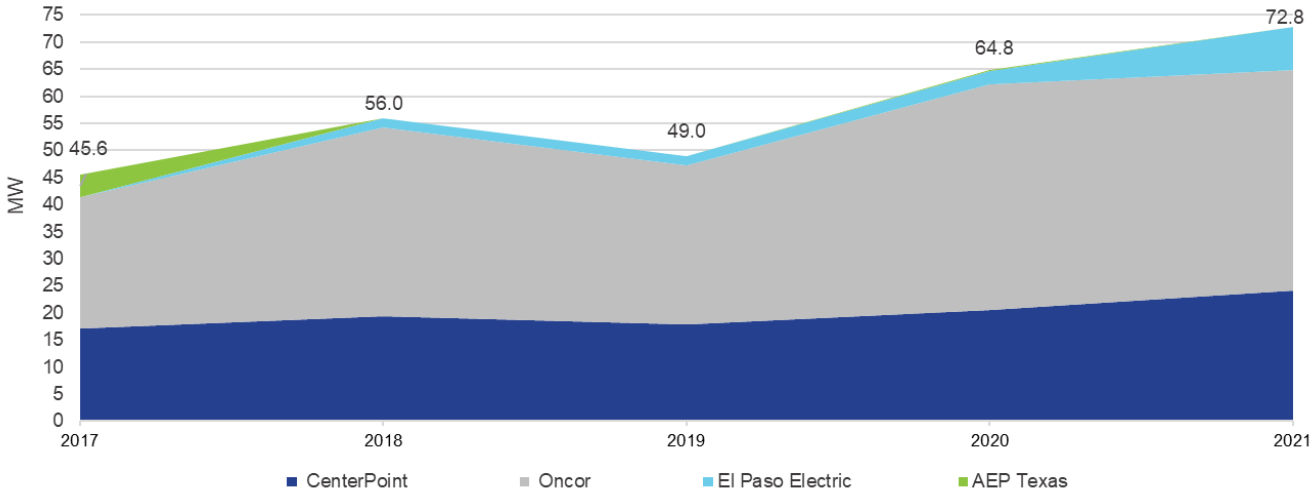
5.3.3 Impact Results

The total PY2021 evaluated savings for the four utilities (CenterPoint, Oncor, El Paso Electric, and AEP Texas) were:

- 72,848 kW (demand reduction), and
- 2,899,088 kWh (energy savings).

These results show a continued increase in savings since PY2019, increasing roughly by 9 MW from PY2020. Figure 35 shows total megawatt savings from residential demand response programs by program year (note that AEP Texas discontinued its residential load management program after 2017). Since PY2019, Oncor has the most significant savings amongst the utilities' residential programs, followed by CenterPoint.

Figure 35. Evaluated Demand Savings of Residential Load Management Programs PY2017–2021



TECHNICAL APPENDIX A: COMMERCIAL CONSUMPTION ANALYSIS

The EM&V team completed a commercial consumption analysis with the evaluation of the electricity consumption data for the savings claimed in the Commercial Standard Offer Program (CSOP) and Commercial Market Transformation Program (CMTP) in Program Year (PY) 2020. The PY2020 consumption analysis focused on the lighting measure category, which provides the most energy savings in the Commercial sector. The detailed research plan provided a framework for the consumption data analysis; however, the methodology was dynamic throughout the evaluation in response to data needs and interim analysis findings. This appendix details the steps taken and the outcomes of the analysis.

The primary goal is to inform future updates to the Technical Reference Manual (TRM). Findings from this analysis indicate that the TRM is doing a reliable job of estimating lighting project savings; therefore, we do not recommend updates to the lighting measure in the TRM at this time.

A.1 SUPPLEMENTAL INFORMATION ON WEATHER DATA

All the meters analyzed required a process to weather normalize the consumption results to isolate the energy savings associated with the lighting retrofit. The weather normalized electricity consumption was created from the observed weather data from January 2019 through March 2021 and the actual consumption. Below we give details about the data, weather stations, and missing data.

Collection

Weather data for all ASOS stations were downloaded from Iowa State University's Mesonet[24] and added to our database. The ASOS network is a collection of automated airport weather observations worldwide, with 208 stations in Texas. The data contains hourly temperature readings, and we downloaded data from January 1, 2018, to March 31, 2022. In some cases, there is more than one temperature reading per hour. In these situations, we average the temperature during that hour to come to one temperature for that hour.

Station Selection

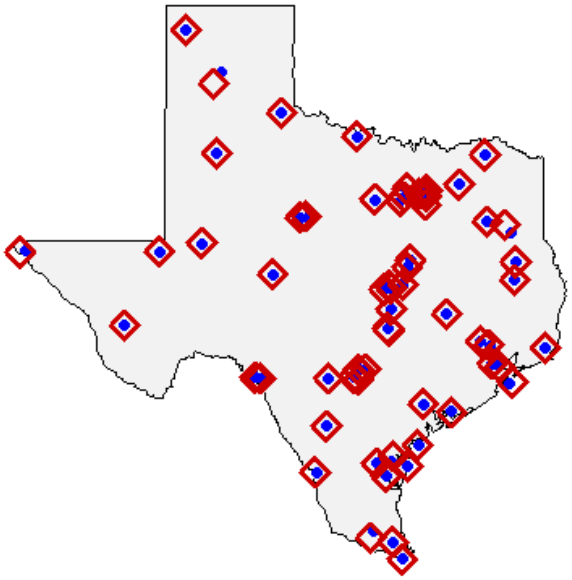
60 of the 214 ASOS stations in Texas were used to collect the weather data. Each ASOS station was matched to one of the 61 TMY3 stations in Texas. Most TMY3 and ASOS stations are co-located, and all TMY3 stations are within 20 miles of their matched ASOS stations.

The matching used the closest ASOS Station to the TMY3 station. Distance between stations is a straight-line measurement, often referred to as "*as the crow flies*." There is one fewer (60) ASOS station used for the analysis because station ATT (Austin) is the closest ASOS station to two different TMY3 stations (Austin Mueller Airport and Camp Mabry).

Figure 36 displays a map of the stations, with the ASOS stations represented by the blue dots and the TMY3 stations represented by the red squares.

[24] https://mesonet.agron.iastate.edu/.

Figure 36. Map of Texas ASOS Weather Stations and TMY3 Weather Stations



Filling Gaps

All 60 ASOS stations used for the analysis were missing some data. To complete the hourly weather observations needed to run hourly regression models, when data were missing, they were imputed from the nearest weather station, the distance measured in a straight line. When imputing data, we open our search to all ASOS stations to get weather data from the closest available station. The final observed weather dataset has contributions from 137 stations.

When filling missing observations with the closest station proves insufficient to complete data for a given station, we use the second closest station to fill the missing data, and so on, until as much missing data as possible are eliminated through data of nearby stations. We go as far as the fourth station for some locations, provided the distance is reasonable, generally less than 30 miles.

