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Public Utility Commission of Texas

Volume 1. Statewide Energy Efficiency Portfolio Report Program Year 2019

TETRA TECH

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Tetra Tech's EM&V team primary report contributors include:

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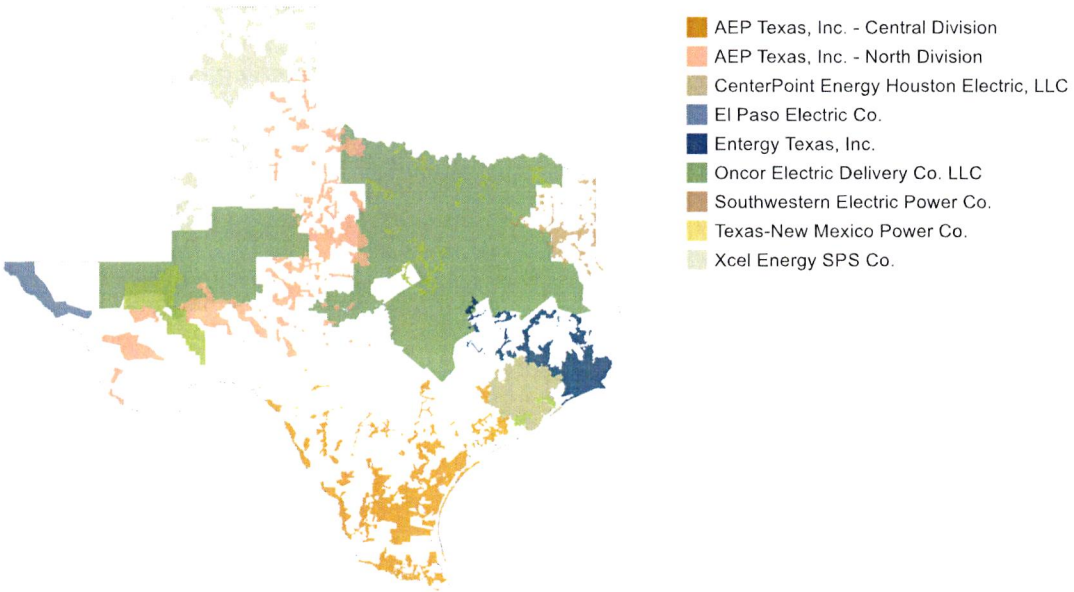
ACRONYMS

AEP TCC	American Electric Power Texas Central Division
AEP TNC	American Electric Power Texas North Division
C&I	Commercial and industrial
CATI	Computer-assisted telephone interview
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
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

The Public Utility Commission of Texas (PUCT) oversees the energy efficiency programs delivered by the state's investor-owned electric utilities: AEP Texas, Inc.[1] (AEP Texas), CenterPoint Energy Houston Electric, LLC (CenterPoint), Entergy Texas, Inc. (Entergy), El Paso Electric Company (El Paso Electric), Oncor Electric Delivery, LLC (Oncor), Southwestern Electric Power Company (SWEPCO), Southwestern Public Service Company (Xcel SPS), and Texas New Mexico Power Company (TNMP). The utilities' service territories are shown in Figure 1.

Figure 1. Territories of Regulated 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. Standard offer programs (SOPs) 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 (MTPs). MTPs provide additional outreach, technical assistance, and education to customers in harder-to-serve markets (e.g., small business, health care, schools, and local governments) and for select technologies (e.g., recommissioning, air conditioner (AC) tune-ups, pool pumps). All utilities provide energy efficiency offerings to low-income customers through hard-to-reach (HTR) programs that are delivered similarly to the residential SOPs. The utilities that are part of the Electric Reliability Council of Texas (ERCOT) also offer targeted low-income (LI) programs that coordinate with the existing federal weatherization program. Finally, the utilities manage load management programs, which are designed to reduce peak demand when needed.

[1] The PUCT approved the application AEP Texas Central Company (AEP TCC), AEP Texas North Company (AEP TNC), and AEP Utilities, Inc. to merge AEP TCC and AEP TNC into AEP Utilities, and then rename that corporate entity AEP Texas, Inc. AEP Texas reported 2019 energy efficiency programs by the legacy AEP TCC and AEP TNC territories, which are now referred to as AEP Texas Central Division and AEP Texas North Division.

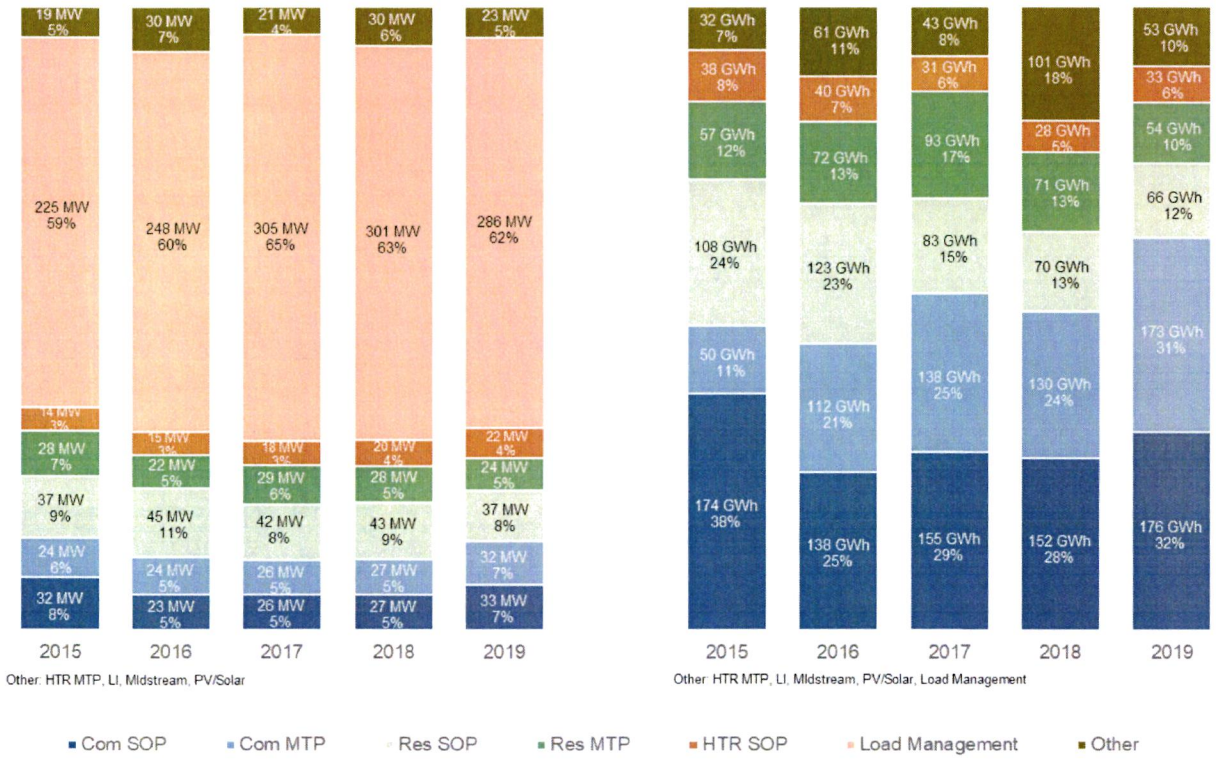
1.1 PY2019 ENERGY EFFICIENCY SUMMARY RESULTS

In program year (PY) 2019, the Texas electric utilities achieved statewide demand reductions of 479,912 kilowatts (kW) at a lifetime savings cost of $16.94 per kW[2]. The utilities achieved statewide energy savings of 651,950,467 kilowatt-hours (kWh) at a lifetime savings cost of $0.01 per kWh.

1.1.1 Savings

As shown in Figure 2, load management programs consistently account for approximately 60 percent of the statewide gross demand reduction (MW). Commercial SOPs and MTPs continue to account for the largest percentage of statewide energy savings, 32 percent and 31 percent, respectively, an increase from prior years.

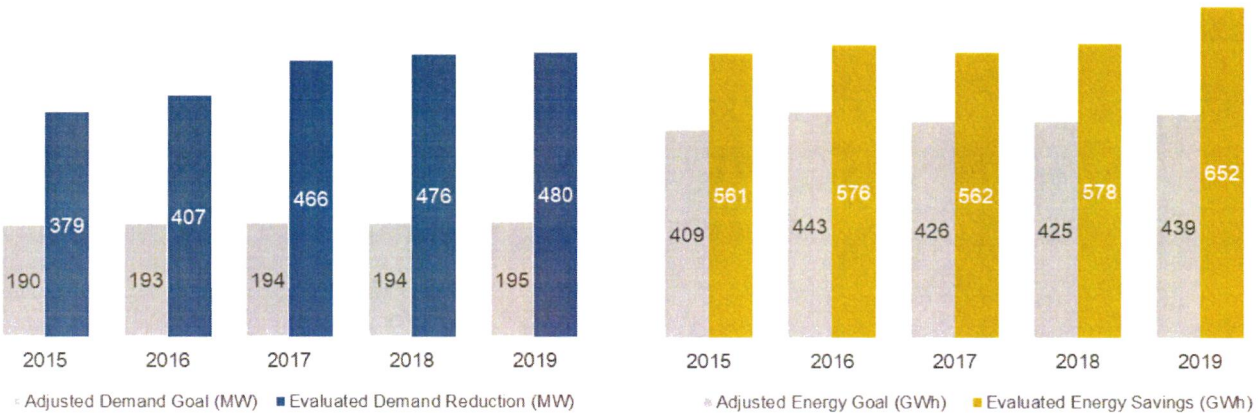
Figure 2. Evaluated Gross Demand Reduction and Energy Savings by Program Type



[2] Excluding load management programs, the lifetime savings cost is $15.41 per kW.

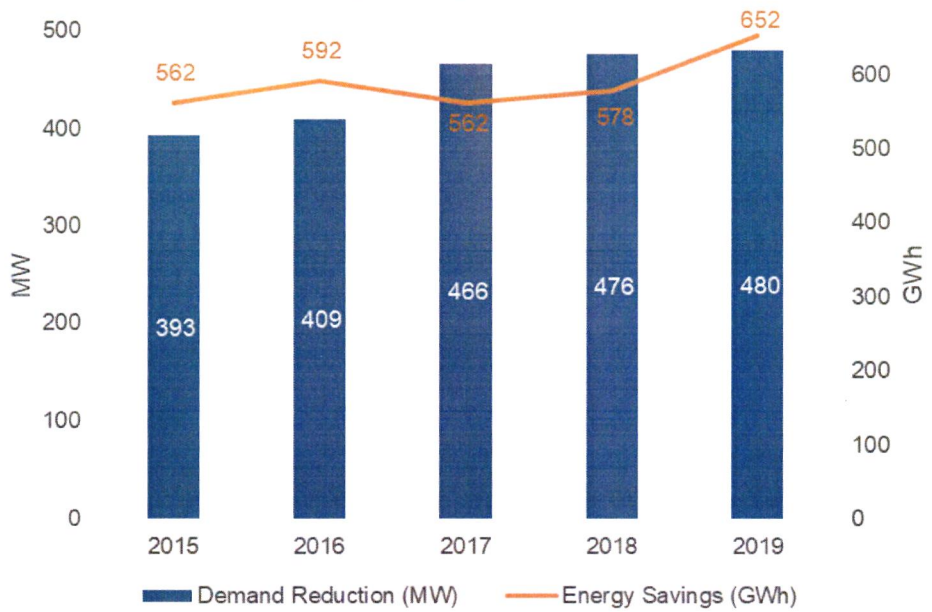
As shown in Figure 3, statewide, the utilities continue to significantly exceed demand reduction goals in large part due to the load management programs. The utilities also are consistently exceeding energy savings goals.

Figure 3. PY2015–PY2019 Legislated Goals and Actual Demand Reduction and Energy Savings



Evaluated gross demand reduction has increased every year since 2015. PY2019 achieved demand reductions of 479,912 kW. Evaluated gross energy savings were 651,950,467 kWh, which exceeds the previous highest savings of 592 gigawatt-hours (GWh) in PY2016 (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 they are installed based on the type of energy efficiency improvement made and how long it typically lasts. The cumulative savings the utilities have achieved since PY2012 are shown in Figure 5 (demand reduction) and Figure 6 (energy savings). Half of the demand reductions and energy savings achieved to date are expected to continue through 2030.

Figure 5. PY2012—PY2048 Lifecycle Demand Reduction by Sector (MW)[3]

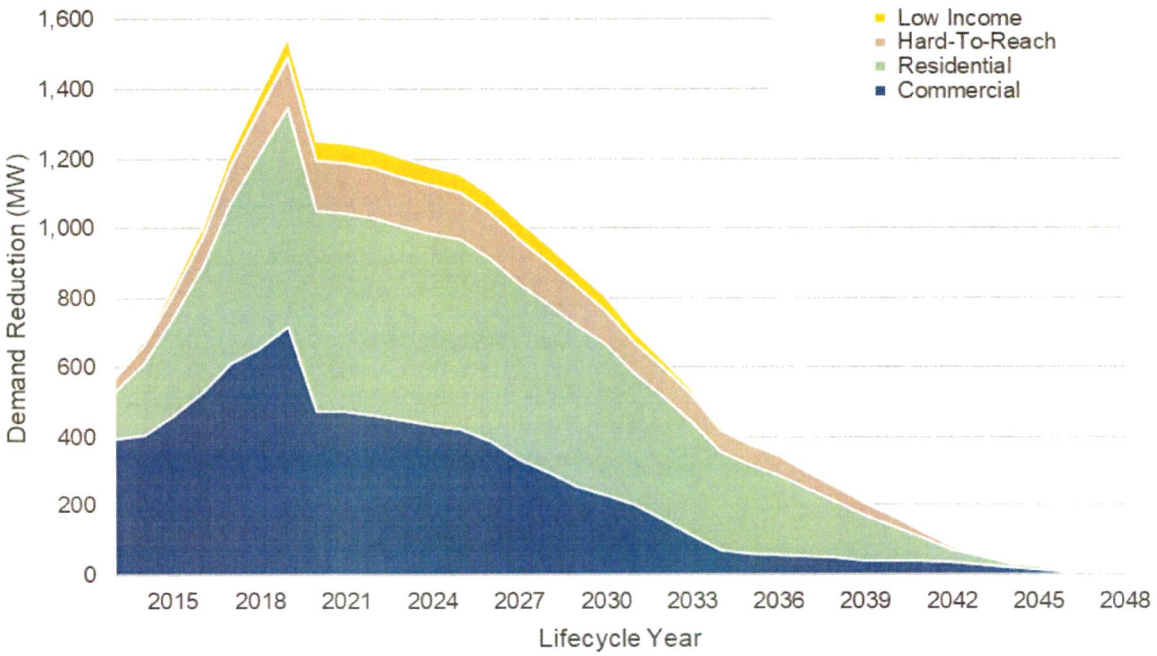
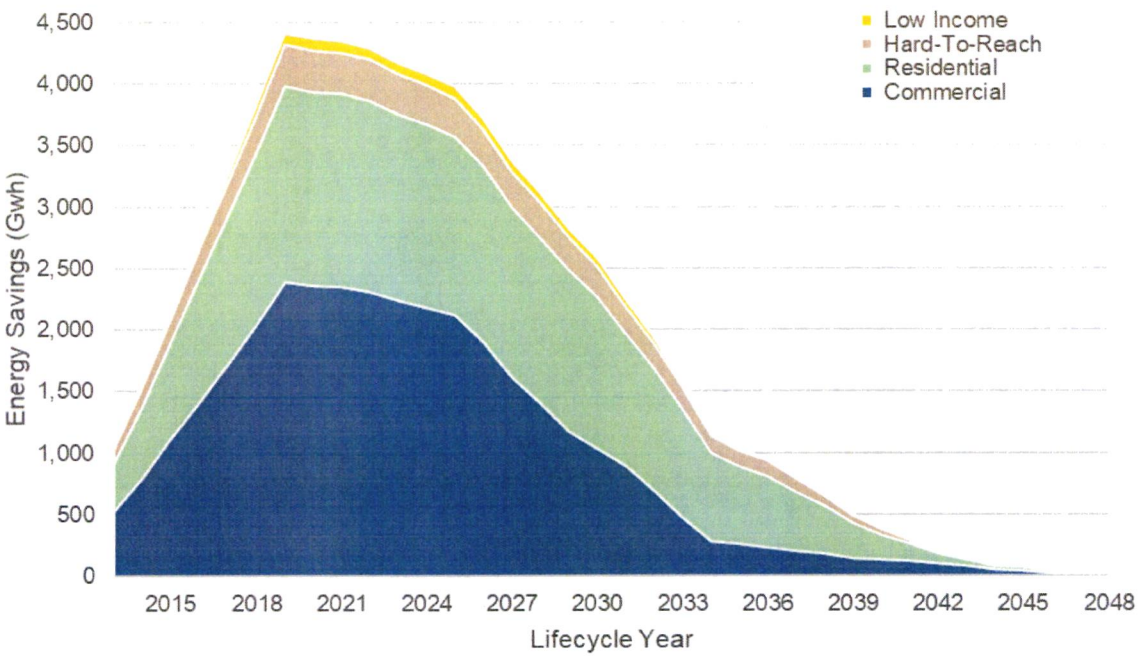


Figure 6. PY2012—PY2048 Lifecycle Energy Savings by Sector (GWh)



[3] Load management programs have a one-year measure life and represent the spike in kW reductions.

Figure 7 and Figure 8 show the types of measures the programs installed and how they contribute to lifecycle savings. Lighting, HVAC, and building shell improvements are delivering the most savings over time.

Figure 7. PY2012–PY2048 Lifecycle Demand Reduction by Measure Category (MW)[4]

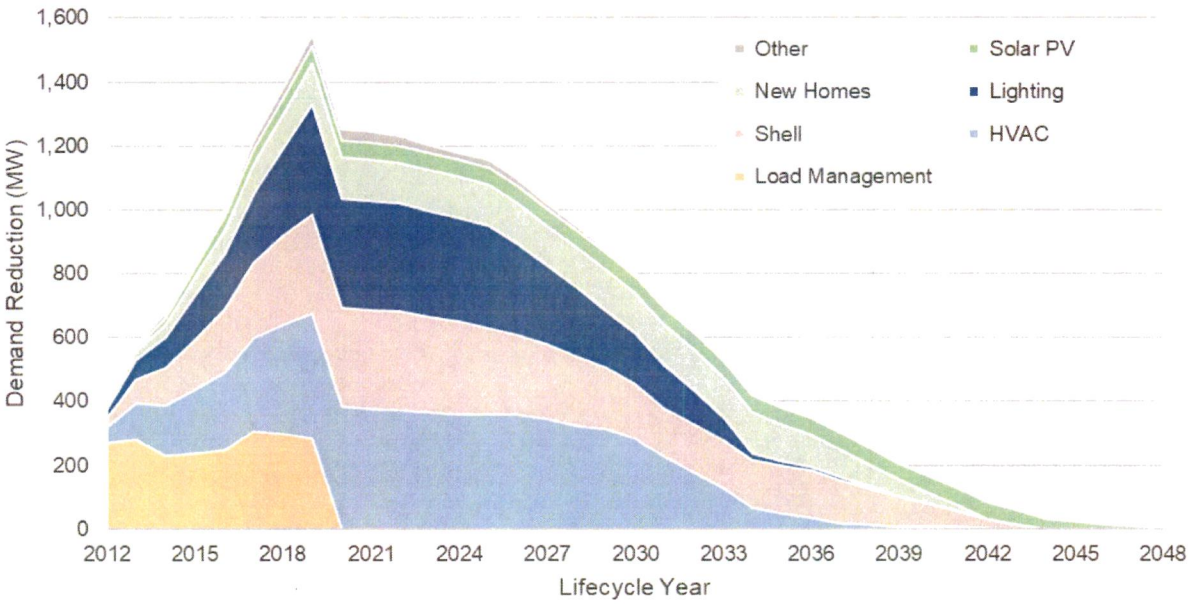
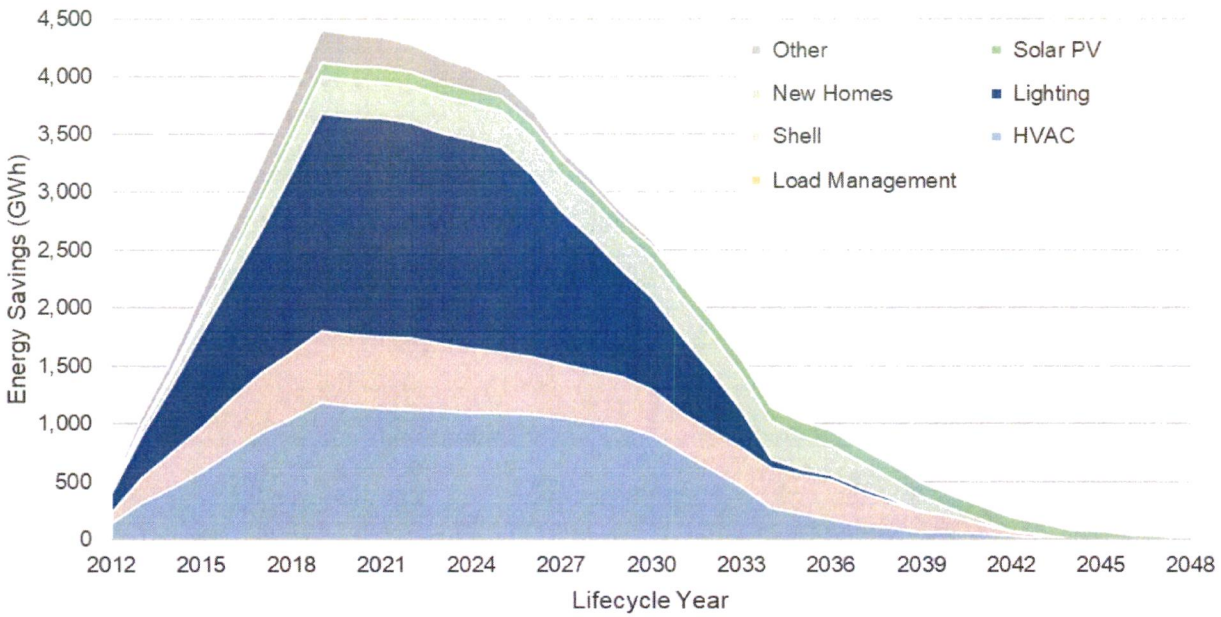


Figure 8. PY2012–PY2048 Lifecycle Energy Savings by Measure Category (GWh)



[4] Load management programs have a one-year measure life and represent the spike in kW reductions.