We filled missing observations with nearby stations until there were no more nearby stations to impute weather data. After borrowing from nearby stations, we dropped stations with more than 14 consecutive missing values. The screening dropped 16 stations and created a final list of 44 stations.

At this point, the distance to borrow from the next station becomes further than we feel accurate. To fill in the remaining gaps, we create a linear interpolation using the observations immediately before and following the stretch of missing hourly data to estimate the temperature during each hour with missing data. Doing this for short streaks of 14 hours or less keeps the estimations reasonable, and some visual inspection of the data has shown periods of approximation to work well.

For example, if June 20 had a reading of 74 degrees at 3:00 p.m. and 78 degrees at 6:00 p.m. with missing data in between, our data imputation procedures would impute those hours as 75.3 and 76.6 for the missing observations at 4:00 p.m. and 5:00 p.m. The data are always filled linearly, representing a gradual increase or decrease in temperature throughout the missing observations. Approximated temperature readings make up less than 0.3 percent of all observations for every station and, on average, represent under 0.1 percent of a station's hourly weather observations.

A.2 SCREENING CRITERIA DETAILS

This section describes the screening criteria employed to choose accounts for the PY2020 retrofit consumption analysis. This analysis focused on the lighting measure category, which provides the most energy savings in the Commercial sector. We review the rules applied to exclude accounts from the analysis step by step, stating the exclusionary condition and reasoning that informed the decision. Table 41 at the end of this section summarizes the screening steps and the number of accounts affected. Table 42 and Table 43 show the number of accounts by building type and consumption category.

Defining the Pre- and Post-Periods

Before enumerating the screening steps, we clarify the pre- and post-periods for measurement. The participant group includes customers who received lighting incentives between 1/1/2020 and 12/31/2020. The comparison group is defined as non-participants between 1/1/2017 and 12/31/2020. The past participant group includes customers who received lighting incentives between 1/1/2017 and 12/31/2019. The analysis period has two defined data sets for all accounts in the participant and comparison group. The pre-period is 12 months prior to the participant impact date (if available, otherwise 1/1/2020), while the post-period is 12 months after the participant impact date (if available, otherwise 1/1/2021).

Account Screening

The interval data includes 103,005 total accounts before any accounts are excluded. Table 40 presents the number of accounts by utility before the screening.

Table 40. Number of Accounts by Utility

AEP	CenterPoint	EPE	Oncor	TNMP	Total
26,343	12,469	101	34,532	29,560	103,005

Step 1: Meter Data Begins Later Than Required. We examine the minimum and maximum date that meter data was recorded for an account. As mentioned in the introductory notes, the pre-period is from 1/1/2019 to 1/1/2020 or the participant impact date. The account is screened out if the meter data begins later than 1/1/2019.

Step 2: Meter Data Ends Earlier Than Required. We examine the minimum and maximum date that meter data was recorded for an account. As mentioned in the introductory notes, the post-period is from 1/1/2021 or the participant impact date to 12/31/2021. The account is screened if the meter data ends earlier than 12/31/2021.

Step 3: Solar Interconnect Agreement. We exclude accounts that have a solar interconnect agreement. These accounts are removed from the analysis because their consumption may be misleading since they generate some or all of their own power. All utilities provide data on accounts with solar interconnect agreements.

Step 4: Gaps in Meter Data During the Pre- or Post-Period. We exclude accounts that are missing more than 8 hours of consecutive data (i.e., 32 15-minute intervals).

Step 5: Meters with Multiple Negative kWh Readings. We exclude accounts with more than one kWh interval value below -1. Those values between 0 and -1 are assumed to be rounding errors, while those less than -1 indicate a data issue.

Step 6: Total Usage in the Pre- or Post-Period is Drastically Below the Average Consumption. We exclude accounts that consumed less than 15,000 kWh for the calendar year 2019 or 2020. Consumption under these levels is not representative of typical commercial consumption.

Step 7: Geolocation successfully complete for accounts. The business name was used to geolocate accounts and assign a building type. We exclude accounts that did not successfully return geolocation or a listed building type.

Step 8: Map building type to analysis groups. The building types included in the consumption analysis are limited to warehouses, wholesale goods, retail food sales (grocery), vehicle sales, financial, and medical outpatient. The building types were selected based on two main criteria: the percentage of electricity consumption attributed to lighting and the likelihood of continuing similar operations after the start of the COVID-19 pandemic. Consumption analysis requires savings to be a statistically significant percent change from overall pre-install consumption to identify and isolate the effects of improvements. The analysis will begin by identifying operating and consumption patterns. The targeted building types are expected to have electric consumption patterns that support lighting isolation. The start of the COVID-19 pandemic in March 2020 created an event in the analysis period that uniquely impacts the energy consumption of each C&I customer. Some of the impacts were short-term, such as a decreased building capacity, and others were longer lasting, such as adjusting restaurant operations to focus on take-out business. To increase the likelihood that the post-period analysis is most similar to the pre-period analysis, businesses that are expected to be least affected by the COVID-19 pandemic adjustments were identified.

Final Number of Accounts

Table 41 presents the final number of accounts for each screening step described above. Our remaining percentage of about 36 percent of starting accounts is reasonable, and with the total number still included in the analysis, we are confident in the key findings from the analysis. However, given the high attrition due to insufficient data for some utilities, a process improvement for the next consumption analysis will be for the EM&V team to work upfront with utilities with high attrition to identify if any additional data can be provided and more accounts kept in the analysis. Meters for facilities outside the ideal building types and with low electricity consumption were most likely to be screened out. This is important to ensure that the lighting analysis maintains the focus on the lighting improvements and can eliminate variables from the results.

Table 41. Model Screening Steps by Utility

Step		AEP	CNP	EPE	Oncor	TNMP	Total	Percentage affected
	Starting	26,343	12,469	101	34,532	29,560	103,005	
1	Data started late	5359	541	25	1,196	89	7,210	7.0%
2	Data ended early	252	355	0	18,118	4	18,729	18.2%
3	Solar	106	98	0	79	48	331	0.3%
4	Gap in data	1115	712	57	353	137	2,374	2.3%
5	Negative kWh values	28	0	0	0	0	28	0.0%
6	Low average consumption	14,423	2961	3	3,437	17,776	38,600	37.5%
7	Unsuccessful geolocation	1,770	1764	2	2,650	1,758	7,944	7.7%
8	Not targeted building type	4,134	4249	6	9,800	6,919	25,108	24.4%
Count after screening		**2,396**	**3,991**	**19**	**35**	**2,996**	**9,437**	

After screening, the El Paso Electric accounts were dropped from the analysis. We only had data for 19 accounts, and there were difficulties matching them with the available tracking data for participants with the account numbers. The number of accounts in each selected building group is shown in Table 42. The groups did not have enough participant accounts to perform analysis at the building group level.