1.1.2 Cost-Effectiveness

The avoided costs and overall cost-effectiveness ratios from PY2015 to PY2019 can be seen in Figure 9. The statewide cost-effectiveness has consistently remained above 2.0 using the program administrator cost test (benefits divided by costs). Cost-effectiveness increased to 2.7 in PY2019. While the increased cost-effectiveness is somewhat a result of higher avoided costs, 2.7 is a better ratio than seen in 2015 and 2016 when avoided costs were comparable to 2019.

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

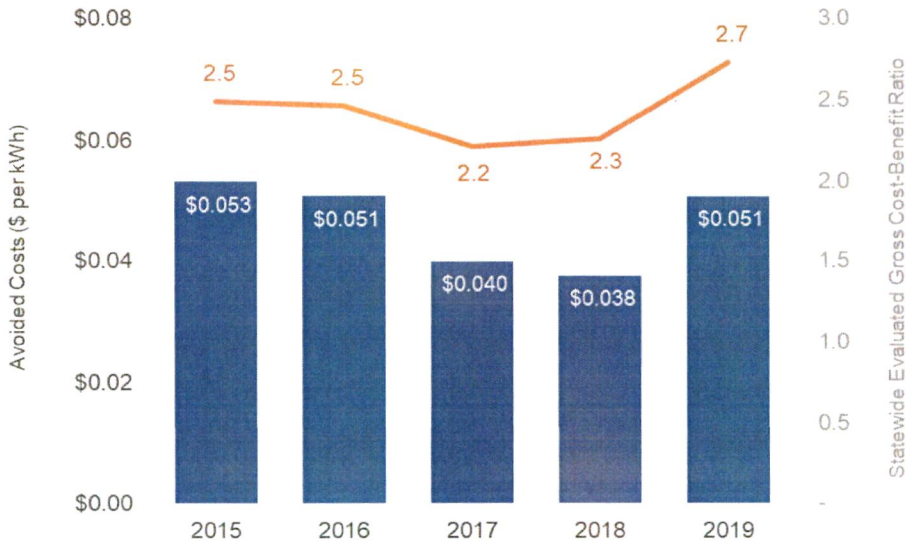
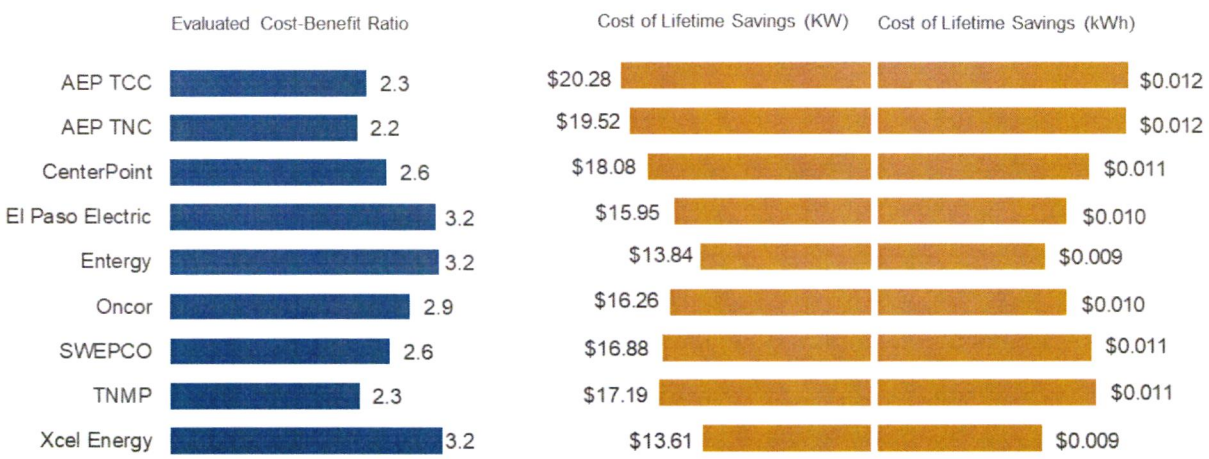


Figure 10 summarizes the cost-effectiveness of each utility's energy efficiency portfolio, including LI programs. All portfolios were cost-effective, ranging from 2.2 to 3.2. The cost per kW ranged from $13.61 to $20.28, and the cost per kWh ranged from $0.009 to $0.012. These costs provide an alternate 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. PY2019 Evaluated Savings Cost-Benefit Ratio and Cost of Lifetime Savings



1.2 EVALUATION, MEASUREMENT, AND VERIFICATION OVERVIEW

In 2011, the Texas Legislature enacted SB 1125, which required the PUCT to develop an evaluation, measurement, and verification (EM&V) framework that promotes effective program design and consistent, streamlined reporting. The EM&V framework is embodied in 16 Tex. Admin. Code § 25.181, relating to Energy Efficiency Goal (Project No. 39674).

The PUCT selected an EM&V team through the Request for Proposals (RFP) 473-17-00002, Project No. 46302. This team is led by Tetra Tech and includes Texas Energy Engineering Services, Inc. (TEESI) (hereafter, "the EM&V team").

Independent EM&V was conducted for Texas electric utilities' PY2019 energy efficiency portfolios. The objectives of the EM&V effort are to:

- document gross and net energy and demand impacts of utilities' individual energy efficiency and load management portfolios;
- determine program cost-effectiveness[5];
- provide feedback to the PUCT, utilities, and other stakeholders on program portfolio performance; and
- prepare and maintain a statewide technical reference manual (TRM).[6]

This Statewide Energy Efficiency Report presents the PY2019 EM&V findings and recommendations, looking across all eight electric utilities' portfolios. It addresses gross and net energy and demand impacts, program cost-effectiveness, and provides feedback on program portfolio performance. Also, it includes findings and recommendations related to savings to inform updates to the TRM.

The PUCT's EM&V independently verifies claimed savings across all programs through program tracking data that is received from the utilities. 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.

Residential standard offer programs (RSOPs), HTR, and LI programs were a *high* evaluation priority for PY2019. These programs continue to comprise a substantial percentage of overall residential portfolio savings and have recently responded to various TRM updates to the envelope measures. Moreover, the EM&V team recommended expanding the measure mix in these programs as a result of prior evaluation research. The EM&V team completed a consumption analysis for the Electric Reliability Council of Texas (ERCOT) utilities' RSOPs, HTR, and LI programs, which is described in detail in Technical Appendix 1 of this report. The EM&V team also conducted surveys with residential service providers to gain insight into program processes from their perspective.

[5] The EM&V team conducts cost-effectiveness testing by applying the program administrator cost test. For LI programs, cost-effectiveness is calculated using the savings-to-investment ratio (SIR).

[6] 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.

Several residential market transformation programs were also a *high* priority in PY2019 as they were either re-designed or newer programs. First, new homes MTPs had an updated statewide energy code and TRM entry in PY2018. The EM&V team conducted a consumption analysis to compare to the programs' savings estimates, described in detail in Technical Appendix 1, to this report. The consumption analysis was complemented with builder and home energy-rater interviews to understand standard practices in the market and how the program is influencing them. Residential upstream lighting programs have increased in the last couple of years and reach a high number of customers through retail channels. A census impact review of these programs was conducted along with retailer interviews and benchmarking research.

Commercial standard offer programs (CSOPs) and the commercial MTPs continued as a *medium* priority in PY2019. These programs continue to represent the largest percentage of statewide savings and continue to explore new customer segments and technologies. While prior EM&V generally found evaluated savings to be similar to the utilities' claimed savings, it also resulted in several recommendations for changes to reported claimed savings.

Load management program evaluations returned to a *medium* priority in PY2019 after being evaluated as *high* priority in PY2018. These programs continue as a substantial contributor to demand reduction (kW) savings. The EM&V team conducted census reviews of all participants' interval meter data in PY2019 to calculate impacts independently following the TRM to compare against utilities' claimed savings.

All other program types are *low* priorities for evaluation because they are small contributors to portfolio savings, have little uncertainty in savings, or had EM&V results in recent years that had limited action items.

Finally, because one of the primary objectives of this report is to provide recommendations for 2021 programs, the EM&V team conducted research in May–June 2020 to provide the context of the impacts of the COVID-19 pandemic on the energy efficiency programs. The EM&V director interviewed utility program managers and directors to characterize how utilities are responding to COVID-19 in their energy efficiency portfolios. Utility interviews are complemented with information from residential program service provider surveys and secondary research of energy efficiency program developments across the country in response to COVID-19.

1.3 KEY FINDINGS AND RECOMMENDATIONS

1.3.1 Adjustment Summary by Utility

The utilities have demonstrated a willingness to work with the EM&V team to improve the accuracy of claimed savings, which 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 several TRM or program changes. The PY2019 EM&V recommended savings adjustments to which utilities fully responded in PY2019 claimed savings are identified in Table 1.

Table 1. PY2019 Recommended Savings Adjustments by Utility

Utility	kW	kWh
AEP TCC	31	60,509
AEP TNC	-59	-254,696
CenterPoint	-52	-234,376
El Paso Electric	-10	-38,210
Entergy	6	10,020
Oncor	-5	-133,229
SWEPCO	-15	-106,311
TNMP	2	-5,019
Xcel Energy	15	72,555
Overall	**-87**	**-628,757**

1.3.2 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 as well as provide feedback that can lead to improved program design and delivery.[7] The PUCT and EM&V team worked with the utilities to establish a process to document utilities' responses to recommendations, referred to as "action plans." Utilities use these action plans, which are also vetted with the Energy Efficiency Implementation Project (EEIP), to respond to program savings, design, and implementation recommendations within the next program year consistent with § 25.181(q)(9). Recommendations made based on PY2017 evaluation research, which was completed in 2018, were expected to be fully implemented in PY2019. Likewise, recommendations resulting from the PY2019 EM&V completed in 2020 are expected to be implemented in PY2021. First, we report on utility progress in meeting recommendations that were to be implemented in PY2019 programs, and then we summarize recommendations from the PY2019 EM&V research to be implemented in PY2021.

1.3.3 Prior EM&V Recommendations

Table 2 through Table 5 summarize the status of PY2017 EM&V recommendations that utilities were to implement in PY2019. Utilities have been responsive to all recommended changes in their program implementation, savings calculations, documentation, communication, and reporting. Of the 22 recommendations, 12 are complete, and 10 are in progress; no recommendations have been left unaddressed.

Commercial recommendations addressed TRM updates and utility quality assurance and quality control (QA/QC) practices. QA/QC practices are noted as *in progress* since some minor discrepancies were found in PY2019.

[7] 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.

Table 2. Commercial Program Recommendations for PY2019 Implementation

Category	Recommendation	PY2019 implementation	Status
HVAC projects	Utilities should use the rated capacities of both the existing and new equipment.	The PY2019 TRM clarified the capacities listed in applicable tables are the rated capacities.	Complete
Lighting projects	Utilities should use the third-party certification agency's tested wattage instead of the manufacturer's rated wattage.	The PY2019 TRM clarified third-party tested wattage should be used, not the manufacturer's rated wattage. Some occurrences of manufacturer's rated wattage were found in the PY2019 EM&V.	In progress
	Fixture code lighting-type suffix descriptors should be properly selected in the calculators.	Utilities conduct QA/QC of fixture code suffix descriptors.	In progress
Building type selection	Differentiate the *supermarket building type* codes from the other codes intended for non-food retail stores.	The PY2019 TRM updated the *lighting building types* codes.	Complete
	Offer guidance for building type selections for lighting projects when the building type is not known, similar to the guidance available for HVAC projects.	The PY2019 TRM included an *Other* building type code for lighting projects to act as a conservative estimate in lieu of site-specific monitoring.	Complete
	Utilities should use the *Other* building category for HVAC and lighting projects when the building type is not in the TRM or request EM&V assistance in determining if a similar building type is appropriate to use.	Utilities conduct QA/QC of the building type and have actively sought EM&V input in several instances. However, some incorrect building type selections were found in the PY2019 EM&V.	In progress
	When multiple exterior lighting control schemes exist in a single project, utilize the *Custom Bldg.* worksheet.	Utilities had the lighting survey form (LSF) implementer create a new *Custom Bldg.* worksheet.	Complete
On-site inspections	Ensure representativeness of on-site inspection sampling by only grouping similar projects that are also implemented at the same building type and size, not just for the same customer.	Utilities are verifying that the projects' building type and size are also similar when sampling for site inspections from a large group of similar projects.	In progress

Residential recommendations focused on documentation requirements, which are all in progress (Table 3). While documentation has improved, there are still some inconsistencies or areas for improvement. Also, the PY2019 EM&V suggests additional requirements may be needed to improve deemed savings estimates.

Table 3. Residential Program Recommendations for PY2019 Implementation

Category	Recommendation	PY2019 implementation	Status
Baseline documentation	Utilities should educate contractors on the documentation requirements outlined in the TRM.	Utilities provided examples of required documentation; this is an item for continued discussion based on PY2019 EM&V results.	In progress
Infiltration test results	Utilities should consider collecting photos of test results to ensure the accuracy and method of testing adheres to BPI standards and the methods outlined in the TRM.	Utilities requested photos of test results; this is an item for continued discussion based on PY2019 EM&V results.	In progress
Direct install measures	Utilities should collect documentation for all direct install measures in addition to the other measures offered.	Utilities are to collect requested documentation or model numbers for direct install measures. The PY2019 EM&V did not review this item.	In progress
Insulation measures	Pictures should be required where insulation levels are visible. Assumptions made during the pre- or post-installation process should be documented and available for the verification process.	Utilities provided service providers with examples of required documentation; this is an item for continued discussion based on PY2019 EM&V results.	In progress

Load management program communication, data, and documentation recommendations were all fully met in the PY2019 EM&V (see Table 4).

Table 4. Load Management Program Recommendations and Action Plans

Category	Recommendation	PY2019 implementation	Status
Commercial	Continue ongoing communications with the EM&V team to resolve minor calculation differences, ensure continued performance, and streamline data provision and analysis efforts.	The utilities continued to work with the EM&V team to review their calculation systems to reduce the number of individual cases with savings variances.	Complete
	Continue to provide quality, on-time data to the EM&V team when requested.	The utilities provided the EM&V team all relevant program documentation and information that was needed to calculate savings.	Complete

Category	Recommendation	PY2019 implementation	Status
Residential	Utilities and implementers of residential load management programs should continue to engage the EM&V team proactively and collaboratively to resolve data and analysis issues.	The utilities worked with the EM&V team to review their calculation systems and supporting data.	Complete
	The utilities should provide documentation for all calculation decisions as they relate to applying the TRM.	The utilities provided adequate records for each meter for each event that streamlined calculations and reduced the cause of potential discrepancies.	Complete

Cross-sector recommendations ranged across measures and baselines that affect both sectors (see Table 5). The two *in progress* photovoltaic (PV) recommendations are noted as such due to the *low* evaluation priority for PV in PY2019. A more in-depth assessment is needed to determine if the recommendations were met entirely.

Table 5. Cross-Sector Measure Recommendations and Action Plans

Category	Recommendation	PY2019 Implementation	Status
HVAC tune-ups	The EM&V team continues to recommend using a rolling three-year average[8] of the efficiency losses to reflect potential changes over time and reduce the volatility from year to year.	Utilities and their implementers are using a three-year rolling average for HVAC tune-ups. The PY2019 EM&V discovered that New Mexico data was included. Going forward, only Texas data should be used.	Complete
	Collect at least a ten percent M&V sample for tune-up measures annually for the commercial and residential populations separately.	Utilities exceed the recommended M&V samples of 10 percent by sector. The PY2019 EM&V found 17 percent of M&V samples was achieved.	Complete
PV	Utilities should use the default values for *module type*, *array losses*, *DC to AC sizing*, and *inverter efficiency* while using PVWatts® to calculate the annual kWh production of a solar PV.	The PY2019 TRM clarified PV tracking and documentation requirements. The EM&V team issued a guidance memo in 2020 to provide further clarification for the new version of PVWatts.	Complete

[8] The three-year average should use M&V data from the most recent completed program years. For example, PY2018 efficiency losses are to be calculated from the average of PY2015, PY2016 and PY2017; PY2019 from the average of PY2016, PY2017 and PY2018; etc.

Category	Recommendation	PY2019 Implementation	Status
	Utilities should update final project energy savings for any changes in the original application.	Utilities will update project savings based on calculations using the final-installed PV system parameters.	In progress
	Processes should be reviewed to facilitate tabular breakpoints not occurring across ranges of typical system design.	Utilities will engage the EM&V team to discuss alternative breakpoints for system tilts.	In progress
Dual baselines	Re-assess the dual baseline methodology in the TRM.	The PY2019 TRM updated the dual baseline methodology.	Complete

1.3.4 PY2019 Key Findings and Recommendations

Based on findings from the PY2019 EM&V conducted across all the utilities, the EM&V team has provided key findings and recommendations for the commercial, residential, and load management programs. Issues that affect both residential and commercial sector programs are summarized in the *cross-sector* section.

1.3.4.1 Commercial Programs

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

- Building type selection
- Major retrofits
- Lighting projects
- HVAC projects
- Recommissioning programs
- Small business programs

Table 6. Commercial Program Recommendations and Action Plans

Category	Key finding and recommendation	Action plan
Building type selection	Commercial interior lighting and HVAC project analysis requires proper *building type* selection as guided by the TRM. The EM&V team encountered several examples of potential conflicts in *building type*. 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 will continue to conduct QA/QC of the *building type* selection and ask the EM&V team for input as needed; this was a PY2017 recommendation noted as *in progress*.