Table 42. Counts of Accounts in Each Building Group

Building group	Participant	Comparison	Past participant	Total
Convenience store	9	666	69	744
Finance	5	719	6	730
Grocery	9	550	28	587
Hardware	0	119	6	125
Health	0	84	1	85
Home goods	0	180	8	188
Laundry	0	198	8	206
Medical outpatient	2	1,363	13	1,378
Parking	0	10	0	10
Uncertain	43	3,947	294	4,284
Vehicle	8	524	27	559
Warehouse	3	515	4	522

Because analysis at a building group level wasn't possible, we grouped the businesses by consumption size, measured by the pre-retrofit annual normalized consumption.

Table 43. Counts of Accounts in Each Consumption Group

Consumption group	Participant	Comparison	Past participant	Total
Under 100,000 kWh	13	4,600	182	4,795
100,000–300,000 kWh	23	2,325	113	2,461
300,000–1 million kWh	26	1,394	75	1,495
Over 1 million kWh	17	556	94	667
Total	**79**	**8,875**	**464**	

A.3 MODEL SPECIFICATIONS, DETAILS, AND RESULTS

The following model was used to estimate weather-normalized consumption in the pre- and post-period for each account. This model was run for each meter, with a separate model performed for the pre- and post-period. For each facility, the model was run with every possible combination of cooling degree hour (65-85 degrees) and heating degree hour setpoints (45-65 degrees), for a total of 441 regressions run for each account in both the pre- and post-period. Once all 441 models were complete, model coefficients were saved for the model with the most explanatory power (highest R^2).

Equation 1. Individual Weather Normalization Model

$$Hourly\ Consumption_{it} = \alpha_i + \beta_1 HDH_{it} + \beta_2 CDH_{it} + \beta_3 Hour\_1_{it} + \cdots + \beta_{25} Hour\_23_{it}$$

Where for each customer 'I' and hour of the year' t':

$Hourly\ Consumption_{it}$ = Actual hourly consumption in the pre- or post-program period

α_i = The participant intercept, representing the kWh baseload at hour 0 of the day

β_1 = The model heating slope, representing the average change in hourly usage resulting from an increase of one HDH

HDH_{it} = The base 45-65 HDH for the nearest weather station is calculated as:

$$HDH_{it} = Base_{45-65} - Temperature_{it}$$

Where HDH_{it} is greater than 0, else $HDH_{it} = 0$

β_2 = The model cooling slope, representing the average change in hourly usage resulting from an increase of one CDH

CDH_{it} = The base 65-85 CDH for the nearest weather station calculated as:

$$CDH_{it} = Temperature_{it} - Base_{65-85}$$

Where CDH_{it} is greater than 0, else CDH_{it} = 0

β_{3-25} = Additional intercepts for each hour of the day, representing the kWh baseload at Hour 1 through Hour 23 of the day

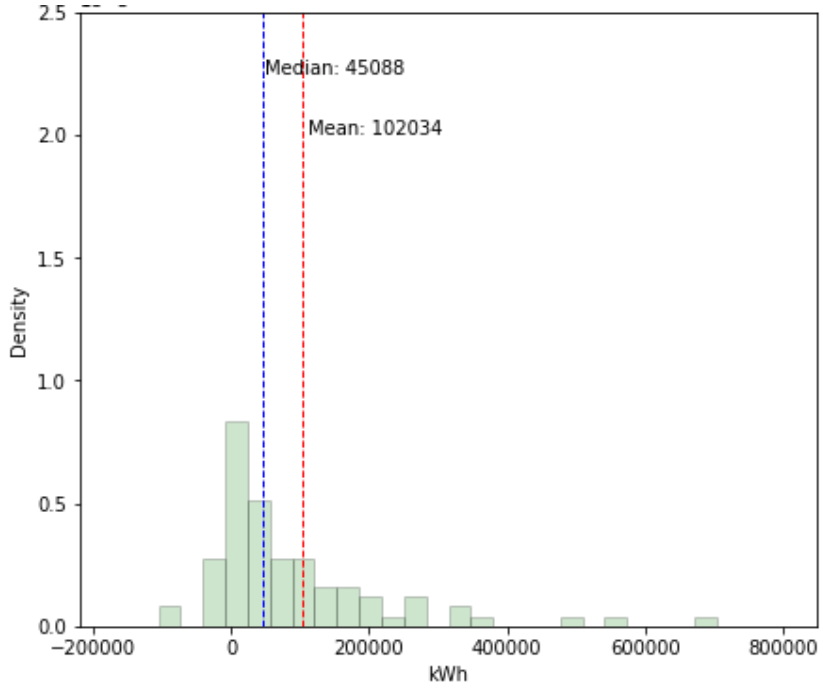
$Hour\_1_{it}$ = Dummy variable indicating the hour of the day. There are variables for Hour_1 through Hour_23

The models were weather normalized using the *CDH*, *HDH*, and *hour_1-23* coefficients for each account in the pre- and post-period and the same values for the matched TMY3 station. CDH and HDH are calculated based on the optimal cooling and heating setpoint determined in the model. The model created a weather normalized consumption estimate for every hour of the pre- and post-period for each account. The difference between the pre- and post-period normalized annual consumption identified operational changes and the savings associated with the lighting retrofit.

A.4 MODELED ANNUAL CONSUMPTION

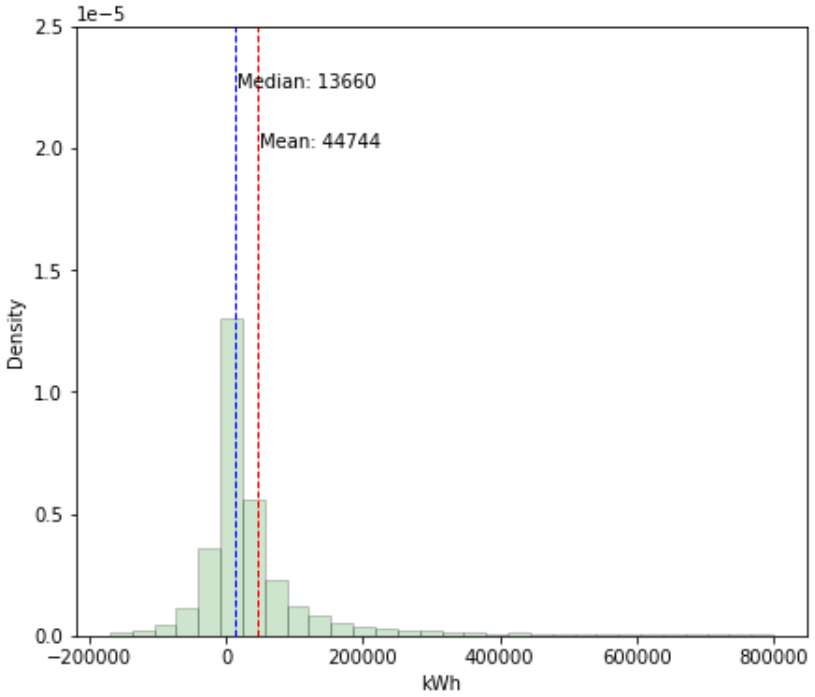
The differences in pre- and post-period normalized consumption for all analyzed accounts are displayed below. For the participant group, the annual mean pre/post difference in consumption was 102,034 kWh and the median difference was 45,088 kWh. The standard deviation was 163,914 kWh. The full distribution of pre/post differences is shown in Figure 37. The mean is larger than the median here because of the spread of larger positive values.

Figure 37. Participant Group Pre- and Post-Period Difference



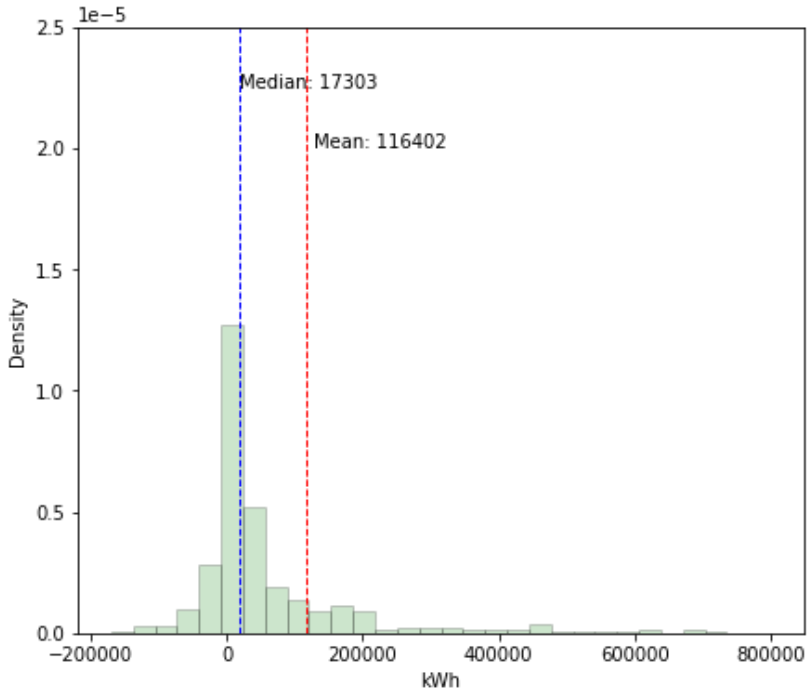
For the comparison group, the annual mean pre/post difference was 44,744 kWh and the median was 13,660 kWh. The full distribution of comparison group pre/post differences is shown in Figure 38. The mean and the median are closer here because the distribution is more evenly centered because the comparison group had many more participants.

Figure 38. Comparison Group Pre- and Post-Period Difference



For the past participant group, the annual mean pre/post difference was 116,402 kWh and the median was 17,303 kWh. The standard deviation was 672,220 kWh, indicating large variability. The full distribution of past participant group pre/post differences is shown in Figure 39.

Figure 39. Past Participant Group Pre- and Post-Period Difference



The past participant group determined the participants that had previously received a lighting upgrade operated similarly to the comparison group. The groups look similar, but the small number of meters creates a much less consistent distribution than the larger comparison group. The consumption analysis removed the past participant group once this was confirmed.

Table 44 below shows the overall average energy savings as a percentage of the pre-treatment consumption. The comparison and participant groups showed a reduction in energy consumption in the post-treatment period. The reduced consumption is expected because of the uncertain market conditions surrounding the pandemic, which adjusted many facilities' operation hours. Overall, the participant group reduced energy consumption by 17 percent compared to 12 percent for the comparison group. The reduction percentage broken down by group is inconsistent because of the small number of participants in each category.

Table 44. Analysis and Consumption Group Model Results Compared to Pre-Treatment

	Analysis group	n	Average normalized energy consumption, pre-treatment (kWh)	Average model savings (kWh)	Savings as percentage of pre-treatment consumption
Below 100k	Participant	13	45,728.30	6,734.85	14.73%
	Comparison	4600	48,615.86	5,897.54	12.13%
	Participant	23	187,026.20	28,852.15	15.43%

	Analysis group	n	Average normalized energy consumption, pre-treatment (kWh)	Average model savings (kWh)	Savings as percentage of pre-treatment consumption
100k–300k	Comparison	2325	174,526.71	31,786.29	18.21%
300k–1M	Participant	26	546,990.56	86,681.13	15.85%
	Comparison	1394	536,431.47	80,959.05	15.09%
Over 1M	Participant	17	1,608,498.97	297,399.47	18.49%
	Comparison	556	3,680,616.02	329,529.60	8.95%
Grand total	**Participant**	**79**	**588,130.48**	**102,033.58**	**17.35%**
	Comparison	**8875**	**385,759.49**	**44,744.47**	**11.60%**

A.5 MODELED SAVINGS AND EX-ANTE SAVINGS

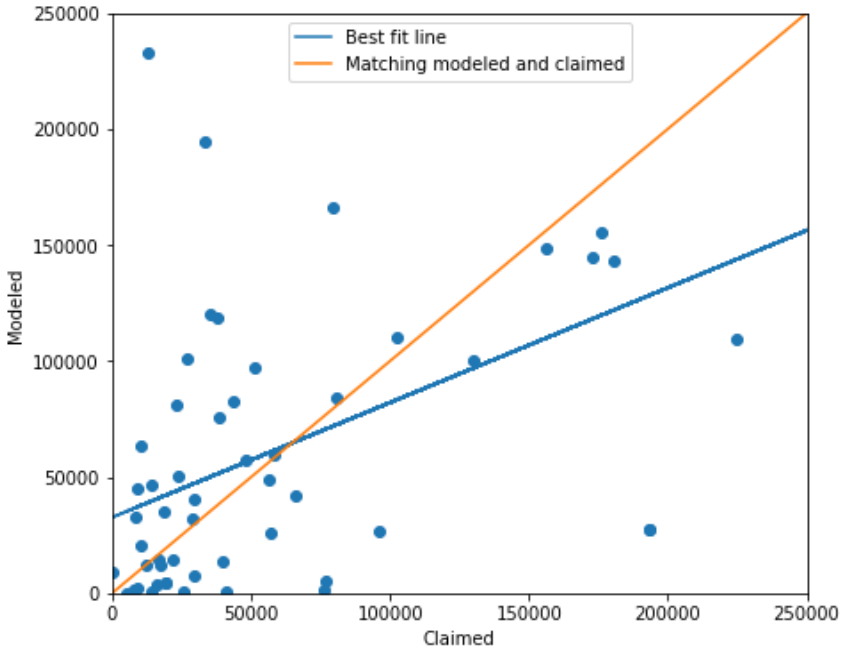
The claimed savings from these lighting retrofit projects are calculated based on the equipment removed and the upgraded equipment installed. The claimed savings normalize the energy savings and identify the reduction in the annual energy consumption. To compare the reduced consumption to the claimed energy savings, the participant group determined the average annual savings for each project from the combined energy modeling results and the combined claimed savings in the programs. The analysis found that the energy consumption model savings are lower than the claimed savings, as shown in Table 45; however, the confidence interval is significant, and matching the claimed savings is possible.