Category	Key finding and recommendation	Action plan
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 TRM should include a *major retrofit* category different from *standard retrofit* and *new construction.*	The 2021 TRM will include guidance on energy savings calculations for a major retrofit project with a building type change.
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 to implement half-watt increment rounding.	Utilities will increase their QA/QC of lighting wattages; this is a PY2017 recommendation noted as *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 will state 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.
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 will provide more guidance for determining the efficiency of split systems.
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 offers several recommendations on the appropriate M&V for recommissioning programs in this report as well as updates for the TRM Recommissioning M&V Protocol.	The PY2021 TRM Recommissioning M&V Protocol will be updated to increase the consistency of the calculation process and the accuracy of savings for M&V claimed energy savings. It will also consider a process to support continuous improvement.

Category	Key finding and recommendation	Action plan
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 will update the *non-residential entrance* and *exit door* infiltration measure guidance.
	The EM&V team noted that only a small percent 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 discuss the potential to increase the use of wall-based occupancy sensors with service providers.

1.3.4.2 Residential Programs

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

- Residential retrofit programs
- Hard-to-reach programs
- Low-income programs
- New homes programs
- Upstream programs

Table 7. Residential Program Recommendations and Action Plans

Category	Key finding and recommendation	Action plan
Residential retrofit programs	Residential retrofit programs are delivering substantial energy savings and winter and summer peak demand reductions. 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. The EM&V team recommends utilities consider best practices from the highest-saving residential programs.	Utilities will identify best program practices and consider diversifying their residential measures mix as applicable for their unique territories.
	A comparison of the consumption analysis results at the measure level indicates the researched TRM deemed savings are overestimating actual savings. Central air conditioning (AC) deemed savings are closest to actual savings. Air infiltration is the most overstated. The EM&V team recommends updates to the TRM to increase the accuracy of the deemed savings.	The PY2021 TRM will include updates for AC, HPs, duct sealing, ceiling insulation, and air infiltration measures.
	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.	The utilities will 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.
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. HTR programs are saving less energy than residential and LI programs, and these savings have decreased since the 2015 consumption analysis. 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 will identify strategies to increase energy savings opportunities for the HTR sector and discuss these strategies with PUCT staff and the EM&V team.
Low-income program	LI programs are the highest savings residential program, with results across utilities ranging from 11 to 21 percent of participants' annual energy use. LI programs use the SIR cost test instead of the program administrator cost test and, therefore, can implement more measures. The EM&V team recommends that utilities share best practices across LI programs, including the innovative strategies employed by the implementer of the highest saving LI program.	Utilities should identify best practices from the highest performing LI program, which has employed unique approaches to serving this sector.

Category	Key finding and recommendation	Action plan
New homes programs	The new homes energy model approach in the TRM does a good job estimating gross energy savings compared to the statewide code, with slight variations by location and heating type. However, a comparison with non-participant homes and results from interviews with builders and raters suggests some level of market transformation is occurring. The EM&V team recommends that utilities revisit their new homes program designs to identify strategies that continue to push the market and maximize net program savings.	Utilities will update program designs to increase net savings. Modifications may include innovative technologies, targeting specific end-uses (especially HVAC), or outreach to segments where the market is not transformed considering the current code.
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 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.
	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.

1.3.4.3 Load Management Programs

Key findings and recommendations are presented in Table 8 for residential and commercial load management programs.

Table 8. Load Management Program Recommendations and Action Plans

Category	Key finding and recommendation	Action plan
Commercial	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.
	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 will update the rounding guidance for commercial load management programs.
Residential	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 will update the rounding guidance for residential load management programs.
	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 EM&V team and applicable utility will review the 2020 TRM language to identify any needed updates for clarity in the 2021 TRM, including the participant definition and rounding for the event-level savings calculations.

1.3.4.4 Cross-Sector

Cross-sector key findings and recommendations are summarized in Table 9 for the following:

- Program tracking data
- Project documentation
- AC tune-ups
- Multifamily
- COVID-19 considerations

Table 9. Cross-Sector Measure Recommendations and Action Plans

Category	Key finding and recommendation	Action plan
Program tracking data	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.	Utilities will review program tracking data and make revisions as needed to include the required fields outlined in the TRM.
	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 will clarify upstream lighting program requirements.
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.	Utilities will discuss how they will address programs that received less than a *good* program documentation score in PY2019 with the EM&V team and PUCT staff.
	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. However, if a utility is employing an eTRM, the EM&V team should review the structural procedures of the program tracked in an eTRM and agree on a list of documentation.	Utilities using an eTRM will provide the EM&V team with process documentation and supporting external documentation to be provided for each program.
	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 inform the EM&V team of their program tracking indicator for *roll-over* projects approved under a prior TRM.

Category	Key finding and recommendation	Action plan
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. In particular, one trade ally was identified with one of the lowest average test-ins who also completed over 90 percent of the projects. 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.
	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 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 M&V dataset from Texas to determine efficiency loss values.
Multifamily	Multifamily buildings can receive incentives from residential or commercial programs, depending on if they are individual or master metered. 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 will address multifamily and single-family eligibility and treatment across residential measures.

Category	Key finding and recommendation	Action plan
COVID-19 considerations	All utilities believe they will meet 2020 commercial goals. Robust project pipelines before the pandemic and customers taking advantage of unoccupied facilities to install energy efficiency projects are two primary drivers of continued commercial program success. Utilities who have already met commercial 2020 goals may want to encourage applicable projects to roll into 2021 so that a strong pipeline is established for the next program year given uncertainty is still expected.	Utilities will consider strategies for continued commercial program success in 2021.
	Small businesses have become more difficult to serve during the pandemic. Utilities should consider exploring low-cost and no-cost measure solutions specifically tailored to small businesses. Utilities should also consider exploring strategies implemented elsewhere in the country, such as leveraging COVID-19 remodels with energy efficiency upgrades.	Utilities will explore different strategies to increase small business participation in 2021.
	While the majority of utilities believe they will meet 2020 residential goals, they have generally seen more challenges. Residential challenges and successes are unique to each utility territory. Utilities may want to consider complementing traditional in-home retrofit services with other program delivery methods such as upstream and midstream venues or self-install options by homeowners and multifamily maintenance staff.	Utilities will assess their residential portfolio measures and delivery options for 2021.
	Utilities are employing remote QA/QC practices, including in-depth engineering desk reviews, phone audits, virtual inspections, and expanded photo documentation. Successful virtual QA/QC processes may decrease on-site QA/QC inspection costs in the future or utility-enhanced QA/QC desk reviews may reduce errors found during the EM&V reviews.	The 2020 EM&V should assess utility project QA/QC in terms of what was able to be feasibly accomplished remotely. A review of remote QA/QC should include an assessment of the value of new practices continuing.
	While all utilities report that their company has implemented health and safety practices for their staff, guidance provided to service providers has varied. The most common approach is the view that service providers are businesses that have their staff and their customer safety at top of mind and are implementing proper practices. The less common method was a required health and safety training for service providers.	Utilities may want to consider providing service providers with applicable health and safety protocols from reputable sources.
	Utilities report that customers are expressing high satisfaction with program services during the pandemic. If not already doing so, utilities should consider including a health and safety question in ongoing program customer satisfaction surveys or other follow-ups with customers.	Utilities will consider follow-ups with customers regarding health and safety satisfaction during the pandemic.

2.0 INTRODUCTION AND PORTFOLIO RESULTS

This Statewide Energy Efficiency Report presents the PY2019 EM&V findings and recommendations, looking across all eight electric utilities' portfolios. It addresses gross and net energy and demand impacts, program cost-effectiveness, and provides feedback on program portfolio performance. It includes findings and recommendations to inform updates to the PY2021 TRM as well as the PY2021 program design and delivery.

First, we overview the EM&V methodology in PY2019; this is followed by portfolio-level results related to program tracking and documentation. Sections 3 through 6 present the commercial, residential, cross-sector, and load management program results. Section 7 discusses research related to COVID-19 considerations in energy efficiency programs. Technical Appendix 1 details the residential programs' consumption analysis methodology. A separate Volume 2 of this report details PY2019 impact results for each utility's portfolio.

2.1 EVALUATION, MEASUREMENT, AND VERIFICATION METHODOLOGY

2.1.1 Overview

In 2011, the Texas Legislature enacted 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 16 Tex. Admin. Code § 25.181, relating to Energy Efficiency Goal (Project No. 39674).

The PUCT selected an EM&V team through the Request for Proposals (RFP) 473-17-00002, Project No. 46302. This team is led by Tetra Tech and includes Texas Energy Engineering Services, Inc. (TEESI) (hereafter, "the EM&V team").

Independent EM&V was conducted for Texas electric utilities' PY2019 energy efficiency portfolios. The objectives of the EM&V effort are to:

- document gross and net energy and demand impacts of utilities' individual energy efficiency and load management portfolios;
- determine program cost-effectiveness;[9]
- provide feedback to the PUCT, utilities, and other stakeholders on program portfolio performance; and
- prepare and maintain a statewide TRM.[10]

The PUCT's EM&V independently verifies claimed savings across all programs through program tracking data that is received from the utilities. Additional EM&V activities (engineering desk reviews, on-site M&V, interval meter data analysis, consumption analysis, participant surveys, in-depth interviews) are conducted based on an evaluation prioritization of high, medium, or low by program type. The PUCT and EM&V team re-visits the prioritization each

[9] The EM&V team conducts cost-effectiveness testing applying the program administrator cost test. For LI programs, cost-effectiveness is calculated using the SIR.

[10] The maintenance of the TRM is informed by EM&V research and coordinated with the Electric Utilities Marketing Managers of Texas (EUMMOT) and the Energy Efficiency Implementation Project (EEIP).

year based on considerations such as magnitude and uncertainty of savings, stage of the program, importance to future portfolio performance, priorities prior EM&V results, and changes in the markets in which the programs operate.

RSOP, HTR, and LI programs were a *high* evaluation priority for PY2019. These programs continue to comprise a substantial percentage of overall statewide portfolio savings and have recently responded to various TRM updates to the envelope measures. Moreover, the EM&V team recommended expanding the measure mix in these programs. The EM&V team completed a consumption analysis for the ERCOT RSOPs, HTR, and LI programs, which is described in detail in Technical Appendix 1 of this report. The EM&V team also conducted surveys with residential service providers to gain insight into program processes from their perspective.

Several residential market transformation programs were also a *high* priority in PY2019 as they were either re-designed or newer programs. First, new homes MTPs had an updated statewide energy code and TRM entry in PY2018. The EM&V team conducted a consumption analysis to compare to the programs' savings estimates, described in detail in Technical Appendix 1 of this report. The consumption analysis was complemented with builder and home energy-rater interviews to understand standard practices in the market and how the program is influencing them. Residential upstream lighting programs have grown rapidly in the last couple of years and reach a high number of customers through retail channels. A census impact review of these programs was conducted along with retailer interviews and benchmarking research.

Commercial standard offer programs (CSOPs) and the commercial MTPs continued as a *medium* priority in PY2019. These programs continue to represent the largest percentage of statewide savings and continue to explore new customer segments and technologies. While prior EM&V generally found evaluated savings to be similar to the utilities' claimed savings, it also resulted in several recommendations for changes to reported claimed savings.

Load management program evaluations returned to a *medium* priority in PY2019 after being evaluated as a *high* priority in PY2018. These programs continue as a substantial contributor to demand reduction (kW) savings. The EM&V team conducted census reviews of all participants' interval meter data in PY2019 to calculate impacts independently following the TRM to compare against utilities' claimed savings.

All other program types are considered *low* evaluation priorities because they are small contributors to portfolio savings, have little uncertainty in savings, or had EM&V results in recent years that had limited action items.

Finally, because one of the primary objectives of this report is to provide recommendations for 2021 programs, the EM&V team conducted research in May–June 2020 to provide the context of the impacts of the COVID-19 pandemic on the energy efficiency programs. The EM&V director interviewed utility program managers and directors to characterize how utilities are responding to COVID-19 in their energy efficiency portfolios. This is complemented with information from residential program service provider surveys and secondary research of energy efficiency program developments across the country in response to COVID-19.

2.1.2 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 PY2019 TRM 6.0 or measurement and verification (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 PY2021 TRM 8.0.

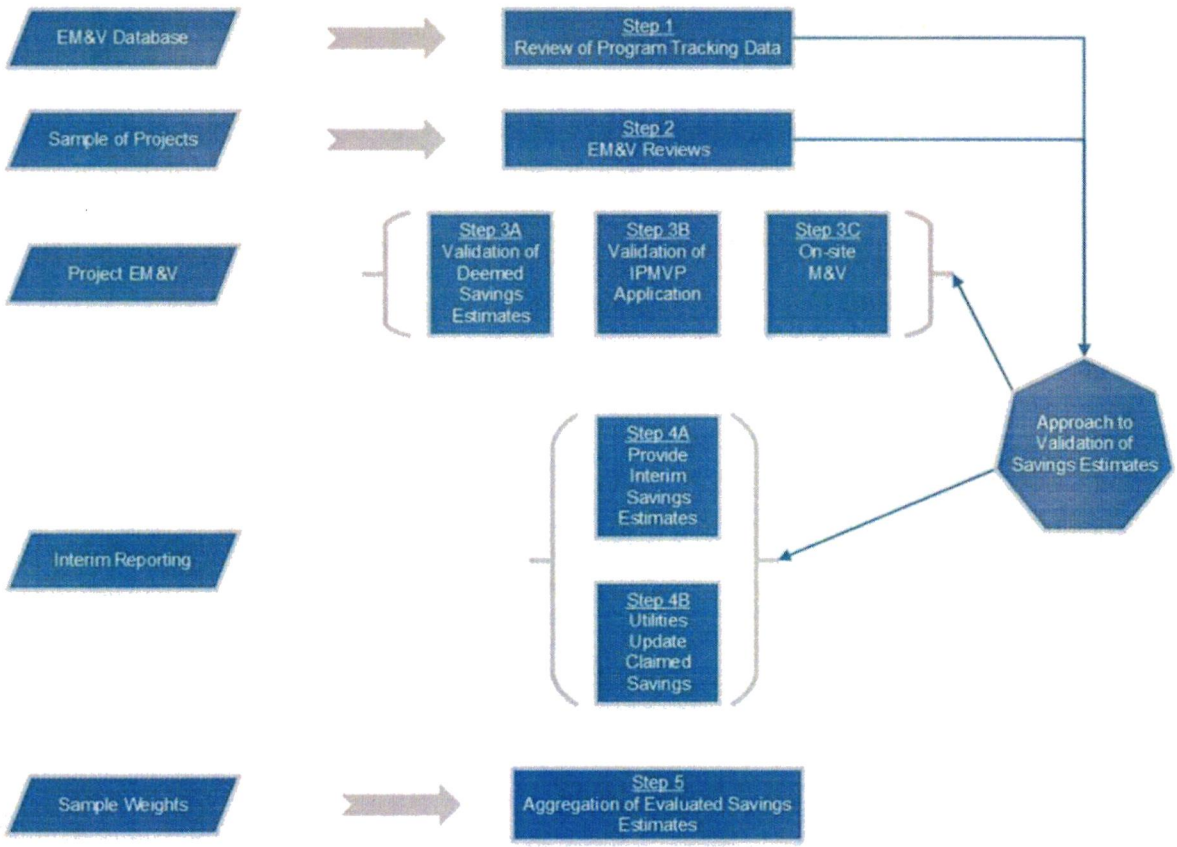
Table 10 shows the EM&V activities completed by program type and evaluation priority.

Table 10. PY2019 Evaluation, Measurement, and Verification Priorities and Activities

Program Type	Evaluation Priority	Claimed Savings Verification Approach	Participant/ Distributor Surveys	Project Desk Reviews	On-site M&V	Interval Meter Data Analysis
Commercial SOPs, Large Commercial MTPs, Retro-Commissioning (RCx)	Medium	Sampled (see desk reviews)	N/A	152	77	N/A
Small Business Programs	Medium	Sampled (see desk reviews)	N/A	50	25	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, Hard-to-Reach, Low Income	Medium	Census	50	N/A	N/A	Participant Consumption Analysis
AC and HP Tune-Up	Medium	Census	N/A	N/A	N/A	N/A
Multifamily MTP	Medium	Sampled (see desk reviews)	N/A	10	N/A	N/A
Residential New Homes MTPs	High	Census	38	N/A	N/A	Participant Consumption Analysis
Upstream MTP	High	Census	13	15	N/A	N/A
All Other Programs	Low	Census	N/A	N/A	N/A	N/A

The evaluated savings are based on project-level realization rate calculations that are then 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 11. Realization rates for utility portfolios, and each utility's program may be found in Volume 2 of this report.

Figure 11. 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 also calculated using the savings-to-investment ratio (SIR).

2.2 PROGRAM TRACKING

Tetra Tech collected, compiled, and reviewed program tracking data for all programs in PY2019. We used the data to support evaluation activities, including sampling, deemed savings reviews, and reporting. During the course of these activities, we identified several issues relating to program tracking data. Some of these were new issues for programs that were evaluated for the first time, while other issues were recurring.

Key Finding #1: Some tracking data did not include the information required by the TRM measure characterizations. This resulted in the EM&V team being unable to verify savings for some measures due to insufficient information.

Examples of this issue include:

- missing square footage for air infiltration measures;
- missing heating or cooling system type for a number of building shell measures;
- heating or cooling system type listed as *space* without clarifying fuel or technology; and
- missing fan speed for ceiling fans.

Recommendation #1a: Ensure that all tracking data includes the required fields outlined in the TRM.

Key Finding #2: Tracking data for upstream lighting programs was inconsistent in its structure and contents. One utility did not clearly label commercial and residential savings line items, while another utility did not include the retailer information where the lighting products were incentivized.

Recommendation #2a: Review tracking data for upstream programs and include the required information for EM&V to verify savings.

- Clearly label commercial and residential savings—this can be by separating line items for each sector or by including separate columns for residential and commercial savings.
- Include retailer information in the tracking data. At a minimum, this should include the retail chain and ideally should also include an identifier for the individual store, such as a store number or street address.

The EM&V team will update the TRM to ensure these requirements are clearly stated.

2.3 PROGRAM DOCUMENTATION

Key Finding #1: Documentation was delayed for many projects in small business programs.

The streamlined process in small business programs typically includes providing program documents (developed as part of the project scope) to the participant immediately after construction. The documentation for small business projects includes (1) a simplified calculator, and (2) documentation of baseline equipment, building type, location of installation, and proposed equipment. The documentation was provided for most projects immediately after installation, but a notable number of projects did not provide the documentation until after the program year. Some projects claimed energy savings with missing project documentation—which is an ongoing issue and a recommendation from PY2018—and therefore is not surprising to see again in PY2019. It is expected to be fully resolved in PY2020.

Recommendation #1a: Documentation should be complete and provided to the small business customer immediately after construction is complete. For projects with claimed savings, copies of the documents should be stored as implementation records.

Key Finding #2: Supporting documentation was limited when using an eTRM.

The eTRM is a form of software that manages participant data and calculates prescriptive savings. The documentation delivered to the EM&V team included participant data and final energy savings but appeared to be missing supporting documentation such as photos, calculation spreadsheets, invoices, and applications. Lack of supporting documentation is expected since the eTRM is software with direct entry of collected information in lieu of historical documents and spreadsheets. With a follow-up meeting and upon review, the EM&V team determined that project documentation was sufficient.

An eTRM reduces the risk of individual project inaccuracies while increasing the potential for system-wide inaccuracies that may affect many individual projects. A thorough program-by-program evaluation should include a review of the software procedures with supporting documentation, as requested by the EM&V team.

Overall, using an eTRM can improve the accuracy and transparency of project savings calculations over traditional methods.

Recommendation #2a: Program administrators (PAs) using an eTRM should provide the EM&V team software procedures and supporting external documentation for each evaluated program.

Key Finding #3: Documentation for commercial projects was inconsistent.

The EM&V team found that documentation was overall good; however, insufficient documentation was submitted for a portion of commercial projects. Missing or insufficient documentation included:

- invoices—25 percent of invoices did not include itemized equipment;
- photos—the incomplete photo sets typically included either equipment nameplate or install location (i.e., zoomed out), but not both;
- qualified products lists (QPL) certificates—25 percent of projects were missing QPL certificates, particularly in the small business and SCORE programs;
- project descriptions—projects that had multiple measures, used custom values (e.g., hours of operation), and other complicating aspects often used overly-simple project descriptions; and
- deficient post-installation notes—40 percent of projects were missing post-install notes, including SCORE programs.