Table 45. Comparison of Consumption Model Results

Analysis group	n	Average model savings (kWh)	Average claimed savings (kWh)	Savings as percentage of claimed	90% confidence interval
Below 100k	13	6,734.85	29,202.84	23.06%	14.63%
100k-300k	23	28,852.15	50,739.67	56.86%	67.0%
300k-1M	26	86,681.13	180,048.13	48.14%	45.13%
Over 1M	17	297,399.47	285,654.66	104.11%	380.25%
Grand total	**79**	**102,033.58**	**140,304.18**	**72.72%**	**89.83%**

Figure 40 shows the relationship between modeled and ex-ante savings for the participant group. This plot shows the modeled savings correlate to the claimed savings, although there are many outliers. There is a general trend in the relationship between modeled savings estimates and ex-ante savings estimates.

Figure 40. Modeled and Ex-Ante kWh Savings for Participant Group



A.6 UTILITY LEVEL RESULTS

Grouping the results by utility, the participant group shows consistent performance. But the comparison group varied by utility. Table 46 shows the modeled savings for both the comparison and participant groups by comparing the savings to the pre-treatment consumption.

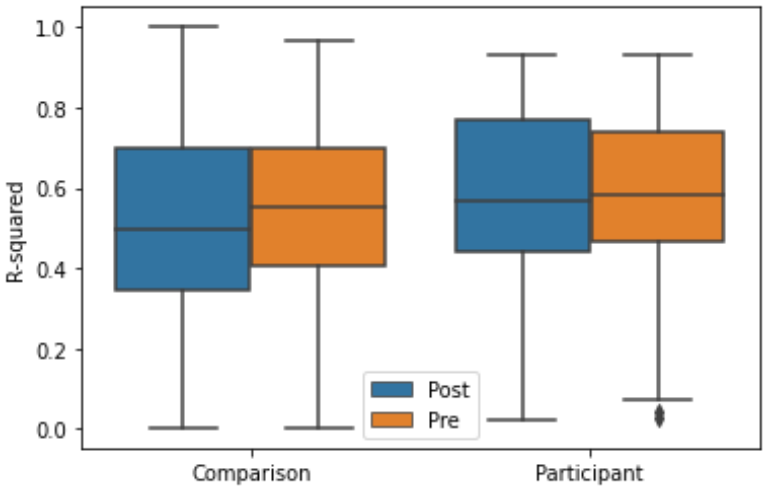
Table 46. Analysis and Consumption Group Model Results by Utility

	Analysis group	n	Average normalized energy consumption, pre-treatment (kWh)	Average model savings (kWh)	Savings as percentage of pre-treatment consumption
AEP	Participant	17	246,713.39	48,736.03	19.75%
	Comparison	2236	160,160.19	13,049.01	8.15%
CenterPoint	Participant	0			
	Comparison	3909	454,932.16	73,860.38	16.24%
Oncor	Participant	35	639,772.24	108,677.41	16.99%
	Comparison	0			
TNMP	Participant	27	736,153.75	126,978.93	17.25%
	Comparison	2730	471,489.92	29,014.40	6.15%

A.7 COEFFICIENT OF DETERMINATION (R^2)

The average R^2 was about 0.57 for the participant group and about 0.54 for the comparison group in both the pre- and post-treatment periods. Figure 41 below shows the distribution of R^2 values for these groupings. There is very little difference in R^2 distributions between pre- and post-periods or participant groups compared to the comparison group. Both groups included a wide range of R^2 values, almost covering the entire range of potential values.

Figure 41. R^2 Distributions



A.8 MODEL HEATING AND COOLING BALANCE TEMPERATURES

Each model uses a heating and cooling balance temperature to identify when heating or cooling is typically used in the facility. The model is developed to test various balance temperatures, with the highest coefficient of determination selected for the analysis. The selected heating and cooling balance temperatures were strongly skewed toward 65 degrees Fahrenheit, as shown in Figures 10 and 11. Sixty-five degrees is the lowest value for the cooling range and the highest value for the heating range. The skewed results are concerning when considering applying the final results of the analysis. However, the different cooling and heating balance temperatures also had similar R^2 values across the whole range, as shown in Figure 42 and Figure 43. This similarity suggests that the individual selection of heating and cooling balance temperatures for commercial buildings is not critical to the overall applicability of the results.