Project documentation is an effective method to ensure project aspects are accurately represented, projects are completed as planned, and savings calculations accurately represent the final project.

Recommendation #3a: PAs should ensure that projects follow the documentation requirements outlined in the TRM.

Key Finding #4: Document, with EM&V prior approval, when using previous versions of the TRM to calculate savings.

PAs should use the current version of the TRM as a basis of savings calculations. If a project's savings calculations are based on a previous version of the TRM, the program administrator should request approval from the EM&V team and document the use of the previous version of the TRM. Without prior approval, the EM&V standard procedure includes calculating ex-post savings using the TRM when savings is claimed (e.g., TRM 7.0 for PY2020 projects).

Recommendation #4a: Update the TRM glossary (and general documentation section) to outline when a previous TRM can be used as a basis of savings calculations.

Key Finding #5: Document pre-inspection results when claiming electric resistance heat for residential projects.

Resulting from the consumption analysis, claiming electric resistance as a heating type is overestimating savings in central AC, heat pump (HP), duct sealing, ceiling insulation, and air infiltration measures. The EM&V team and utilities are investigating why this is happening (e.g., snapback, inaccuracies in claimed heating type).

Recommendation #5a: PAs should document pre-inspection results to ensure an accurate representation of heating type when claiming existing (or baseline) resistant heat.

3.0 COMMERCIAL ENERGY EFFICIENCY PROGRAMS

The EM&V team evaluated the commercial energy efficiency programs described below. There are two types of programs: SOPs and MTPs. An SOP is a program under which a utility administers standard offer contracts between the utility and energy efficiency service providers. These contracts specify standard payments based upon the amount of energy and peak demand savings achieved through energy efficiency measures, 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 that result in increased adoption of energy-efficient technologies, services, and practices.[11] SOP and MTP programs continue to represent the largest percentage of statewide savings.

Commercial SOP: The Commercial SOP provides incentives for new construction and retrofit installation for a wide range of 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 that are installed in new or retrofit applications and result in verifiable demand and energy savings. Commercial Solutions MTPs can include midstream programs that provide incentives at the distribution point to installation contractors that have the intention of installing the equipment for eligible commercial or industrial customers.

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 assistance in areas such as energy master planning workshops, energy performance benchmarking, and identifying/assessing/implementing energy efficiency measures. Energy efficiency improvements include capital-intensive projects and implementing operational and maintenance practices and procedures. Financial incentives are provided to 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 an engineering analysis. Financial incentives are provided to facility owners and retro-commissioning agents for the implementation of energy efficiency measures and projects completed by approved project deadlines.

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

Small Business MTP: The Small Business MTP is designed to assist small business customers with identifying and implementing cost-effective energy efficiency solutions for 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.

CoolSaver AC Tune-Up MTP: The CoolSaver AC Tune-Up MTP is designed to overcome market barriers that prevent residential and commercial customers from receiving high-performance AC system tune-ups. The program works through local AC distributor networks to offer key program components, including: (1) training and certifying AC technicians on protocols and tune-up and airflow correction services, and (2) paying incentives to AC contactors for the successful implementation of AC tune-up and airflow correction services. Contractors that wish to participate enter into a contractor partnering agreement that specifies the program requirements. Contractors are trained on the AC tune-up process and given incentives and discounts for the cost of field equipment designed to diagnose and quantify energy savings opportunities. Energy savings are captured through the correction of AC system inefficiencies identified during the tune-up activities.

Solar Photovoltaic MTP: The Solar Photovoltaic MTP offers financial incentives for the installation of eligible distributed solar energy generation equipment on the premises of customers served by the utilities. These programs are available to utility customers, including residential customers, businesses, and schools. The utility has a limited group of EESPs determined through a selection process based on meeting minimum eligibility criteria, complying with all program rules and procedures, and submitting documentation describing their projects.

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

3.1 SUMMARY RESULTS

This section presents statewide summary results, followed by key findings and recommendations from the impact evaluations of SOP and MTP programs.

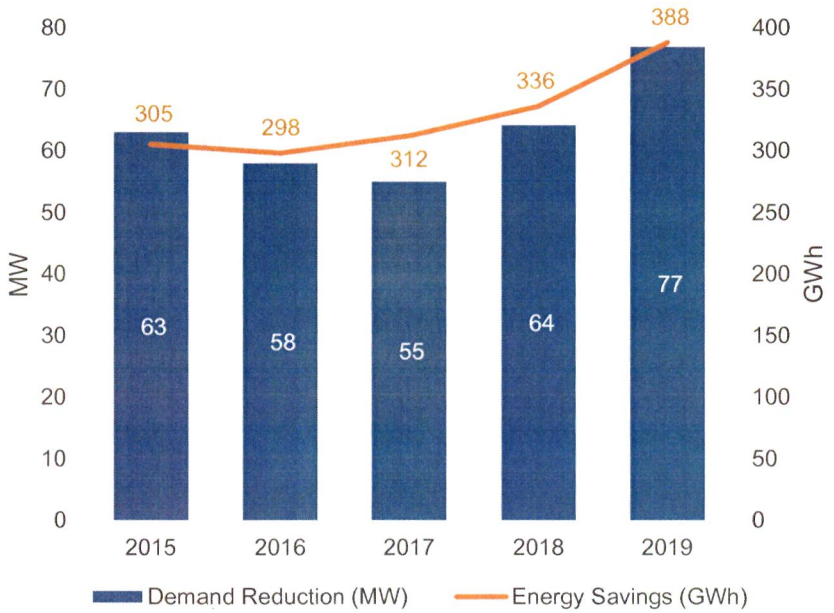
3.1.1 Savings

The statewide PY2019 evaluated gross savings from commercial sector programs were:

- 76,916 kW (demand reduction), and
- 387,866,543 kWh (energy savings).

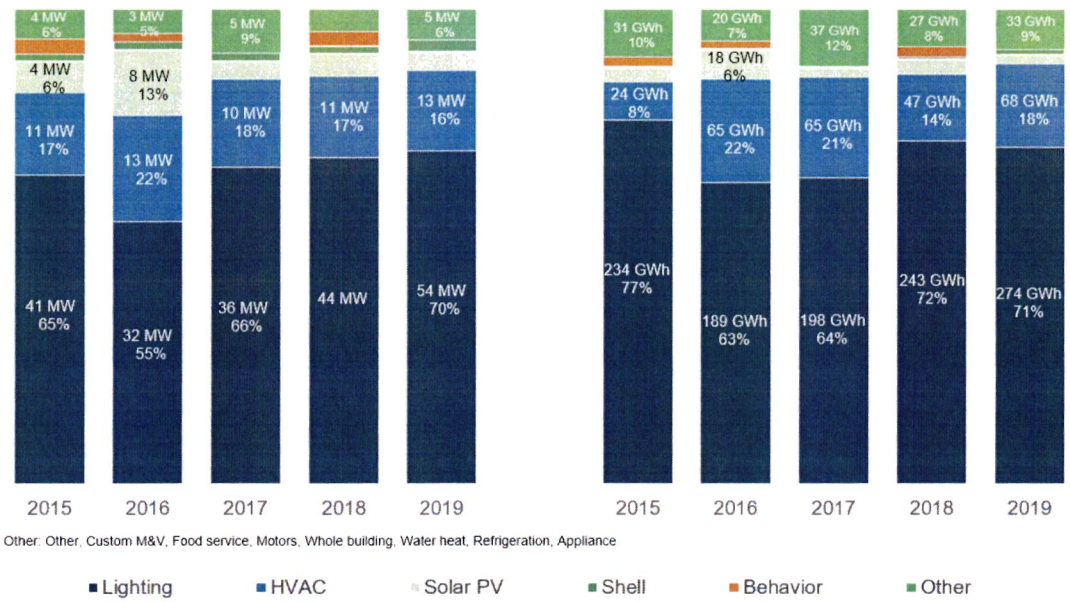
As shown in Figure 12, both of these results reflect an increase from PY2018. PY2019 also has the highest commercial sector results since EM&V started in PY2012.

Figure 12. Total Statewide Evaluated Demand Reduction and Energy Savings by Program Year—Commercial Programs PY2015 – PY2019



As indicated in Figure 13, lighting measures still account for the majority of the energy savings (70 percent) and demand reduction (71 percent). PY2019 saw HVAC and lighting measures making up approximately 86 percent and 89 percent of demand reduction and energy savings, respectively.

Figure 13. Distribution of Statewide Evaluated Gross Demand Reduction and Evaluated Gross Energy Savings by Measure Category—Commercial Programs PY2019 Excluding Load Management PY2015 – PY2019

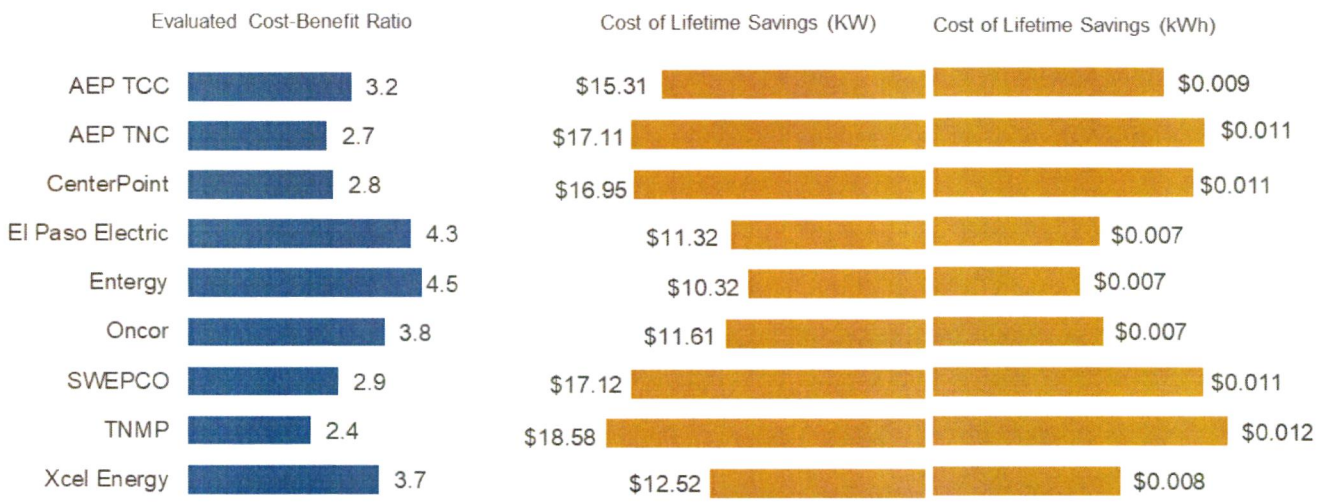


3.1.2 Cost-Effectiveness

Figure 14 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 3.4 statewide based on evaluated savings, and 3.1 based on net savings. Utilities' results ranged from 2.4 to 4.5 based on evaluated gross savings, and 2.2 to 4.0 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 14 also summarizes the cost of lifetime kWh and kW for each utility's commercial sector programs. The cost per kWh ranges from $0.007 to $0.012, and the cost per kW ranges from $10.32 to $18.58. These costs provide an alternate way of describing the cost-effectiveness of a portfolio of commercial programs. Those portfolios with a higher cost-effectiveness ratio will have a lower cost to acquire savings and vice versa.

Figure 14. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Commercial Programs PY2019

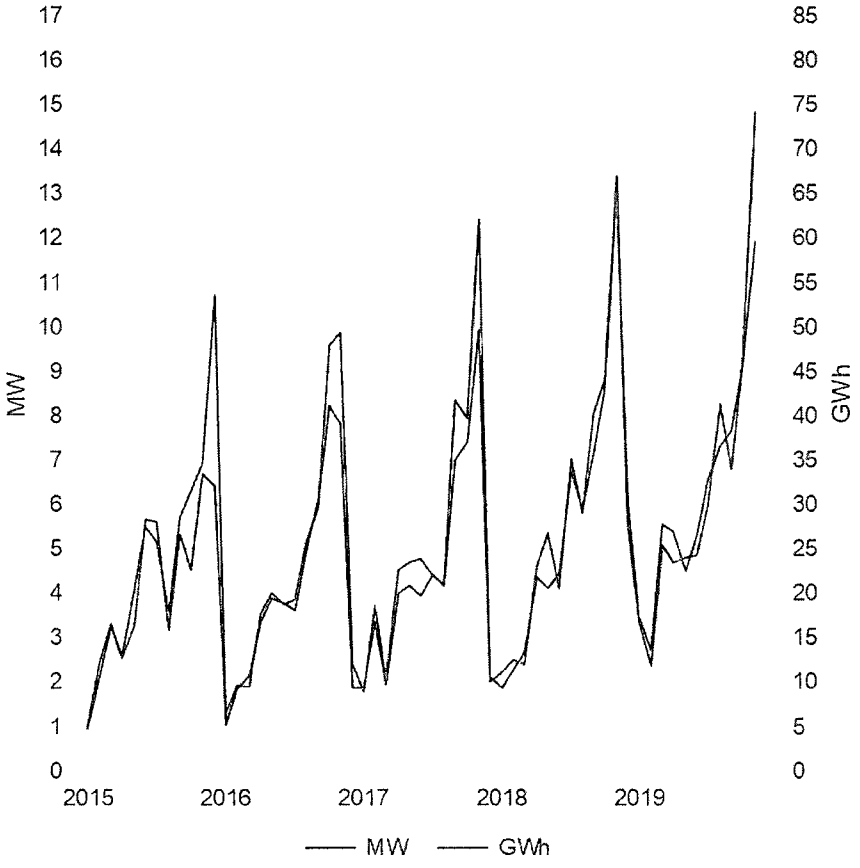


3.1.3 Timing of Project Completion

The commercial programs have a historical pattern that kW and kWh savings are closely linked and that the savings increase monthly as the year progresses, as shown in Figure 15. Each year, the first quarter has lower claimed energy savings as the programs launch the new initiatives. The second and third quarters have increasing savings as the programs gain momentum. The fourth quarter increases momentum further and accounts for more than one-third of the energy savings for the year.

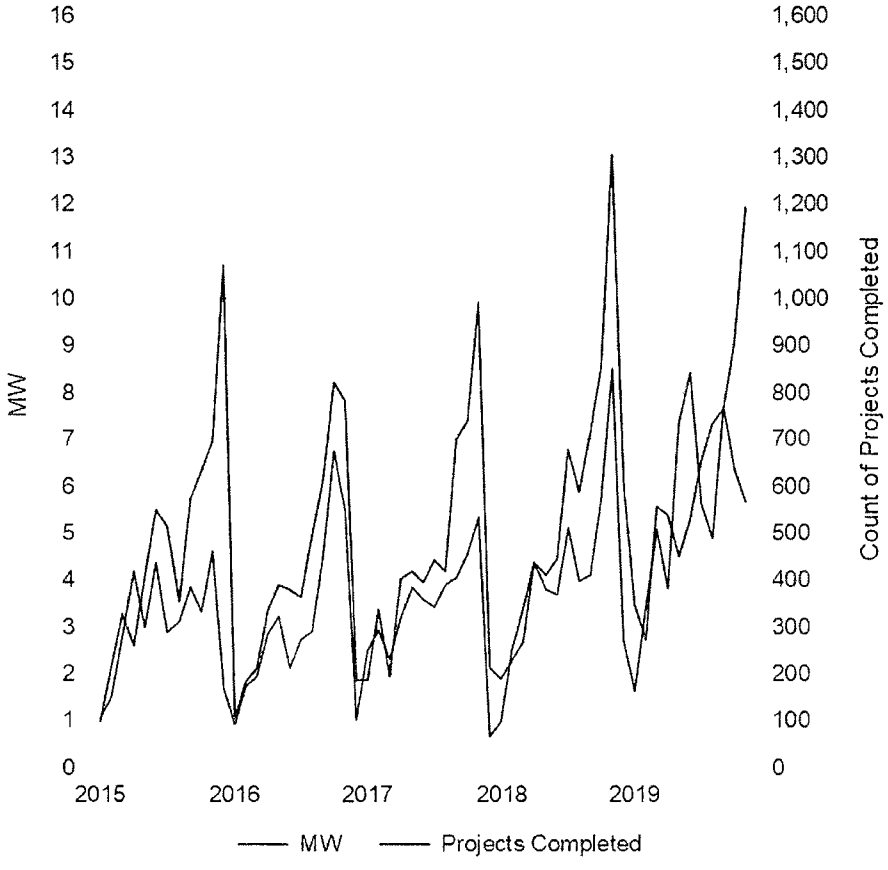
This pattern is typical for commercial programs on an annual cycle; however, the increasing disparity between the fourth quarter and the first quarter of the following year could be smoothed out. In the past four years (2016-2019), the share of the energy savings claimed in the fourth quarter is between 40 percent and 60 percent, which is significantly larger than the other quarters. The increased reliance on the fourth quarter may result in a slower start at the beginning of the next year.

Figure 15. Monthly Evaluated Gross Demand and Energy Savings Over Time—Commercial Programs PY2015-2019



One reason for the increased savings in the fourth quarter is the increased project size. In Figure 16, this is represented by the size of the gap between the *MW* and *project completed* lines in the graph. Larger projects tend to take longer to implement and tend to be finalized near the end of the calendar year to coordinate with participant budgeting cycles. Smaller projects can be completed more quickly at the beginning of the year once incentives are announced. This year many more projects were completed earlier in the year, and the larger projects were completed at the end of the year, which resulted in higher savings in the fourth quarter. This pattern supports the opportunity to more easily carry over projects and momentum into the first quarter of 2020 to reduce the historical first quarter slow down.

Figure 16. Monthly Number of Projects and Evaluated Gross Demand Savings Over Time—Commercial Programs PY2015-2019



If the programs can effectively raise participation in the first quarter, this will alleviate pressure to accelerate programs later in the year and allow for a more even delivery. Savings claimed in the first quarter will alleviate pressure for high performance in the fourth quarter and allow for better preparation for the January launch and increased early participation. Interviews with utilities found that a strong project pipeline in the first quarter of 2020 helped alleviate some program pressure due to the pandemic.

3.2 COMMERCIAL STANDARD OFFER PROGRAMS

3.2.1 Evaluation, Measurement, and Verification Overview

Commercial SOP programs were *medium* evaluation priorities in PY2019. These programs continue to comprise a substantial percentage of the overall statewide portfolio savings. The EM&V team conducted desk reviews and on-site M&V for a sample of projects from these programs.

For the desk reviews and on-sites, the EM&V team applied the method prescribed in the PY2019 TRM 6.0 to verify energy savings and demand reduction for each project sampled. Comparing the evaluated savings to the utility claimed savings showed agreement in most

cases. The average realization rates across all SOP programs were 80.2 percent and 108.0 percent for demand and energy savings, respectively.[12] Based on the results of the evaluation, the EM&V team has outlined key findings and corresponding recommendations, described below.

3.2.2 Key Findings and Recommendations

Key Finding #1: The building type utilized in the energy savings calculation does not always reflect the predominant facility use.

Commercial interior lighting and HVAC project analysis requires proper building type selection as guided by tables within the TRM. For lighting, these tables provide guidance for operating hours and summer peak coincidence factor for a variety of building types. The HVAC building type tables provide guidance for heating and cooling estimated full load hours and demand factors based on the building type and HVAC system type. In some cases, facilities could reflect multiple potential building types, although only one should be selected for energy savings calculations.

The building type selection should match the predominant indoor facility use type based on the surface area. Below are several examples of potential conflicts in building type that have been encountered during evaluation:

- A medical clinic with a larger underground parking area is considered a medical clinic, not underground parking.
- An arts-based high school with many rehearsal and auditorium spaces is considered a high school, not public assembly.
- A manufacturing facility that has been augmented to be a warehouse with small custom adjustments to products should be considered a warehouse, not a manufacturing facility.

Recommendation #1a: Use the predominant building use based on the surface area to select the building type for energy savings calculations.

Key Finding #2: Major building retrofits that change the building type did not use the most appropriate baseline.

The Texas TRM differentiates between *new construction* projects and *retrofit* projects for the baseline used in energy savings calculations. A small number of retrofit projects also include a change in building use. For example, a conversion of (1) a warehouse to an indoor sports area, (2) a retail building to a religious building, or (3) a manufacturing building to a warehouse. These conversions require different HVAC loads and lighting requirements from the original facility type; however, the energy savings calculations should not include the adjustment in the baseline needs between the two facilities. The new facility energy efficiency potential is not that it is replacing a more or less energy-intensive business, but rather that it is more efficient than a standard option installed for that building use or type.

The Texas TRM does not include a major retrofit category different from a standard retrofit and new construction.

Recommendation #2a: Update the TRM to provide guidance on energy savings calculations for major retrofit projects with a building type change.

[12] These are realization rates prior to utilities adjusting savings based on evaluation results.

Key Finding #3: LED lighting wattage continues to need small adjustments to match DLC or ENERGY STAR-qualified product lists.

The lighting savings calculations had a significant amount of wattage adjustments for installed lighting equipment. The adjustments had two primary reasons: (1) the LED lighting manufacturer wattages were used instead of wattages from the DLC or ENERGY STAR-QPL, and (2) the half-watt denominations allowed by the TRM were not utilized. The half-watt adjustment was introduced in PY2018 affecting fixtures under 25 watts and has been extended in PY2019 to include all wattages for more accurate savings calculations and increased consistency. The use of the manufacturer wattage in the energy savings calculation should be corrected to match QPL-listed wattage. Most projects included documentation of the equipment, which lists the QPL wattage.

Recommendation #3a: Update the savings calculation process to ensure the use of QPL-listed wattages for installed equipment and continue to implement half-watt increment rounding.

Key Finding #4: Existing lighting fixtures that remain in place post-installation were excluded from post-install lighting inventory.

Lighting retrofit projects may install new fixtures in locations different from where the existing lighting fixtures are located. Some projects have the ability to allow the existing lighting fixtures to remain in place without impacting the performance of the new lighting fixtures. When the existing fixtures are not removed, these fixtures must be counted in the post-install lighting inventory.

In this situation, although the existing fixtures are intended to be off all the time, over the life of the new equipment, it is possible that the existing lighting fixtures may be switched on as part of the building's operations.

Recommendation #4a: State in the TRM that the existing lighting fixtures remaining after the lighting retrofits are still considered installed and should be included in the post-install lighting inventory.

Key Finding #5: Efficiency of split systems determined using the manufacturer's test results needs to align the published system efficiencies with a common condenser unit.

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 AHRI's listings. The efficiency and capacity of the condenser and air handler pairing should be used in the energy savings calculations. When those values are not available, the manufacturer's test results are acceptable as long as they do not exceed the median of all AHRI-listed air handling units paired with the installed condenser unit.

In this case, the necessary documentation for an unlisted split system pair should include all AHRI-listed air handling units paired with the installed condenser unit and the associated efficiencies. Doing so will prevent having to rely solely on the manufacturer's test results and risking an overestimation of the energy savings.

Recommendation #5a: Update the TRM to provide more guidance for determining the efficiency of split systems. Split systems should use the AHRI-listed efficiency of the condenser and air handler pair installed. When a split system pair is not AHRI-listed, then the efficiency submitted by the manufacturer is acceptable with a maximum value of the median AHRI-listed efficiency of the pair, including the condenser.

3.3 COMMERCIAL MARKET TRANSFORMATION PROGRAMS

This section presents results for the Commercial Solutions, SCORE, Retro-Commissioning, and Small Business MTPs that were a *medium* evaluation priority in PY2019[13, 14].

3.3.1 Evaluation, Measurement, and Verification Overview

The EM&V team conducted desk reviews and on-site M&V for a sample of projects from the medium priority commercial MTP programs. For the desk reviews and on-sites, the EM&V team applied the method prescribed in Texas TRM 6.0 to verify energy savings and demand reduction for each project sampled. Comparing the evaluated savings to the utility-claimed savings showed agreement in most cases. The average realization rates across MTP programs that received desk reviews and on-site M&V are outlined in Table 11.[15] The statewide realization rates for the different MTPs are shown below to provide additional context to the key findings and recommendations.

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

Table 11. Realization Rates for Market Transformation Programs

Program	Realization rate (kW)	Realization rate (kWh)
Commercial Solutions MTP	92.0%-100.7%	99.0-100.2%
SCORE MTP	78.7%-107.0%	83.0%-107.3%
Retro-Commissioning MTP	100.0%-100.1%	100.0-100.2%
Small Business MTP	91.3%-100.0%	90.3%-100.3%

3.3.2 Key Findings and Recommendations

3.3.2.1 Large Commercial Market Transformation Programs (Commercial Solutions MTP and SCORE MTP)

All key findings and recommendations outlined for the SOP programs in Section 3.2 are equally relevant to the Large Commercial MTPs (Commercial Solutions MTP and SCORE MTP). Some MTPs include the use of M&V methodology to claim savings for some projects, and the Retro-Commissioning MTP findings and recommendations are relevant to those projects.

The EM&V team identified an additional finding related to Key Finding #1 discussed in section 3.2.2:

Key Finding #1: Exterior area was considered when determining the facility use based on multiple kinds of square footage.

[13] Solar Photovoltaic programs were considered a *low* evaluation priority and only received a tracking system review in PY2019.
[14] CoolSaver AC Tune-Up is discussed in section 5.0.
[15] These are realization rates prior to utilities adjusting savings based on evaluation results.

The building type selection should be based on interior square footage. Exterior square footage for specialty areas, such as fields or auditoriums, should be entered in the exterior lighting calculation and not affect the interior lighting calculation.

Recommendation #1a: Recommendation #1a, noted in Section 3.2.2, is still relevant here.

3.3.2.2 Retro-Commissioning Market Transformation Program

The M&V methodology is used to claim energy savings for retro-commissioning, behavioral, operational, controls, or custom energy savings. The M&V methods provide a framework to provide 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 are allowing this energy efficiency claiming type to be used more frequently, which can create 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 Volume 4 of the TRM, requires comprehensive projects to be compliant with IPMVP-Option C and should have the expectation of savings greater than 10 percent of utility bill (or sub-metered) energy use. 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: M&V claimed savings modeling could be improved to enhance the accuracy of energy savings calculations.

The M&V methodology creates energy savings claimed for commercial and industrial (C&I) projects that are based on actual operations and can be very accurate. But, in the calculation process, the method requires custom decisions and assumptions for the modeling of each project. The EM&V team found that assumptions and modeling could be improved to increase the accuracy of the savings calculated, although there was not a consistent, identifiable decision which could be improved. Detailed below are the individual modeling assumptions and processes identified by the EM&V team that should inform modeling improvements in the future.

- **Electric consumption billing data detail.** The ideal electric consumption billing data measurement frequency is hourly or shorter to create a robust model of the facility operations. For C&I projects that have consistent daily or monthly profiles throughout the year, the daily and monthly measurement frequencies can produce consumption models that are of equal quality. However, for C&I projects that have non-consistent variables, such as weather or occupancy, the daily and monthly measurement frequencies can produce consumption models with variable accuracy.

  Furthermore, the peak demand calculation method relies upon electricity consumption during a critical hour. Daily or monthly data do not provide the detail necessary to measure demand reduction. When the detail is not available, the M&V analysis requires an engineering judgment calculation to correlate the peak demand at the top 20 hours, which introduces risk for both the baseline and improved peak demand values.

- **Match data collection frequencies and increments**. Electric consumption data, in many cases, are collected by multiple data collection meters or site meters throughout the project. The calculations require that the data used to develop each regression model needs to have the same frequency reading and increment of measurement.

- This year, the EM&V team identified projects which the billing meter data measured in 9 kW increments, which made the regression model highly dependent on the rounding of the actual measurement. Modeling the energy consumption increment created a different consumption pattern versus a smaller increment. In addition, the data collection increased the frequency of readings from once an hour to once every five minutes partway through the post-install measurement period. The increased frequency of the reading provided better detail to develop a regression model. Although when combining the data from the two meters, it is necessary to match the increment of measurement (once an hour) because the regression modeling evenly weights each measurement point. In this case, without the adjustment to the increment, the new meter readings every five minutes increased their importance by 20 times over the hourly readings (because there are 20 five-minute readings per hour) in the regression model.

- **Peak demand calculation from M&V projects requires relevant data for the top 20 peak demand hours.** Regression models identify statistically relevant energy consumption trends. This process eliminates the outlier data points so that they do not augment overall consumption, which is the ideal process to follow when determining annual consumption (kWh). However, the TRM definition of peak demand requires an analysis of the consumption during times that are considered outliers.

  The M&V analysis for the winter and summer peak demand (kW) is different from annual consumption analysis (kWh). Therefore, a different approach should be utilized to capture the peak period more specifically.

- **The peak kW calculation of RCx projects must evaluate the whole system.** M&V projects determine the peak demand savings of the entire system. For projects that claim savings only through the regression model, the whole system winter or summer peak is evaluated. Although when prescriptive projects occur within the M&V data collection period that claims savings separately, those values are subtracted from the modeled M&V savings to eliminate double counting. The peak demand savings periods, winter or summer, must match for both the prescriptive project and the M&V period to determine the peak savings for the whole system.

  Multiple measures at the same facility, including RCx and HVAC system interaction, should sum the summer peak or sum the winter peak. A combination of summer peak for one component and winter peak for another component claims more peak demand reduction than the project provides.

- **Baseline period consistency should be improved.** The TRM requires one year of pre-install data for a regression model baseline[16]. The TRM does not define the acceptable period for that data or how to handle non-routine events (NRAs) during that period.

  The baseline model should be developed from the pre-install data from the 365 days immediately before the start of the project. Adjustment should be allowed from the

[16] Where less than a year of data is not feasible, methodologies should be considered on a case-by-case basis and agreed upon with the M&V team.

previous 365-day measurement period and account for NRAs, as applicable. Required documentation must, however, include a clear justification of the adjustments in the M&V plan.

Recommendation #1a: Update the TRM (Volume 4, section 2.4, M&V Miscellaneous) to increase the consistency of the calculation process, and the accuracy of savings for M&V claimed energy savings.

Key Finding #2: On-site evaluation of RCx projects shows that the customers could benefit from follow-up after monitoring has started.

On-site conversations between the building operators and the EM&V team during M&V on-site visits identified improvements in energy efficiency that are still available after the project completion. Throughout the measurement period (12 months following project completion), equipment and controls can continue to be refined and new opportunities identified to increase energy savings over time, which is a typical continuous improvement process.

However, the current M&V process analyzes savings in the 12-month measurement period, then applies those savings to the five-year EUL (estimated useful life). Therefore, any continuous improvement actions that occur during the measurement period only receive partial value during the five-year EUL period. If continuous improvement occurs after the measurement period, no value is claimed by the energy efficiency program.

An alternative approach to encourage continuous energy improvement throughout the EUL will support best practices for participants in the program and may lead to more accurate energy savings calculations.

Recommendation #2a: Update the TRM (Volume 4, section 2.4: M&V Miscellaneous) to include an alternate calculation approach to encourage continuous improvement at the participant facility.

3.3.2.3 Small Business Market Transformation Program (Including Open Market Transformation Program)

Key Finding #1: More detailed documentation is needed to perform the calculations for the *weather stripping* measure.

Building envelope energy-efficiency measures, such as weather stripping, are more dependent on the detail and quality of the installation compared to other equipment-based measures.

The *non-residential weather stripping* measure is included in the TRM as the *entrance and exit door infiltration* measure; this measure applies to the installation of weatherstripping or door sweeps on entrance and exit doors for a contained, pressurized space. Entrance and exit doors often leave clearance gaps to allow for proper operation. The gaps around the doors allow for the infiltration of unconditioned air into the building, adding to the cooling and heating load of the HVAC system.

Weatherstripping and door sweeps are designed to be installed along the bottom and jambs of exterior doors to prevent air infiltration to conditioned space. When not installed properly, air can still flow through the remaining gaps limiting the energy savings potential. Therefore, care should be taken to ensure proper sealing for the entire length, as well as proper corner sealing

at the joints, and the maximum coverage is achieved. Weatherstripping type and install location should be selected to minimize gaps.

The submitted documentation for weatherstripping should become more detailed. The EM&V team recommends using a 1/8-inch increment for all lengths and widths associated with this measure. Additionally, the building type, heating type, and cooling type should be clearly documented in addition to the calculation work and result.

The calculation of energy savings should evolve to account for the air movement through remaining gaps, as well as the air movement impeded by the weatherstripping.

Recommendation #1a: Update the *non-residential entrance and exit door infiltration* measure (section 2.3.3 in Volume 3 of the TRM) to account for the remaining open area and clearly indicate the detail of documentation collected on-site.

Key Finding #2: Lighting controls are rarely installed in small business projects.

The EM&V team noted that 4 of the 43 sampled small business lighting projects claimed lighting controls savings. Based on the evaluation of lighting retrofit projects, it is believed that 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.

Recommendation #2a: Consider an increased use of wall-based occupancy sensors as a larger part of the Small Business program delivery.

Key Finding #3 and Recommendation #3a discussed in section 3.2.2 are equally relevant to small business projects.

4.0 RESIDENTIAL ENERGY EFFICIENCY PROGRAMS

4.1 SUMMARY RESULTS

This section presents the residential sector results from all relevant EM&V activities.

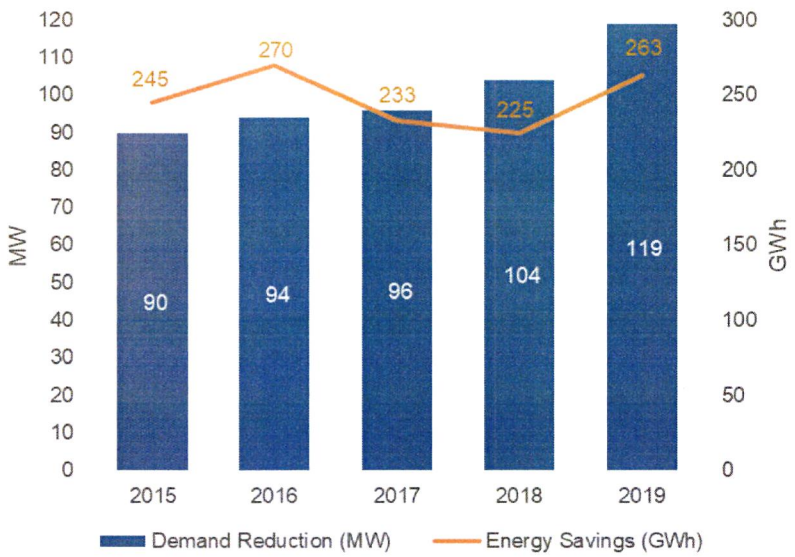
4.1.1 Savings

Statewide PY2019 evaluated gross savings from residential sector programs was:

- 118,911 kW (demand reduction); and
- 262,656,084 kWh (energy savings).

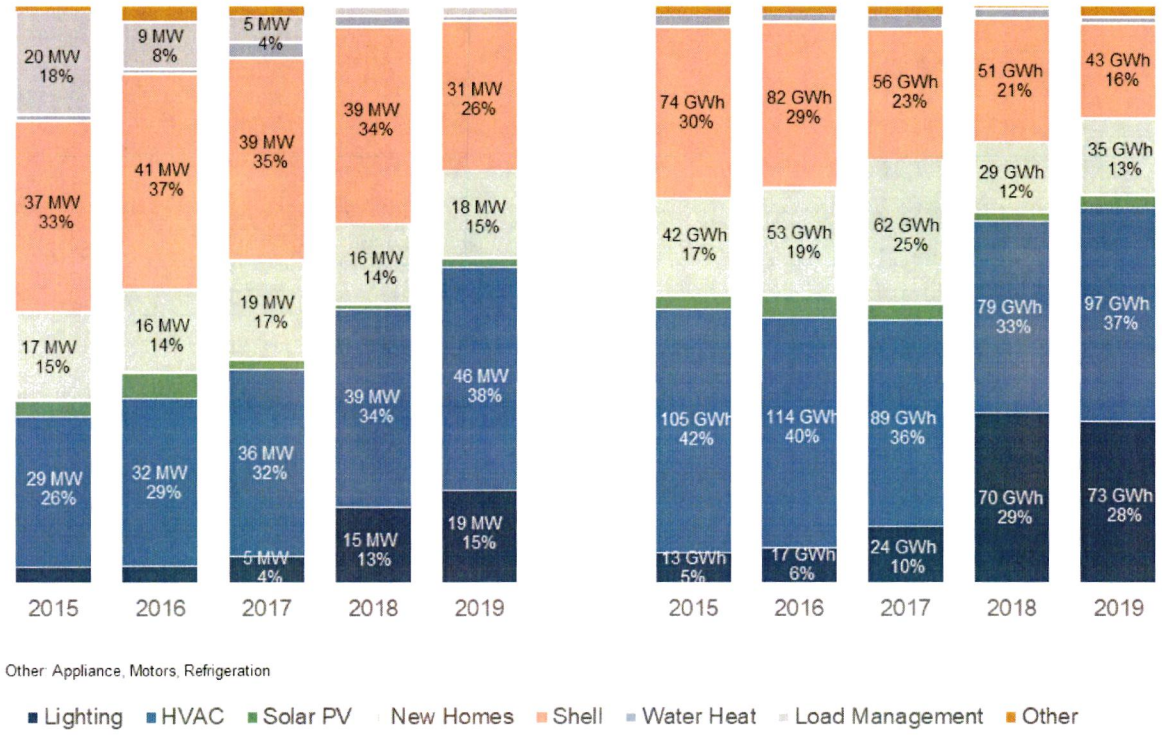
As seen in Figure 17, the demand reduction achieved in PY2019 was the highest since the evaluation started in PY2012. Energy savings were higher in PY2019 than in recent years. A TRM update decreasing residential envelope measures came into effect in the PY2017 TRM. PY2019 residential savings are approaching PY2016 levels prior to the TRM envelope measure update.

Figure 17. Total Statewide Evaluated Gross Demand Reduction and Energy Savings by Program Year—Residential Programs PY2015—PY2019



For PY2019, the majority of residential demand savings (excluding load management) was derived from HVAC. The majority of energy savings was also from HVAC (37 percent), closely followed by lighting (28 percent). New homes and shell measures make up a majority of the remaining savings (13 percent and 16 percent, respectively). Figure 18 presents the breakdown of savings by measure category and demonstrates that the utilities have been successful in diversifying their measure mix for residential savings.

Figure 18. Distribution of Statewide Evaluated Gross Demand Reduction and Gross Energy Savings by Measure Category—Residential Programs PY2015—PY2019

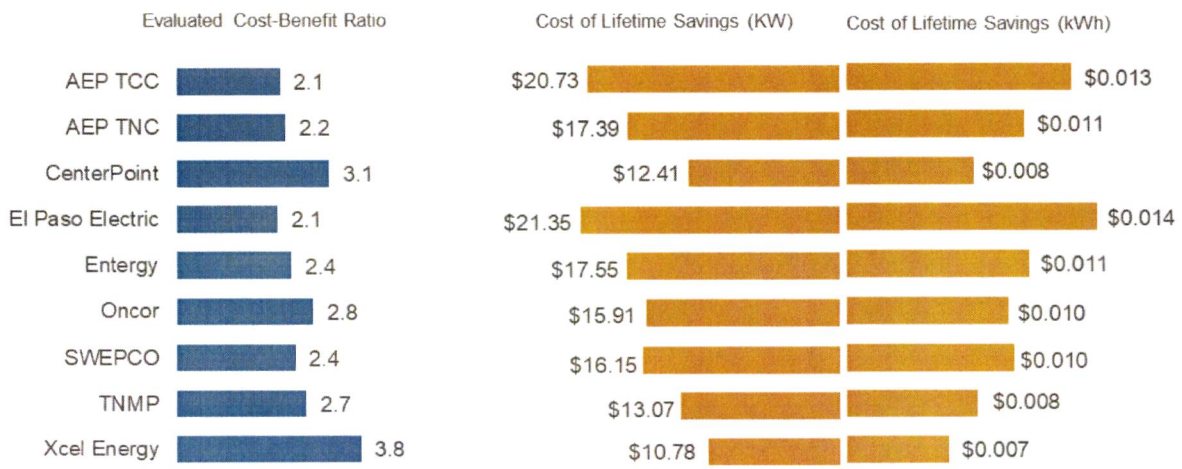


4.1.2 Cost-Effectiveness

Residential sector programs' cost-effectiveness statewide is 2.8 based on evaluated gross savings, and 2.4 based on evaluated net savings. Like the commercial sector, the residential sector cost-effectiveness varied among utilities, with evaluated gross savings results ranging from 2.1 to 3.8 and evaluated net savings results ranging from 1.9 to 3.5. As with the commercial sector, this is in part due to the differences in the types of programs offered by different utilities.