Figure 42. Cooling Setpoint Distribution

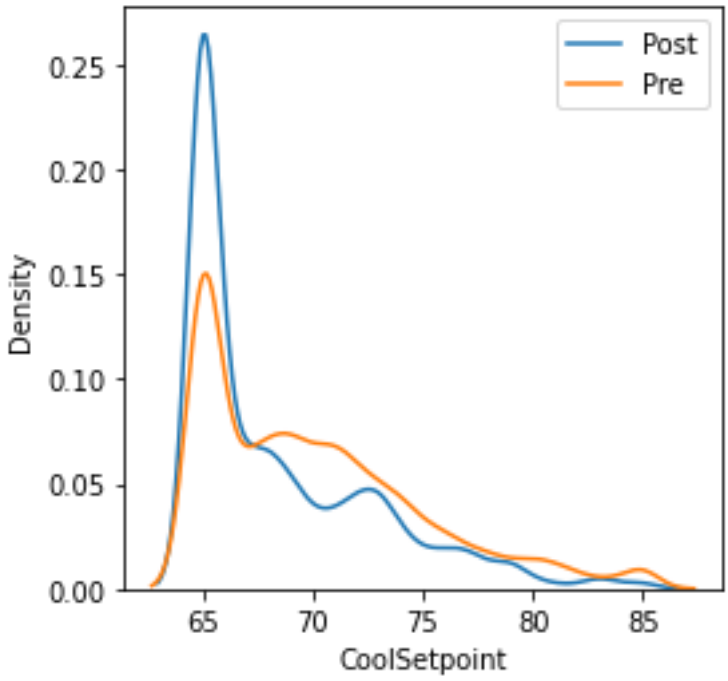


Figure 43. Heating Setpoint Distribution

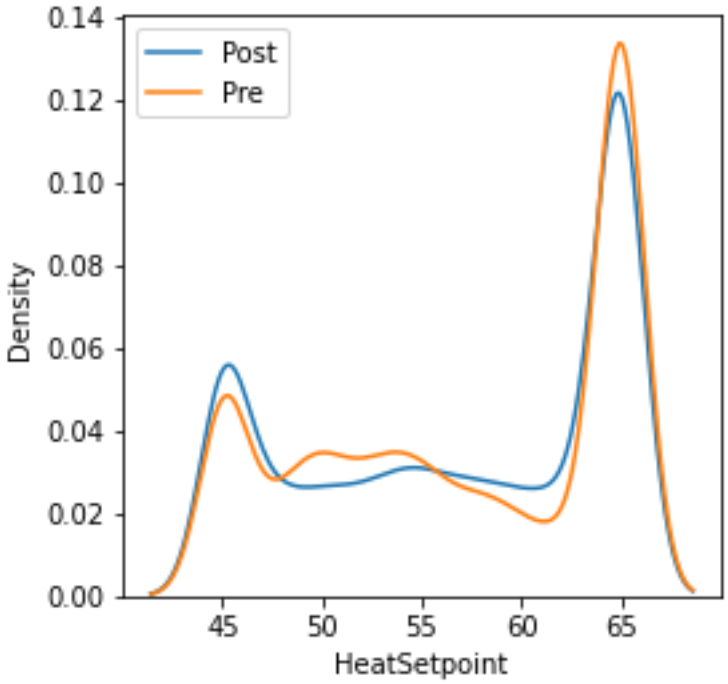


Figure 44. R^2 Distribution by Cooling Setpoint

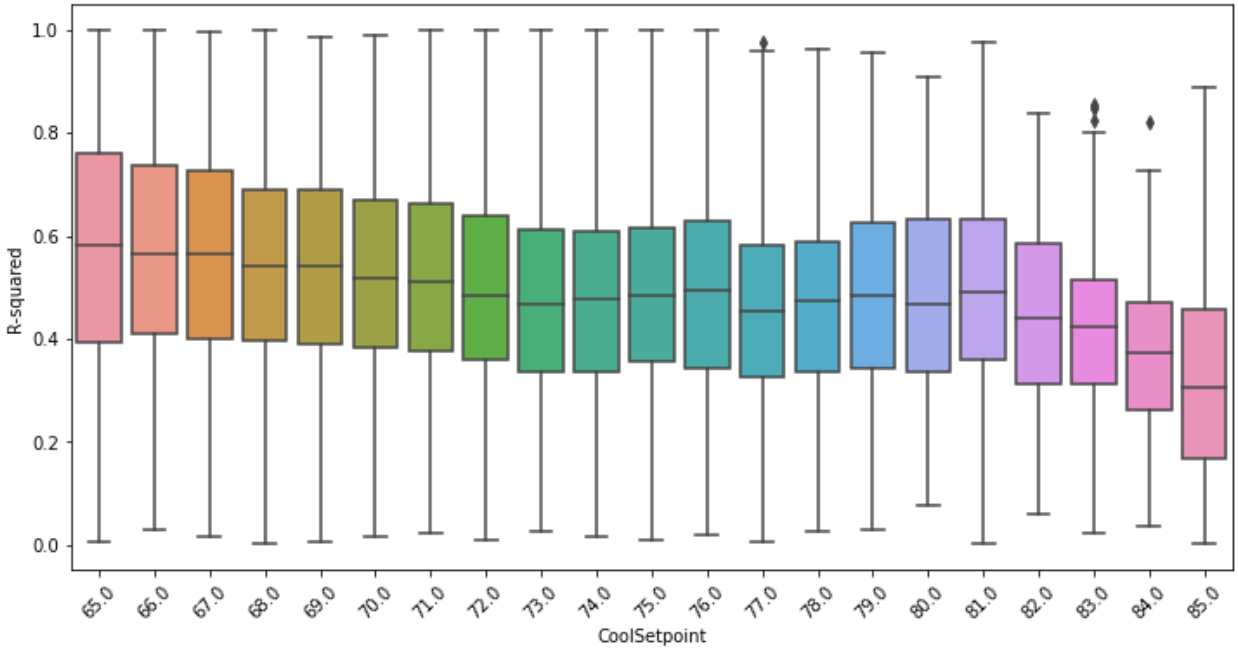
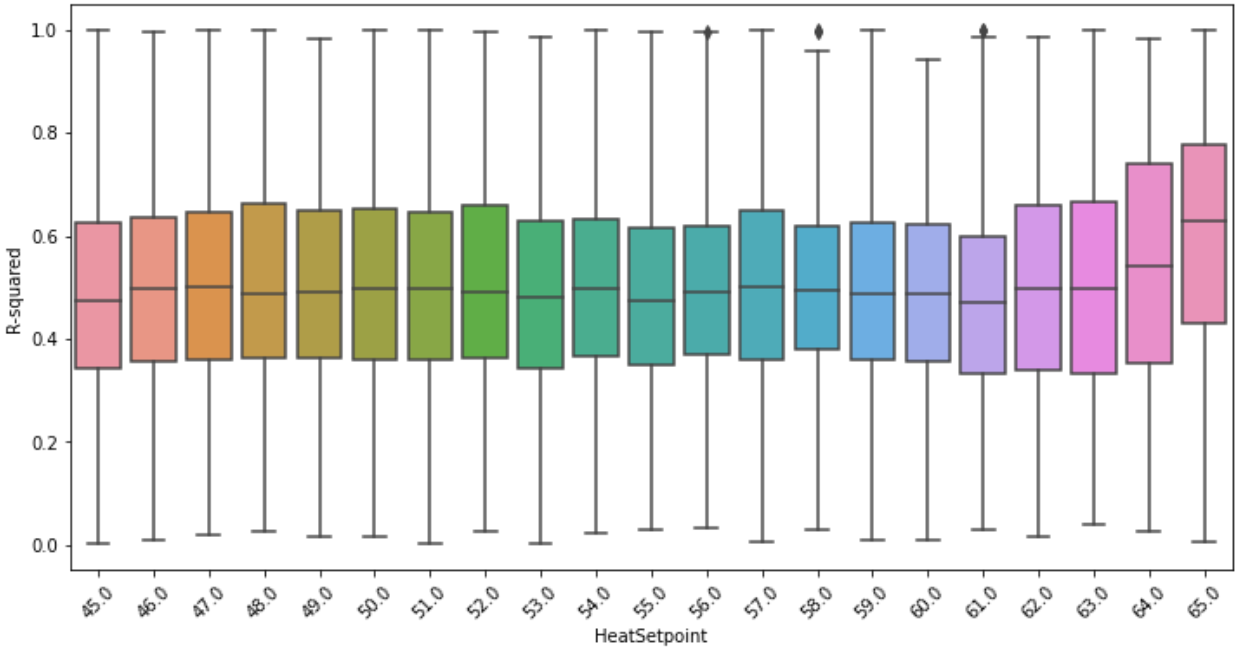