Figure 19 summarizes the cost-effectiveness of each utility's residential energy efficiency portfolio and the cost of lifetime kWh and kW for each utility's residential sector programs. The cost per kWh ranges from $0.007 to $0.014, and the cost per kW ranges from $10.78 to $21.35. 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.

Figure 19. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Residential Programs PY2019



4.2 RESIDENTIAL STANDARD OFFER, HARD-TO-REACH, AND LOW-INCOME PROGRAMS

4.2.1 Program Overviews

The EM&V team evaluated the residential energy efficiency programs described below. Like the commercial energy efficiency programs, there are residential SOPs and MTPs. The residential SOPs 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. On the residential side, HTR and LI programs are also offered and were developed to provide comprehensive energy efficiency retrofits for single and multifamily customers who meet the income guidelines of the program.

Residential SOP: The Residential SOP provides incentives to project sponsors for a wide range of retrofit measures that reduce demand and save energy in single-family and multifamily buildings. Residential SOPs target retrofit measures for residential customers, with incentives 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 an RSOP.

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 low-income 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 energy efficiency of the home.

4.2.2 Key Findings and Recommendations

Key Finding #1: Residential programs are delivering substantial energy savings and winter and summer peak demand reductions, but results vary across utilities and program types.

On average, across the ERCOT utilities, RSOPs 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.

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. HTR programs are saving less energy than residential and LI programs, and these savings have decreased since the 2015 consumption analysis. 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.

LI programs are the highest savings residential program, with results across utilities ranging from 11 to 21 percent of participants' annual energy use. LI programs use the SIR cost test instead of the program administrator cost test and, therefore, can implement more measures. The implementer of the highest saving LI program has implemented innovative strategies with service providers.

Recommendation #1a: Consider best practices from the highest-saving residential programs to increase overall savings delivered to customers statewide.

Key Finding #2: The consumption analysis performed by the EM&V team found that for the primary residential measures investigated, the deemed savings in the TRM are overestimated.

The EM&V team conducted a consumption analysis comparing the performance of implemented measures versus the TRM deemed savings values. A comparison of the consumption analysis results at the measure level, indicate the researched TRM deemed savings are consistently overestimating actual savings at varying levels as described below. The EM&V team targeted envelope measures including air infiltration and ceiling insulation as well as HVAC measures such as duct sealing and AC and heat pump systems. The results showed that residential AC deemed savings are closest to actual consumption, and air infiltration and ceiling insulation are the most overstated.

Generally, the AC measure roughly matched TRM savings at 75.7 percent of TRM energy savings. However, the HP measure only achieved 42.7 percent of TRM energy savings. The EM&V team found that the heating savings associated with an electric resistance baseline are the most overstated.

The EM&V team found that envelope measures such as ceiling insulation and air infiltration were achieving just 25.9 percent and 2.3 percent of TRM energy savings, respectively. The ceiling insulation TRM savings for existing insulation under R-5 is exponentially greater than the TRM savings for R-5 and above and may be overstated. Discrepancies in savings coming from the air infiltration measure are likely due to testing methods and differences in multifamily versus single-family. In addition, the EM&V team's prior research suggests that air infiltration may not be properly implemented as the EM&V team has found major air leaks during prior on-site inspections.

The EM&V team found that the duct sealing measure achieved 57.4 percent of TRM energy savings. Looking at the savings comparison of single-family homes versus multifamily homes, the EM&V team found the percent of TRM savings for single-family to be 60.4 percent and multifamily to be 22.6 percent. This difference is likely due to the probability that the ducts in a multifamily building are located within conditioned space and special considerations should be added to the TRM for multifamily savings.

The EM&V team is also considering behavioral differences as reasonable cause for a portion of the discrepancies in savings. The *snapback* effect is a phenomenon where energy efficiency reduces the marginal cost of energy; therefore, energy consumption will increase, offsetting any gains achieved by the efficiency measures.

Recommendation #2a: Update the PY2021 TRM to increase the accuracy of the deemed savings for residential retrofit programs. The TRM working group will update the following measures for the PY2021 TRM: AC, heat pumps, duct sealing, ceiling insulation, and air infiltration. The TRM working group will examine baselines, testing and documentation requirements, and special considerations for multifamily projects to improve the accuracy of savings.

Recommendation #2b: Develop and deliver customer education on energy conservation and the proper use of installed equipment along with the energy efficiency measures to address the *snapback* effect.

Recommendation #2c: Identify needs and support the training of implementation contractors to address measures that may be improperly implemented and, therefore, not delivering savings as intended.

4.2.3 Impact Results

Residential retrofit programs were designated as *high* evaluation priorities for PY2019. These programs continue to comprise a considerable percentage of residential statewide portfolio savings and have been responding to substantial TRM updates to the envelope measures. As part of the impact evaluation, the EM&V team conducted a consumption analysis of the ERCOT utilities' residential SOPs—including HTR and LI—to evaluate energy and demand impacts.

Similar to the consumption analysis conducted as part of the PY2015 evaluation activities, the goal of the PY2019 consumption analysis was to help the EM&V team, the PUCT, Texas electric utilities, and other stakeholders to better understand the savings resulting from the measures installed through the residential existing homes programs. The findings and recommendations previously discussed will inform updates to the TRM for PY2021.

Overall the EM&V team found that, while the programs are delivering substantial savings to customers, the researched residential measures in the TRM are generally overestimating savings. In addition, savings differ across program types and across utilities. The EM&V team conducted a consumption analysis of PY2018 RSOP, HTR SOP, and LI program participants. Technical Appendix 1 presents a detailed version of the consumption analysis methodology. This report section summarizes both the methodology and approach and readers interested in more detail should consult the Technical Appendix.

4.2.3.1 Methodology

The consumption analysis focused on major measures that contributed significant portions of the residential portfolio statewide. We included PY2019 participants in the analysis as a comparison group by analyzing changes in their meter data before receiving any measures.

We received 15-minute interval meter data for over 33,000 PY2018 participants covering January 1, 2017, through December 31, 2019. This time period ensured that we had at least twelve months of data before and after these customers received measures. We received meter data for over 29,000 PY2019 participants covering the same time frame, which we filtered down to the dates before they received a measure. We screened both groups for a number of criteria as part of our data cleaning process, resulting in approximately 65 percent of each group remaining in the analysis sample. The full details of the screening process are in Appendix 1-B: Screening Criteria Details.

Next, we combined the screened meter data with observed weather from the National Oceanic and Atmospheric Administration (NOAA) as well as typical weather from the typical meteorological year 3 (TMY3) dataset from the National Renewable Energy Laboratory (NREL). We used these weather data to weather-normalize metered energy consumption. This process estimates a household's energy usage under typical weather conditions, minimizing the impact of extreme temperatures on the resulting energy consumption estimates. We optimized each household's weather-normalized energy consumption using a series of regressions that model the home's response to weather under different temperature settings. The resulting weather-normalized energy consumption provides the basis for the remaining analyses. Appendix 1-A: Supplemental Information on Weather Data provides a detailed description of the weather-normalization process.

4.2.3.2 Consumption Analysis Summary Results

Using the weather-normalized energy consumption, we implemented a series of program- and measure-level fixed-effects models to estimate the energy savings and demand reduction resulting from the programs. The programs overall save between 4.9 percent (for HTR SOP) and 15.9 percent (for LI) of participating households' pre-treatment energy usage. These results are net savings and include a decrease from a comparison group that accounts for external factors to the program. See Table 12.

Table 12. Program-Level Consumption Model Results Compared to Pre-Treatment Usage

Program Group	n	Normalized Energy Consumption, Pre-treatment (kWh)	Model Savings (kWh)[17]	Savings as % of Normalized Energy Consumption
Residential SOP	13,988	16,067	1,228	7.6%
Hard-to-reach SOP	6,501	13,771	681	4.9%
Low-income	1,808	11,255	1,794	15.9%

While the analysis shows that the programs save a sizeable amount of energy for participants, we found that the consumption data analysis resulted in much lower savings than estimated by the TRM. All three program types are saving around a third of TRM deemed savings estimates, ranging from 30.1% for the HTR SOP to 38.6% for the RSOP. See Table 13.

Table 13. Program-Level Consumption Model Results Compared to TRM-Calculated Savings

Program Group	Average Model Savings (kWh)	Average TRM Savings (kWh)	Model Savings as a Percentage of TRM
Residential SOP	1,228	3,182	38.6%
Hard-to-reach SOP	681	2,263	30.1%
Low-income	1,794	4,700	38.2%

The results vary by measure. Central air conditioners (AC) are the measure with results where savings estimates between the consumption data model results and the TRM deemed savings are the closest. In contrast, air infiltration had the widest discrepancy between consumption analysis results and TRM deemed savings. See Table 14.

Table 14. Measure-Level Consumption Model Results as Percentage of TRM-Calculated Savings

Measure	RSOP	HTR SOP	LI
AC	75.3%	153.9%*	84.7%*
Air Infiltration	-4.6%	13.4%	18.3%
Ceiling Insulation	17.3%	32.7%	87.7%
Duct Sealing	57.3%	67.7%	135.1%*
Heat Pump	44.6%	43.2%	34.7%

*Result is based on fewer than 50 observations and should be treated as qualitative.

[17] The model savings are adjusted by the energy change seen in the comparison group across the same time period as the participant group.

The EM&V team applied the peak demand methodology described in the TRM, identifying the top 20 hours per weather station and comparing average demand across these hours between the pre- and post-treatment periods. These results show the programs are generating peak demand reductions even more effectively than energy savings, particularly in the winter peak period. See Table 15.

Table 15. Program-Level Consumption Model Peak Demand Reduction

Program	Peak Period	Weather-Normalized Peak kW, Pre-treatment	Peak kW Reduction	Reduction as % of Pre-Treatment Peak
RSOP	Summer	4.83	0.86	17.7%
	Winter	4.83	1.14	23.6%
HTR SOP	Summer	3.19	0.51	16.1%
	Winter	4.38	0.88	20.2%
LI	Summer	3.01	0.71	23.6%
	Winter	3.66	1.24	33.8%

The measure-level peak demand reductions are similar to the measure-level energy savings results, except for duct sealing. Either the TRM underestimates winter peak demand reductions for this measure or utilities are not claiming the winter peak for the measure. See Table 16.

Table 16. Measure-Level Consumption Model Peak Demand Reduction

Measure	Summer Peak			Winter Peak		
	RSOP	HTR SOP	LI	RSOP	HTR SOP	LI
AC	68.7%	74.2%*	47.1%*	n/a		
Air Infiltration	-9.4%	-0.1%	4.5%	-0.6%	5.3%	31.7%
Ceiling Insulation	6.5%	16.8%	25.0%	18.1%	27.7%	37.5%
Duct Sealing	18.3%	22.9%	133.7%*	172.6%	250.4%	247.8%*
Heat Pump	13.7%	9.5%	10.4%	53.8%	36.1%	23.8%

*Result is based on fewer than 50 observations and should be treated as qualitative

4.2.4 Process Results

This section summarizes findings from the process surveys completed with PY2019 participating EESPs for residential SOPs including HTR and LI.

Key Findings

- The energy efficiency programs have influenced the EESP's business practices towards energy efficiency improvements and recommendations for their customers.
- EESPs are satisfied with all program aspects. Highest satisfaction was for the support received (33 of 50 respondents). Responses to questions or concerns from the utilities saw the most mentions of *very satisfied* (30 of 50 respondents).

Study Methodology

The EM&V team pulled a list of all PY2019 participating RSOP EESPs from the EM&V database. Because the EM&V team was targeting 50 completed surveys and the total number of participating EESPs was 276, a census was taken to determine who will be contacted for this effort. A total of 50 surveys were completed between May 8, 2020, and June 22, 2020, with a response rate of 18 percent. The average interview length of the telephone surveys was 17 minutes. See Table 17.

Table 17. Residential Standard Offer Program
Energy-Efficiency Service Provider's Survey Response Rate

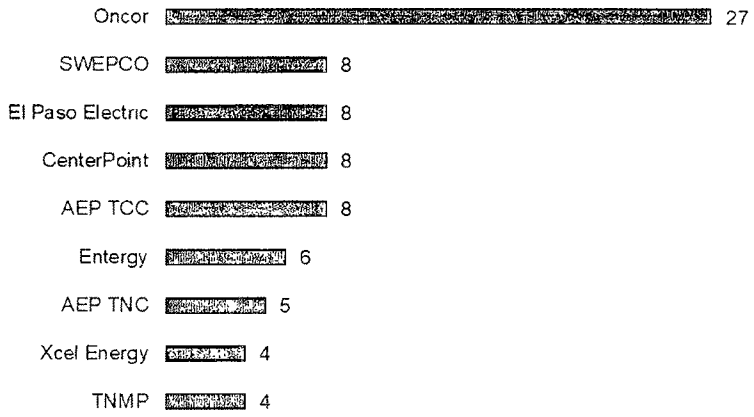
Dispositions	Overall
Sample	**276**
Not a utility customer	0
Affiliated with utility	0
Eligible sample	**276**
Does not recall participating	6
Incompletes (partial surveys)	10
Not completed	210
Completed	50
Response Rate	
Response rate (completed/eligible sample)	**18.1%**
Average survey length (minutes)	**17.2**

The EM&V team designed the survey around key researchable topics aimed to understand how the programs are operating from the EESPs' perspectives. Questions covered motivators and barriers to participation, satisfaction, needed improvements, and program influence. The surveys were first completed through a web survey (38 completes). Follow-up surveys were then completed in Tetra Tech's in-house survey research center (SRC) using computer-assisted telephone interviewing software (CATI) to achieve the total target of 50 completes.

Firmographics

All 50 surveyed EESPs have installed energy-efficient equipment or provided services through one or more of the nine electric utility companies shown in Table 18 below. Oncor saw the most reported participation, with over one-half of the respondents submitting projects through its RSOP programs.

Table 18. EESP Reports of Residential Standard Offer Program Project Submission by Utility Company (n=50)



*Source: EESP Survey Question P3. Results may exceed the number of respondents because more than one answer was allowed.

Figure 20 and Figure 21 show the services and products that the EESPs offer in Texas compared to the services and products provided through both residential and HTR SOPs. HVAC equipment and services were reported the most for residential SOP EESPs, whereas HTR SOP EESPs reported more weatherization-related services, such as insulation and air sealing. The majority of EESPs (35 out of 50 respondents) said they had qualifying projects completed without going through a utility program, which provides possible opportunities for increased program participation. It also supports earlier NTG research, which discovered spillover resulting from the programs.

Figure 20. Residential Standard Offer Program Service and Products Compared to Program Submissions (n=32)

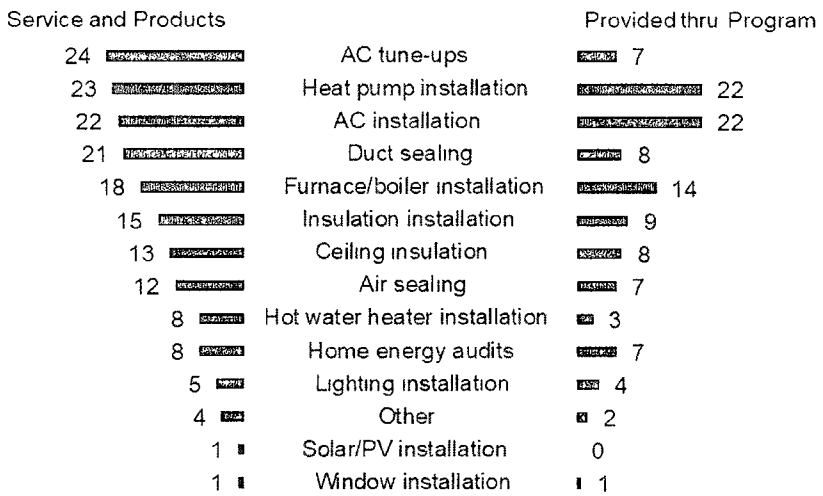
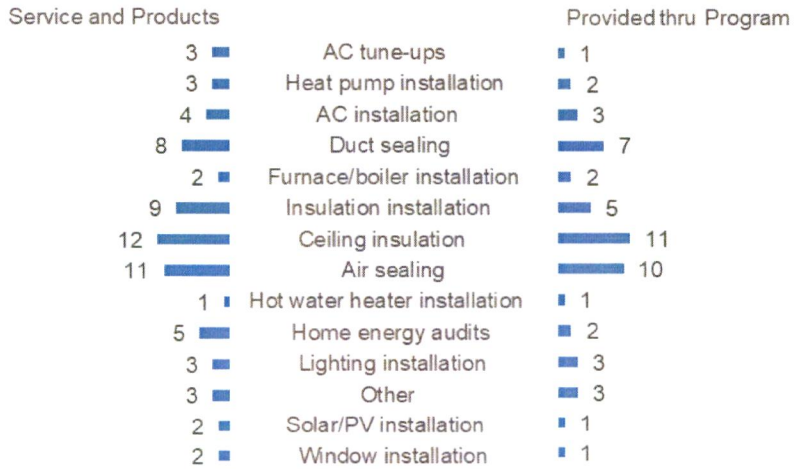


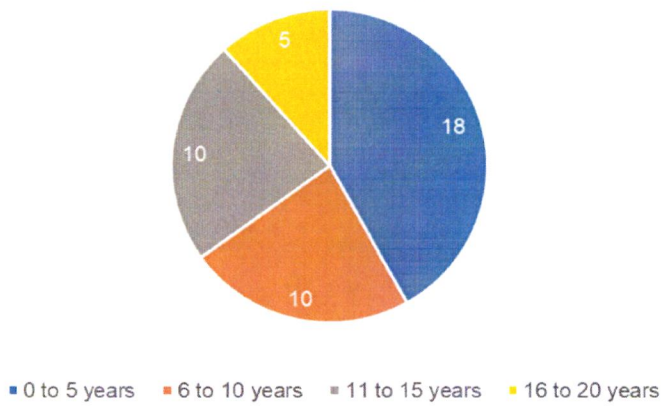
Figure 21. Hard-To-Reach Standard Offer Program Service and Products Compared to Program Submissions (n=18)



*Source: EESP Survey Questions P4a P4b.

Figure 22 shows that more than one half of the EESPs surveyed have been installing energy-efficient equipment or performing services through the RES and HTR SOPs for more than five years (25 respondents). Eighteen respondents have been participating for five years or less.

Figure 22. Number of Years Participating in the Residential and Hard-To-Reach Standard Offer Programs (n=43)

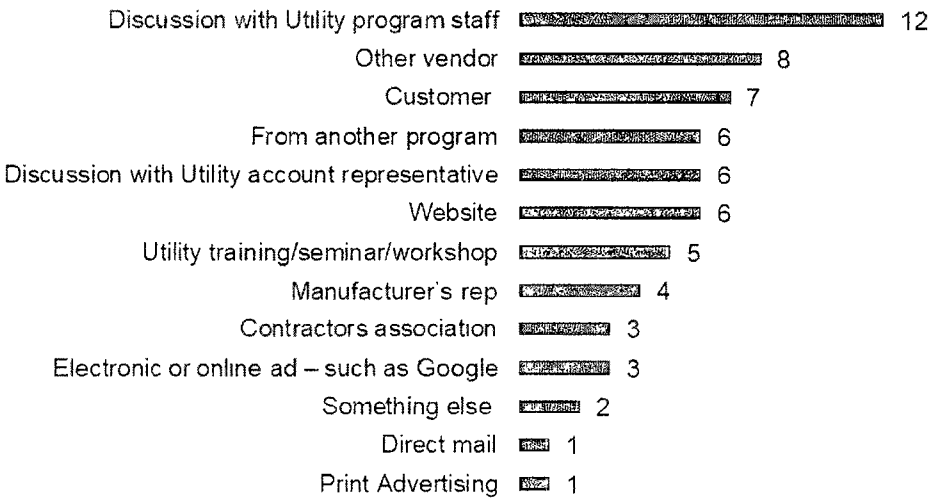


*Source: EESP Survey Question P2. *Don't know* responses have been excluded.