Figure 45. R^2 Distribution by Heating Setpoint



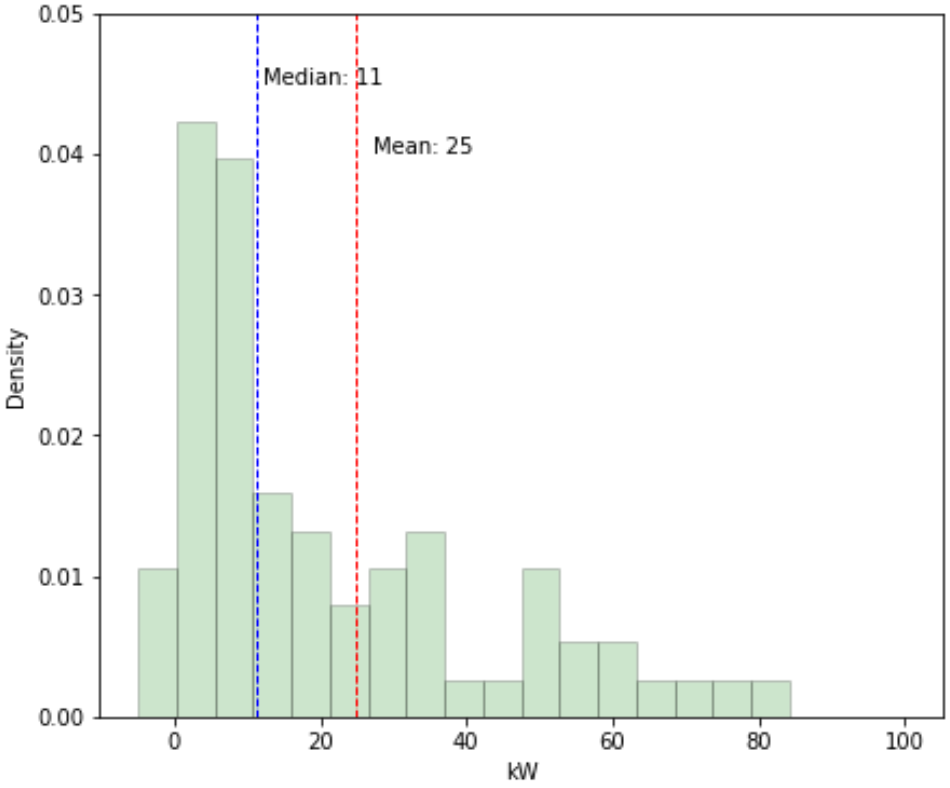
A.9 MODELED PEAK DEMAND

The peak demand weather-normalization models are used to estimate hourly demand impacts. The key difference between this model and the annual consumption weather-normalization models is that rather than fitting the model to the whole year of TMY3, only the top 20 hours from the Peak Probability (PPA) Tables in the TRM Volume 1 are determined by the model. The model is developed to identify both the weather variables and a unique factor for each hour (1-23). This results in a model that can identify the hourly demand estimate for the top 20 hours in winter and summer for the pre- and post-periods in the climate zone of the meter location.

The hourly demand estimates for the pre- and post-period for the top 20 hours followed the TRM methodology. First, the modeled peak demand is multiplied by each hour's peak demand probability factor (PDPF). Next, the sum of these terms is divided by the sum of the PDPF values. This process is repeated for both the pre- and post-period, providing an estimate of peak demand in the pre-period and the post-period for both summer and winter peak periods. We finally subtract the post-estimate from the pre-estimate, with the difference being our reduction in peak demand for that account. The modeled peak demand reduction is the greater of the winter or summer peak demand reduction.

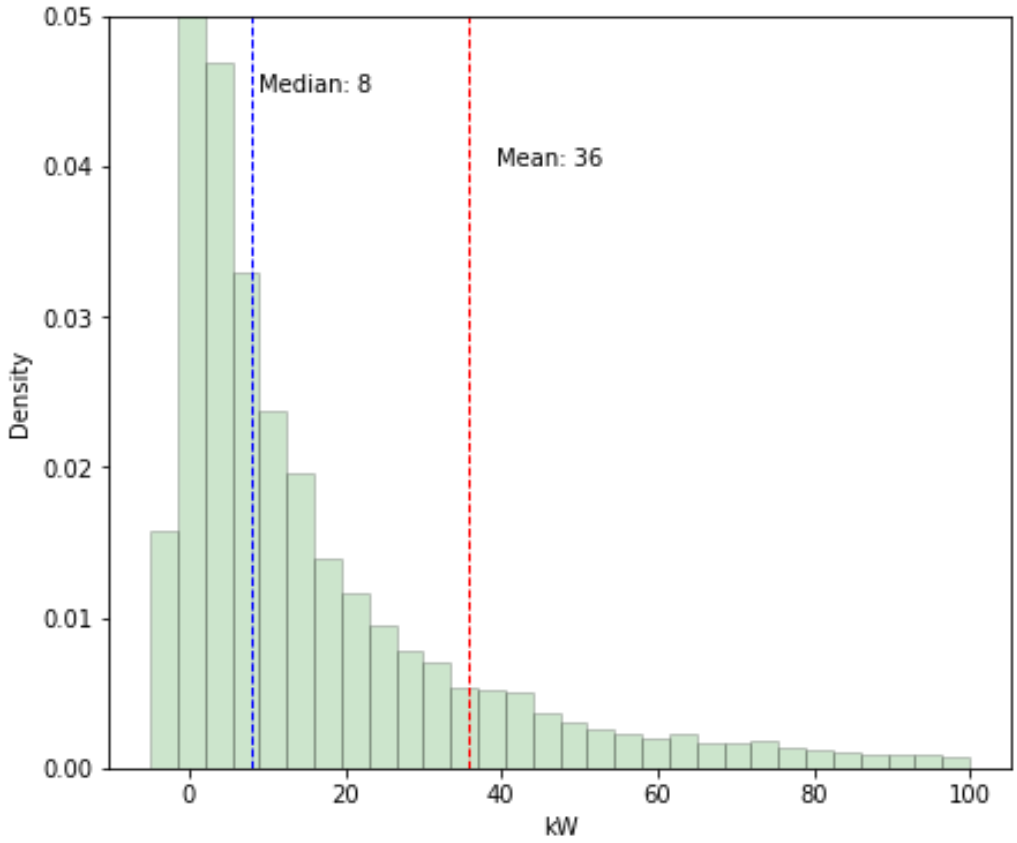
However, the peak reduction in the analysis of the participant group is apparent. The annual mean pre/post difference in demand was 25, and the median difference was 11. The standard deviation was 33. The distribution of pre/post differences up to 100 kW is shown in the figure below. The mean is larger than the median here because of the spread of larger positive values and the high density of smaller reductions.