Program awareness

EESPs were asked how they became aware of the Texas RSOPs and HTR SOPs. The most mentioned source was utility program staff (12 respondents). Eight EESPs said they heard about the program through a vendor (8 respondents), and 7 respondents said they learned about it from a customer. From another program, discussions with account representatives, and utility websites were the next most mentioned sources (6 respondents each). Figure 23 shows all the mentioned sources of program awareness.

Figure 23. Energy-Efficiency Service Provider Source of Program Awareness (n=50)

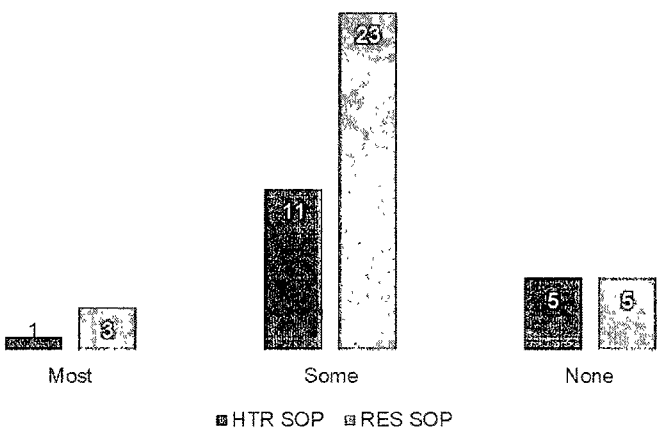


*Source: EESP Survey Question P1.

Customer interactions

Of the 50 EESPs interviewed, all but one said they always inform their customers that the equipment or service is being incentivized through the RSOP or HTR SOP offered by their utility company. Only one EESP said they never mention it. Of the 49 respondents who do inform their customers, when asked if most, some, or none of their customers are aware of the program before they mention it to them, 39 said some or most customers were aware. Ten EESPs said that none of their customers were aware before hearing about it from the EESP. Figure 24 provides a visual on customer awareness.

Figure 24. Number of Customers Aware of the Program Prior (n=49)



*Source: EESP Survey Question P6b.

EESPs can pass the program incentives directly to their customers or use them to mark down the price of the project. Over half (27 respondents) of EESPs said they use the incentive to mark down the price of the equipment or service. One-third (15 respondents) said the incentive

goes directly to the customer, and the remaining 6 respondents said they employ some sort of hybrid approach depending on the situation.

EESPs were asked what they see as the primary barrier to customers investing in energy efficiency improvements. Over one-half (27 respondents) said cost is the primary barrier. Eight EESPs said there are no barriers, and another eight said lack of awareness was the primary barrier. Six EESPs mentioned customer concerns noting the primary barrier being about the return on investment.

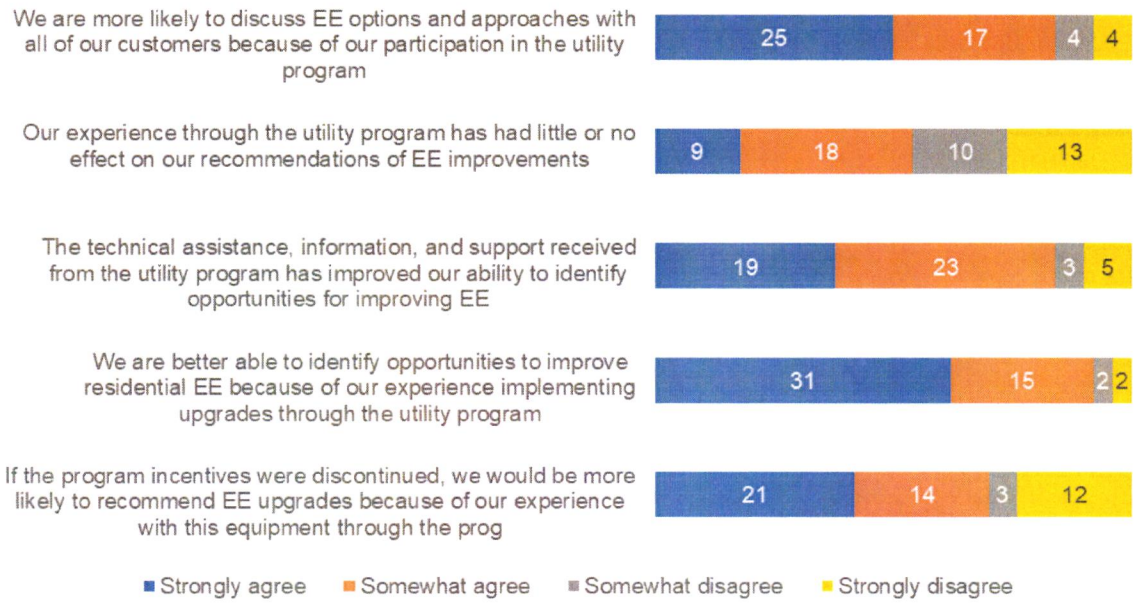
When asked what EESPs see as the primary barrier to customers participating in the program, the cost was again the most mentioned (13 respondents). Thirteen said the return on investment was the primary barrier, and eight said the incentives are too low. Twelve said there are no barriers to program participation, and seven said lack of awareness is the primary barrier. Two others mentioned the primary barrier is that it is not needed because the customer is already efficient, or that it is not offered everywhere in Texas.

Program Influence

The program has influenced EESP's business practices towards energy efficiency improvements and recommendations. EESPs were asked if they strongly agree, somewhat agree, somewhat disagree, or strongly disagree with five statements regarding the program to assess the program's impact and influence. Figure 25 shows the results of each statement. All 50 respondents said they either *strongly agree* or *somewhat agree* with at least one of the statements.

Most EESPs (42 respondents) *strongly agree* or *somewhat agree* with the statement, "We are more likely to discuss energy-efficient options and approaches with all of our customers because of our participation in the utility program," with one-half saying they *strongly agree*. Just under one-half (23 respondents) either *somewhat agree* or *strongly disagree* with the statement, "Our experience through the utility program has had little or no effect on our recommendations on energy-efficient improvements." Only nine *strongly agree* with that statement. Most EESPs surveyed (42 respondents) said they *strongly agree* or *somewhat agree* that the technical assistance, information, and support they received from the program improved their ability to identify energy-efficient improvement opportunities. Almost all (46 respondents) said they are better able to identify opportunities to improve residential energy efficiency because of their experience with the program. Finally, EESPs were asked if the program incentives were discontinued, would they be more likely to recommend energy-efficient upgrades because of their experience with the program, and most (35 respondents) said they *strongly agree* or *somewhat agree*.

Figure 25. Agreement Statements about the Program (n=50)

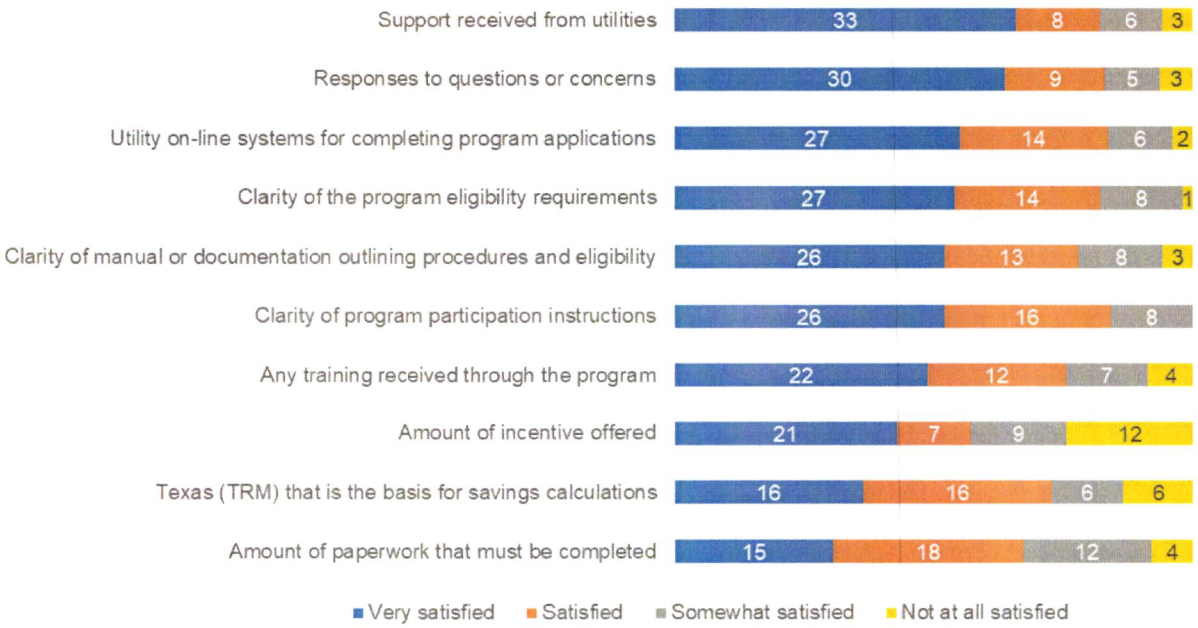


*Source: EESP Survey Questions P12a to P12e.

Program Satisfaction

EESPs are satisfied across all program aspects. The EESPs were asked to rate their satisfaction with specific program components using a four-point scale: very satisfied, satisfied, somewhat satisfied, and not at all satisfied. Figure 26 shows that respondents were consistently *very satisfied* or *satisfied* across all elements. Support received, and responses to questions or concerns from the utilities had the most responses of *very satisfied* (33 and 30 respondents, respectively). The incentive amount saw the most mentions of *not at all satisfied* (12 respondents).

Figure 26. Energy-Efficiency Service Provider Satisfaction with Program Aspects (n=50)



*Source: EESP Survey Questions P5a to P5j.

For all responses of *not at all satisfied*, EESPs were asked what improvements could be made to increase their satisfaction. Of the 26 respondents asked, *providing bigger incentives* was most mentioned (12 respondents). Next was *providing more program support* (3 respondents) and *reducing the administrative burden* (3 respondents). Two said *more communication*, and another said they *would like to learn more about the calculations of incentives*. The other five did not have any suggestions.

The survey also asked respondents why they said they were *very satisfied* or *satisfied* with any of the program aspects. The most mentioned responses were that (1) it helps people who otherwise could not afford it, (2) it makes more efficient equipment more affordable, (3) it helps increase sales, (4) it helps the customer save energy, (5) there is good program support, and (6) it is easy to use. Here are a few comments from respondents:

"[The program] a great channel for people who can't otherwise afford to invest in energy efficiency."

"Helps the low income and elderly."

"Helps homeowners understand importance of energy-efficient systems."

"Everything is easy to follow online."

"It helps us sell more jobs with the incentives that are offered."

"The utilities make every effort to ensure that low-income goals are reached."

4.3 NEW CONSTRUCTION MARKET TRANSFORMATION PROGRAMS

The EM&V team reviewed residential new construction programs as part of the PY2019 program evaluation. The evaluation for these programs included builder and rater interviews to research NTG and consumption data analysis to evaluate program impacts.

4.3.1 Program Overviews

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 the programs with energy models to describe the program-sponsored homes. The utilities compare these energy models with code to estimate energy savings.

4.3.2 Key Findings and Recommendations

Key Finding #1: The energy models used by the utilities accurately estimate gross savings compared to code. The EM&V team compared weather-normalized energy meter data for PY2018 program homes with the estimates from the raters' energy models and found the results to be consistent.

Recommendation #1a: Continue to monitor updates to code and to energy modeling software to ensure the TRM is up to date and accurate.

Key Finding #2: The new homes market in Texas has some level of transformation.

New homes built outside of the programs display similar efficiency to those built through the program in many, but not all, areas investigated in the consumption analysis. This similarity was discovered by a comparison of meter data between participating and non-participating homes. While the interviews with builders support that about half of the market is transformed (a 52 percent free-ridership rate), it also supports a high level of spillover (a 15 percent spillover rate) that helps explain some of the limited differences found in the consumption analysis. The overall new homes NTG from the builder interviews is 64 percent, which indicates that program design updates to maximize net savings should be considered, but that there is still opportunity in the new homes market to affect change.

Recommendation #2a: Update new homes program designs to focus efforts on different segments and aspects of the new homes market that have not been transformed considering current code. These updates might include:

- focusing on particular end-uses such as HVAC, where builders report barriers to installing high-efficiency equipment;
- targeting areas or particular builders in a utility territory that have less efficient practices;
- incorporating distributed generation technologies such as solar photovoltaic systems; and
- promoting innovative building practices by pushing builders to increase home efficiency further through programs such as Leadership in Energy and Environmental Design (LEED) or Zero Energy Ready Homes.

4.3.3 Impact Results

New homes programs were designated as *high* evaluation priorities for PY2019. These programs continue to comprise a considerable percentage of overall statewide portfolio savings and recently went through a major TRM update as a result of the code adoption of the 2015 International Energy Conservation Code (IECC). As part of the impact evaluation, the EM&V team conducted a consumption analysis of the ERCOT utilities' new homes programs to evaluate energy and demand impacts.

4.3.3.1 Methodology

The EM&V team conducted a consumption analysis of PY2018 new homes program participants. Technical Appendix 2 presents a detailed version of the consumption analysis methodology that we summarize in this section.

The consumption analysis focused on comparing actual metered energy consumption with the modeled estimates that resulted from applying Volume 4 of the TRM. We analyzed a comparison group of non-participating homes that were constructed around the same time to determine whether the programs push the efficiency of new homes beyond standard market practice. We limited the comparison group to counties where there were participating homes, and we acquired property tax data to incorporate square footage since building size is a primary driver of energy consumption.

We received 15-minute interval meter data for over 14,000 PY2018 participants from when the meter went online (or January 1, 2017, if the meter went online earlier) through December 31, 2019. This time period ensured that we had at least twelve months of data following home construction. We focused the analysis on the latest 12-month period (January 1, 2019 through December 31, 2019) to look at a consistent time frame for all accounts. We also received meter data for over 56,000 non-program new homes covering the same time frame. We screened both groups for a number of criteria as part of our data cleaning process, resulting in approximately 97 percent of participants and 33 percent of comparison meters remaining in the analysis sample. The full details of the screening process are in Technical Appendix 2.

Next, we combined the screened meter data with observed weather from the NOAA as well as typical weather from the TMY3 dataset from NREL. We used these weather data to weather-normalize metered energy consumption. This process estimates a household's energy usage under typical weather conditions, minimizing the impact of extreme temperatures on the resulting energy consumption estimates. We optimized each household's weather-normalized energy consumption using a series of regressions that model the home's response to weather under different temperature settings. The resulting weather-normalized energy consumption provides the basis for the remaining analyses. Technical Appendix 2 provides a detailed description of the weather-normalization process.

The primary focus of the consumption analysis was to evaluate the accuracy of the TRM measure characterization in estimating energy savings resulting from the new homes programs. This measure characterization provides the utilities with guidance on how to configure energy modeling software to characterize the baseline (or reference) home as well as the program (or as-built) home. Energy modeling software focuses on the building's energy performance, especially the building shell, HVAC, and some major appliances. The software does not include additional plug loads that occupants install once they move in, such as additional lighting, small appliances, computers, and TVs and entertainment systems. These additional plug loads are

included in the meter data provided by the utilities, so we implemented a plug load adjustment factor when comparing with TRM energy savings to account for this difference. However, because there is limited research on the extent of plug load energy usage, especially specific to either Texas or new homes, we specified a plug load factor of 15 percent of annual energy consumption based on the research we had available.[18]

4.3.3.2 Consumption Analysis Results

We compared the weather-normalized meter data with the energy consumption estimates based on the TRM methodology, removing plug load from the meter data as described previously. The TRM estimated energy savings within five percent of the weather-normalized results, which shows an extremely good alignment between the TRM approach and the weather-normalized meter data, especially given the limited research available to solidify the plug-load factor. While we saw some differences by different characteristics (heating system type and geographic location), the TRM is intended to average out over the entirety of projects completed.

We also compared weather-normalized consumption between the program homes and a comparison group of new homes that did not receive a program incentive. The results of this comparison are less straightforward since we had limited available characteristics about the comparison group. During this analysis, we found that, on average, program homes were larger than nonparticipating homes. Initially, this presented counterintuitive results that program homes used more energy. We calculated an energy use intensity (kWh per square foot) for each group. We then multiplied that by the average square footage per group to arrive at a square footage normalized energy consumption which resulted in some energy savings for program homes, but the savings calculated through this method were much lower than calculated by the TRM. While the TRM calculated an average of 1,672 kWh savings per home, the comparison group analysis resulted in only 674 kWh savings per home, or roughly 40 percent of the savings estimated by the TRM. This percentage suggests that non-program homes also exceed the efficiency levels required by code, which indicates that some level of market transformation has taken place. The market transformation may be, in part, due to the program incentives, but also other market factors. These factors are supported by the NTG study conducted as part of this year's evaluation, which the following section discusses.

[18] https://www.esource.com/es-wp-14/mind-gap-taking-comprehensive-look-plug-load-energy-use

4.3.4 Process and Net-to-Gross Results

In this section, we summarize the builder and rater interview results for the Texas new homes programs. We first provide an introduction to the objectives and sampling for the interviews, followed by key findings for each program statewide, and any applicable utility-specific findings.

Introduction

The EM&V team completed builder and rater (market actors) in-depth interviews for the Texas new homes programs in May and June 2020. The primary objective of these interviews was to gather information on program influence on market actors' recommendations and sales practices to inform NTG. Throughout the interviews, the EM&V team also captured process-related information provided by these market actors, such as:

- experience working with the utilities,
- satisfaction with various components of the program(s),
- perceptions of the market and barriers to adoption, and
- areas the program is working well and opportunities for improvements.

The EM&V team obtained the market actor sample from PY2019 program tracking databases, utilities, and implementation contractors. At a minimum, we received the market actor company name and telephone number. Some market actor data also included individual contact name, email address, projects completed, and associated savings.

The EM&V team completed a total of 15 unique market actor interviews—12 builder interviews and 3 rater interviews. Because all of the raters and almost all of the builders work with different utility programs, the 15 unique market actor interviews represent 38 utility program-level completed interviews—28 builder interviews and 10 rater interviews. Since the population of rater companies across Texas is small, the EM&V team attempted to contact almost all of the rater organizations. Builders were randomly sampled with a goal of obtaining representation from all utility programs, as well as some variance in the number of homes completed through the programs. Table 19 documents the number of completed interviews by utility and market actor type.

Table 19. Number of Builder- and Rater-Completed Interviews by Utility*

Utility	Number of Builder Interviews Completed (n=12)	Number of Rater Interviews Completed (n=3)
AEP	3	1
CenterPoint	10	3
Entergy	11	3
TNMP	4	3
Total	**28**	**10**

*The counts represent the number of market actors working within each utility territory. Market actors that serve customers in multiple territories are represented more than once.

Since the number of market actors interviewed for each utility program is limited, results are qualitative and may not be representative of the entire population of interest. All numeric results (e.g., satisfaction ratings) are presented in number of responses rather than percentages to reflect the qualitative nature of the data. Additionally, the information presented reflects the

perception of the market actors, which may or may not accurately reflect intended program design and delivery.

4.3.4.1 Overarching Key Findings for New Homes

The EM&V team spoke with a sample of Texas home builders and raters. This section first presents the results of the home builder interviews, followed by rater interviews.

Builders

The EM&V team spoke with a mix of builders that work across the four new homes programs in Texas. Organizations included in the study vary by the number of homes built annually (under 10 to thousands) as well as the type of home (primarily production, but also semi-custom homes). All but one builder said that all of the homes they build are built in areas that enforce the IECC 2015 energy code and that their rater completes a full rating on all of their homes, whether the homes receive utility incentives or not. In addition to home ratings, raters provide various other key services for builders—they handle utility incentive paperwork and online submittals, as well as provide builders with code change information and training. Raters handle so much for builders that builders rarely use the training or technical support provided by the utility programs.