Figure 46. Participant Group Pre- and Post-Period Difference



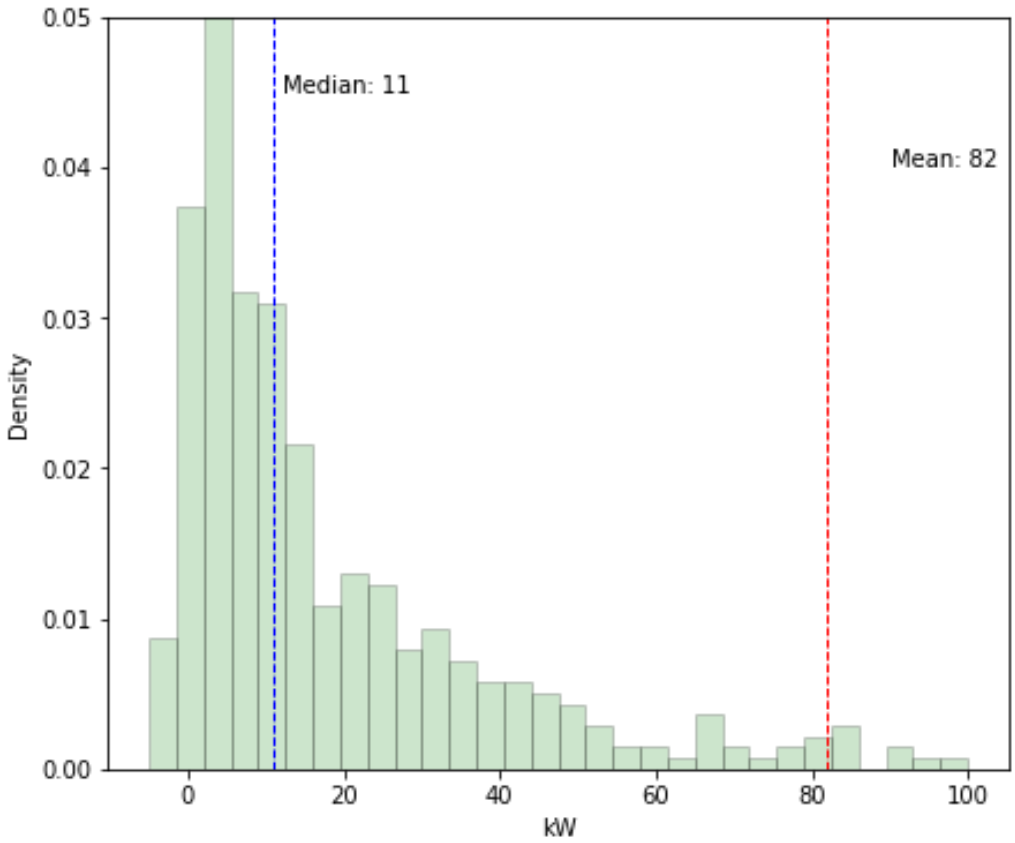
For the comparison group, the annual mean pre/post difference was 36, and the median was 8, with a standard deviation of 237. The distribution of comparison group pre/post differences up to 100 kW is shown in the figure below. The mean and the median are further apart here because of the long tail of high savings accounts over 100 kW. These facilities may have incurred shutdowns during peak demand hours, resulting in a peak demand reduction from non-operation as opposed to energy efficiency during operation.

Figure 47. Comparison Group Pre- and Post-Period Difference



The past participant group had an annual mean pre/post difference of 82, and the median was 11. The standard deviation was 609, indicating large variability similar to the comparison group and exacerbated because of the small number of meters in the analysis group. The distribution of past participant group pre- and post-differences up to 100 kW is shown in the figure below. Again there is a long tail of high savings above 100 kW that indicates past participants may have incurred shutdowns during the peak demand hours, creating a peak demand reduction resulting from non-operation as opposed to energy efficiency during operation.

Figure 48. Past Participant Group Pre- and Post-Period Differences



Similar to the annual KWh consumption analysis of the past participant group, this group showed similar results to the comparison group with more significant variability. Therefore this group was removed from the consumption analysis.

The figures above show that the participant group had a lower mean peak demand reduction than the comparison group. However, the comparison group was skewed by large peak demand reduction indicative of shutdowns over the peak demand period. The distribution of the participant group is much more compact and with a much lower density on zero peak demand reduction, indicating the peak demand reduction of the participant group is a result of energy-efficient treatment during operation. In contrast, the comparison group results include a higher proportion of facilities that showed a peak demand reduction because of non-operation. These two conditions show that the comparison and participant groups likely reacted differently to the market conditions.

Table 47 provides a more detailed review of the peak demand savings for the participants divided by meter peak demand. The participants consistently showed peak demand reduction equal to about 24 percent of the pre-treatment summer demand. Facilities with a smaller load show a higher proportion of demand reduction because the lighting is a larger portion of their overall demand. Therefore, the project will reduce a higher percentage of the peak demand load.

Table 47. Comparison of Modeled PDPF Peak Demand Savings for Participants

Participant analysis group (pre-treatment summer kW)	n[25]	Average normalized peak energy demand		Average model savings (kW)	Savings as a percentage of summer pre-treatment
		Pre-treatment summer (kW)	Pre-treatment winter (kW)		
Under 20 kW	11	9.04	6.18	3.13	34.6%
20 kW to 200 kW	53	81.96	58.02	21.73	26.5%
Over 200 kW	8	389.71	207.53	82.66	21.2%
All groups total	**72**	**105.01**	**66.71**	**25.66**	**24.4%**

A.10 MODELED SAVINGS AND EX-ANTE PEAK DEMAND SAVINGS

The peak demand is challenging to compare modeled demand reduction to claimed because the claimed value is a sum of the winter or summer periods determined at each lighting fixture and is not available in the tracking data. Therefore, some projects will claim summer or winter savings, but many claim a mix of summer and winter demand. The modeled demand measured the combined impact of all light fixtures in either summer or winter.

The analysis approached the peak demand savings to identify the peak demand reduction between the participants' pre-install and post-install measurement periods. Figure 49 compares the modeled peak demand reduction and the ex-ante claimed peak demand. The modeled savings are below the matching line because of the mismatch between the claimed peak demand process and the consumption measurement.

However, the modeled savings for projects that claimed less than 20 kW demand reduction was greater than expected. As project size increased, the projects became less likely to meet the peak demand. This finding matches the expected pattern of results because the larger projects are more likely to mix summer and winter peak demand in the claimed savings, whereas a smaller project will be more consistent between lighting fixture claims.

[25] The *n* in the participant group is lower for the peak demand analysis because there were several meters where the post-treatment demand model did not provide a viable result.

Figure 49. Modeled and Ex-Ante kW Savings for Participant Group