The majority of home builders interviewed have been building homes through the Texas programs for two to five years, with some (4 of 12) noting they have been participating for 14, 15, even up to 20 years. Because of the relatively long-standing experience with the program, most respondents could not recall how they first heard about the program.

Almost all builders interviewed service customers across multiple service territories. The interviews probed these builders on differences in program requirements, satisfaction, etc. by utility. Other than a few variations in program design, builders did not identify differences among the various utilities for this program.

Satisfaction

Builders were asked to rate their level of satisfaction with various elements of the program (very satisfied, satisfied, somewhat satisfied, and not satisfied). As reflected in Table 20, nearly all builders said they were *very satisfied* or *satisfied* with most of the areas discussed. Responses to questions and concerns received the most *very satisfied* ratings, and the *amount of incentive offered* received the most *somewhat satisfied* ratings.

Table 20. Satisfaction with New Homes Programs Components

Program Component	Number Very Satisfied	Number Satisfied	Number Somewhat Satisfied	Number Not Satisfied	Total Responders*
Support received from utility	16	12	0	0	28
Clarity of program eligibility requirements	20	6	2	0	28
Responses to questions/concerns raised	24	4	0	0	28
Training received	5	4	6	0	15
Amount of incentive offered	6	13	7	0	26

Program Component	Number Very Satisfied	Number Satisfied	Number Somewhat Satisfied	Number Not Satisfied	Total Responders*
Amount of paperwork required	11	14	2	0	27
Utility online program application process	7	11	0	0	18

* When the number of responders does not equal 28, responses were either *not applicable* or *don't know*.

Use of Incentives and Participation Barriers

Builders typically use the incentive to reduce their cost of building the home—whether that is using the incentive to mark down the home price or using it to offset the increased cost of more efficient products and practices. No builders said the incentive goes to the customer. Additionally, the EM&V team spoke with only one builder who said they always tell their customers that their utility is contributing funds to their home. The other builders said they *sometimes* (4 of 12) or *never* (6 of 12) inform their customers of the utility incentive. Not informing customers could be one reason why only one builder said that most of their customers are aware of the utility program.

Similar to past findings and other markets, builders stated that the most prevalent barrier to customers' purchasing program homes is cost. The cost barrier is an issue in a couple of different (but related), ways:

- The new homes market is a competitive one, especially the production home market; builders noted they could not afford to substantially upgrade the energy efficiency of their homes without additional incentives, or they will price themselves out of their markets.
- Even though energy efficiency has been around for many years, consumers are still generally not willing to pay more for this feature.

> *"It's probably a money barrier for them [consumer] to get more efficient equipment. [Builder] is putting in 16 SEER air conditioners. We cannot sell a higher SEER in homes because it's not tangible; it just doesn't make monetary sense."*

Some builders said that consumers generally expect homes to be energy efficient, and even ask questions about ratings, appliances, etc. Still, knowledge does not always transfer to a willingness to pay. Builders also noted that talking to consumers about increasing their home's energy efficiency can be a challenging discussion to have, especially if it means a trade-off between energy efficiency and some other aesthetic (e.g., countertops, lighting, flooring upgrades). One builder did say, though, that they had customers come back to them to complain about high energy bills, so they did something about that:

> *"I think customers would maybe say that it might not be a good investment. But when they move into bigger homes, they start to care when they start seeing their utility bills. Generally speaking, if we were to tell them how much of the home building cost went to the energy efficiency side, they might think that was a lot of money. [Builder] made the change from green to energy efficiency in 2008. Our rater is part of Environment for Living, and they give every person a guarantee for their utility usage. So everyone knows what the vast majority of their bills will look like. We started a couple of communities*

with a conditioned attic and did a comparison, and there's about an $800 to $1,00 difference. We show people that all the time."

Given this information, it is not surprising that the item rated lowest for satisfaction is the amount of incentive offered by the utility. In summary, there are a number of reasons for this including:

- A number of builders mentioned that, while the incentive is nice to have, the available dollar value is low compared with the additional cost to build a home according to the program's requirements.
- Though almost all respondents also said that, as a standard practice, they build homes that meet or exceed program requirements; many of the builders mentioned they have been building energy-efficient homes for so long, they would not do otherwise.
- There are a lot of other program influencers in the market that force builders to build more efficient homes if they want to stay competitive (e.g., ENERGY STAR, Environments for Living®, etc.). Some builders would like to see the utility programs include more innovation in achieving higher efficiency levels, but also noted that the incentive would need to cover the incremental costs to get there.

"A previous utility was aggressive in marketing their program (Good Cents), and the consumer would come in the door and know about the program; it's not that way now."

"I don't know any builders that are not energy efficient builders. Most everyone is doing some kind of ENERGY STAR deal. I think everyone's stuff is pretty energy efficient."

"Customers do not fully understand what energy efficiency all entails."

Training and Technical Assistance

The EM&V team asked respondents a series of questions related to training and technical assistance provided by the utilities, and their relative importance in the builder's decision to build energy-efficient new homes (using a 0 to 10 scale where 10 was *very important*, and 0 was *not at all important*). As can be seen in Table 21, many program elements were rated by builders as either *not important* (0, 1, 2, or 3 rating) or *moderately important* (4, 5, 6, 7 rating). These ratings are likely because builders said they rely on their raters to provide program information, training, and to complete many of the program requirements. The component that the greatest number of builders rated as *important* (8, 9, or 10 rating) was the *program incentive* (18 of 22), even though the incentive was rated lowest for satisfaction by most builders. The EM&V team's interpretation of this is that, while builders may say the incentive is too low, it is ultimately the incentive that keeps them in the program(s). One builder noted:

"The incentive for both of them [Utility1 and Utility2] is fair. It's a good amount of money if your homes can pass. For [Utility3], it's a seamless deal; they send me lots of money. The other ones kind of pick and choose through my houses. I'm not sure why I pass [Utility3], and I don't pass the others."

The low importance ratings reflected in the technical support and training seminars provided by utilities are largely due to builders relying on their raters for this type of information. Of the builders that said they do use utility-provided technical or training resources, it has mostly been either once a year or for questions related to navigating program requirements. One builder noted that the utilities need to be proactive about calling them to ask how they can help. Another builder suggested that the utilities could provide better information related to the incentives and

the cost-benefit of participating; the utilities could do better at helping builders understand how they could truly benefit from the program.

Table 21. Importance of New Homes Programs Technical and Training Components

Program Component	Important (8 - 10 Rating)	Moderately Important (4 – 7 Rating)	Not Important (0 - 3 Rating)	Total Responders
Technical support provided by the utilities	5	8	9	22
Information provided by representatives of the utilities	9	11	2	22
Training seminars provided by the utilities	0	7	15	22
Information provided by the utility websites	12	0	10	22
Company's past participation in a program sponsored by the utilities	13	5	4	22
The program incentive	18	0	4	22

Attribution

The EM&V team is tasked with estimating net savings, which was accomplished by completing NTG research and producing NTG ratios statewide for the new homes programs. In Texas, net savings have been defined as "those savings that are attributable to the programs, inclusive of free-ridership and spillover"[19] based on the definitions of these terms in § 25.181 (c).

The EM&V team used a self-report approach through builder interviews to calculate NTG ratios.

Free-Ridership refers to actions taken by participants (builders) through a program that would have occurred in the absence of the program. In other words, a *free rider* is a program participant who would have made some amount of the program-rebated energy-efficient improvements if the program had not been offered.

Spillover refers to additional energy-efficient equipment installed, or actions taken due to program influences but without any financial or technical assistance from the program. The EM&V team relied on builder interviews to determine the spillover rate.

The final NTG ratio is then calculated using the following formula. The ratio can be applied to the population to determine the final net savings value.

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

As a simplistic example, if a program has a free-ridership rate of 20 percent, and a spillover rate of 8 percent, the NTG ratio would then be:

NTG Ratio = 1.00 – ((0.20) + (0.08))
NTG Ratio = 0.88, or 88%

[19] Evaluation, Measurement, and Verification Plans for Texas Utilities' Energy Efficiency and Load Management Portfolios – Program Years 2012 and 2013 (Final June 12, 2013).

A higher NTG indicates program influence on decisions and high attribution toward behaviors. A lower NTG factor indicates a low level of influence, which may be further indicative of market transformation, a need for incentive restructuring, etc. There are occasions where outliers exist in the data. Outliers are cases that provide responses that extensively deviate from the norm. While important to account for these cases, depending on the project size and the number and composition of survey completes, these data can significantly swing the results.

Within NTG research, the spillover calculation has the potential of capturing large outliers, which could then influence the overall NTG ratio considerably. While it is important to recognize these cases' spillover results, the EM&V team needs to be careful to manage the results such that NTG is not overstated due to potential self-reporting bias. Therefore, the EM&V team will cap the spillover rate calculated for individual market actors at 200 percent.

Summary of Results

Table 22 summarizes the statewide NTG results and the NTG methodology, which are then discussed in more detail below. As already mentioned, the results are based on builder interviews.

Table 22. Net-To-Gross Summary

Program Category	Program Type	Free-Ridership	Spillover	NTG Ratio	NTG Methodology
Residential Market Transformation Program (RMTP)	New Homes	49%	15%	64%	Market actor (builder surveys)

4.3.4.2 Methodology

The EM&V team used builder interviews as the only method to calculate free-ridership and spillover for the new homes programs. No customer surveys were completed for the new homes programs because the utilities do not collect end-use customer information for new homes completed through the programs; this is not surprising given that the programs' upstream implementation focus is working with builders.

Builder free-ridership and spillover results were weighted by the number of total energy-efficient projects completed by each builder and submitted to a utility program to account for a different level of builder activity.

4.3.4.3 New Homes Net-To-Gross Results

Free-Ridership

As mentioned earlier, the NTG approach for the new homes programs differs from other types of programs. While the customer may be aware of the benefits or be involved in the decision, the majority of the program's marketing, outreach, and education are directed to builders. The main intent is to encourage the builders to adopt above-code energy efficiency products and practices that meet each utility's specific requirements. Therefore, it is most important to understand, from the perspective of the builder, what their perception is of their building practice in the absence of the program.

We calculated a free-ridership rate of 48 percent for the new homes programs. The free-ridership rate is based on 28 builder responses.

Spillover

The EM&V team calculated the spillover rate for the new homes programs at 15 percent. The market actor results include responses from 12 unique builders. Several builders provided *don't know* responses to spillover-related questions, in which case we treated them as contributing zero spillover. While this is a conservative approach, it reflects that these builders do not have widespread practices that contribute to spillover like some other builders.

Benchmarking

For residential new construction, the EM&V team reviewed NTG ratios established by four different entities—Nicor Gas and ComEd in Illinois (implemented as one program), Public Service Company of Oklahoma, Oklahoma Gas and Electric, and the collective PAs in Massachusetts. NTG ratios ranged from 65 to 100 percent. The Texas utilities' new homes programs' NTG of 64 percent appears reasonable compared to the benchmarked utilities but also indicates more can be done to increase the NTG ratio and net savings.

4.3.4.4 Considerations for Program Design and Delivery

For the Texas new homes programs, a confluence of factors continues to affect the NTG ratio for these programs, including the fact that many of the builders have been around for a number of years, there are a fair number of production builders, and energy building codes differ across areas. As noted earlier, the majority of home builders interviewed have been building homes through the Texas programs for two to five years, with some (4 of 12) noting they have been participating for 14, 15, even up to 20 years. On the one hand, given the longevity of the Texas new homes programs and their focus on changing building practices, it seems reasonable to assume that it has affected practices in nonparticipating homes and thus has generated spillover. On the other hand, the longevity of the Texas programs virtually assures a substantial number of free riders in the program. In fact, the EM&V team heard during interviews with participating builders that they are generally committed to building energy-efficient homes, whether there is a program incentive or not.

Builder comments from the interviews conducted by the EM&V team reflect the lower NTG ratio:

"Such a hard question. Like I said, everyone feels the same; there's no way you cannot do energy efficiency and still sell a house."

"We didn't know what the incentives were - everyone was happy because we got a rebate on some of this, but we had already decided how we were going to build our homes."

"We have always tried to be a step ahead on energy efficiency; when SEER was 10, we put in 12, we have always done radiant barriers, etc. So we were already doing a lot of these items."

"We don't do this because of the program; we put the stuff in the homes that we do to due right by the customer; it's the right thing to do."

"I'm not really doing anything more than what the competition and market is requiring."

"We've been building homes for so long this way, we just might not strive for the top tier."

Another major factor for new homes programs to contend with is building codes. While Texas has a statewide energy code (IECC 2015), several municipalities have adopted higher codes than what is required at the statewide level. A key challenge surrounding building codes is the enforcement of these codes. Without enforcement, it can often be the case that builders that are not participating in energy efficiency programs are not building to code. Given these challenges, the Texas new homes programs should continue to have their programs evolve as building codes evolve. For example, a couple of the new homes programs have already shifted their focus to a code-based energy savings goal (e.g., new homes must save 15 percent more kWh than a home built to code).

Two critical components to the new homes market that the EM&V team was not able to assess was the nonparticipating builder market and code compliance. A statewide market assessment that includes these two items would strengthen the research and provide further insight into the market and NTG issues.

Raters

The EM&V team spoke with at least one rater representative for each of the four new homes programs in Texas. Rater organizations included in the study vary by the number of home ratings annually (hundreds to thousands), and work with anywhere from three to upwards of "dozens" of builders. All three raters said they anticipate about the same amount of new homes business in 2020, even given the current COVID-19 pandemic. Many of the builders that these raters work with are building to ENERGY STAR standards or similar types of programs (e.g., Environments for Living®).

All three raters we spoke with work with builders across multiple utility new homes programs. The interviews probed these raters on differences in program requirements, marketing, program interactions, etc. by utility. Other than a few variations in program design, raters did not identify differences among the various utilities for this program.

Satisfaction

Raters were asked to rate their level of satisfaction with various elements of the program (very satisfied, satisfied, somewhat satisfied, and not satisfied). As reflected in Table 23, nearly all raters said they were *very satisfied* or *satisfied* with most of the areas discussed. Similar to builder satisfaction ratings, the responsiveness of program staff received the most *very satisfied* ratings, and *the ease of filling out and submitting required program documentation* received the most *not satisfied* ratings.

Table 23. Satisfaction with New Homes Programs Components

Program Component	Number Very Satisfied	Number Satisfied	Number Somewhat Satisfied	Number Not Satisfied	Total Responders
Overall program satisfaction	7	3	0	0	10
Ease of filling out and submitting required program documentation	4	3	0	3	10
Responsiveness of program staff to questions	10	0	0	0	10
On-site inspection process	2	7	1	0	10
Technical support	4	6	0	0	10

Program Requirements and Interactions

Most raters indicated that communication related to program requirements has continued to be pretty clear. When asked about what program requirements builders or subcontractors find hardest to meet, one rater said, "None, as long as the program requirements stay the same." This rater mentioned that, "Sometimes a particular house is not suited well to a duct blaster, so it may not pass, but in general the majority of houses are fine." One rater mentioned that HVAC documentation could be a challenge for subcontractors, particularly smaller ones because they have to have staff to enter the information. Sometimes submitting the AHRI certificate or making sure the subcontractor is completing Manual J forms is a challenge. The third rater mentioned that, due the differences across programs, it could be difficult for builders to understand and adjust their construction to meet program requirements when working across service territories. This rater also mentioned that there are situations where builders make agreements with utilities, but the rater is left out of the communication loop—this can lead to issues in builders meeting their obligations to the utilities.

While raters told us that their builders understand the program requirements, the raters take care of almost all program activities for their builders, helping to ensure program requirements are met. Raters told us they enter all program information into the required portals, from both the builder and rater perspectives. One rater mentioned that they provide their building files to the utility, but then are also required to enter the data on a website. Submitting the information twice can create an environment for human error, which can result in a home being rejected and an unhappy builder. As a result, this rater mentioned that streamlining the program requirements so they can stay on top of their paperwork would be very helpful. All three raters mentioned that they are receiving the support they need within a timely manner, which is also reflected in the number of raters rating *responsiveness of program staff* as *very satisfied*.

Similarly, raters we spoke with told us that the process for certifying to the IECC 2015 specifications is going fine. This energy code has been in place for a few years now, so other than a few potential outliers, raters told us that almost all builders work in jurisdictions that have adopted IECC 2015. Additionally, raters said that subcontractors know what the IECC 2015 requirements are and that the only additional training needed would be training done in Spanish.

Future Challenges and Recommendations

When asked what they think the biggest challenges are for constructing or selling energy-efficient homes going forward, two of the three raters noted code changes, and the third rater

said overcoming the perception that all new homes are energy efficient. Raters suggested that education is needed to change this perception and increase demand for energy-efficient homes.

"Just depends on where the code goes; foresee insulation of envelope of home will have to change."

"Code changes. The builders will just have to deal with it, and decide whether to go with above code programs."

"Perception that all new homes built these days are energy efficient; consumers take this for granted, and it's not true. Energy efficiency varies by builder. My company offers an energy guarantee."

When asked for suggestions about how the new homes programs participation process could be streamlined, one rater said that all three programs they work with are now allowing batch uploads. Because they work mainly with production builders, the batch upload process has been "really helpful." One rater said the input system is "clunky," and not working correctly. The third rater said their builders would like to have the ability to use "Docu-sign" documents; they don't want to have to print things out.

The most critical support the new homes programs could provide to raters in the near future is providing close communications related to programs and program changes.

"Help the raters communicate with their builders about how the programs are changing and have conversations about which path to compliance/best path to compliance for each builder. There have been times where program management staff tells the builders to do one thing, but the raters were telling the builders something else. Need to all work together more cohesively."

"Just continue to provide information and updates as to what matters for claiming savings, and make database updates."

4.4 UPSTREAM MARKET TRANSFORMATION PROGRAMS

Upstream market transformation programs were a *high* evaluation priority in PY2019 as they were relatively new in the Texas portfolio, but have been increasing as a percentage of statewide savings. EM&V activities included conducting desk reviews, gathering process information, and researching NTG ratios for these measures through retailer interviews triangulated with secondary research.

4.4.1 Program Overviews

Advanced Lighting MTP: The Advanced Lighting MTP offers point-of-purchase discounts to residential customers at participating retail stores for the purchase of qualified (i.e., ENERGY STAR-rated) high efficiency LED lighting products.

Retail Platform MTP: The Retail Platform MTP provides incentives to residential and small commercial customers through in-store discounts for qualifying ENERGY STAR-rated LED lighting and energy-efficient appliances.

Home Lighting MTP: The Home Lighting MTP offers customers in-store discounts for the purchase of LEDs through qualifying retailers.

Texas Appliance Recycling: The Texas Appliance Recycling program is designed to encourage customers to recycle old refrigerators and freezers.

Residential Recycling MTP: The Residential Recycling MTP offers customers no-charge pick-up services for old refrigerators and freezers and offers incentives for each unit picked up.

4.4.2 Key Findings and Recommendations

Key findings and recommendations are presented below based on the NTG research, tracking system review, and desk reviews conducted by the EM&V team.

Key Finding #1: The LED market is transforming but is not yet transformed.

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.

Recommendation #1a: Use an NTG of 50 percent to assess net savings of upstream lighting programs to ensure they are still a cost-effective mechanism to deliver savings to ratepayers.

Key Finding #2: Lamp quantities and savings are not clearly tracked in the data.

Previous guidance from the EM&V team for upstream lighting programs recommended five percent of upstream lighting program benefits and costs be allocated to commercial customers, with the remaining 95 percent allocated to residential customers. It is not clear from the tracking data if utilities are implementing this correctly. In some cases, the total quantity is tracked alongside the commercial quantity, but in others, only a single input for quantity is tracked. The EM&V team also found that in some cases, there were no indicators as to whether savings were calculated using the residential or commercial methodology.

Recommendation #2a: Utilities should consider tracking total lamp quantity, residential quantity allocation, and commercial quantity allocation along with corresponding savings in separate columns to verify the residential and commercial allocation is applied accurately.

Key Finding #3: Documentation does not clearly match the tracked data.

In some cases, the EM&V team found that invoices provided did not line up with the tracking data.

Recommendation #3a: Invoices should clearly show the total quantity of each incented lamp sold per store. The utilities should consider linking stores and invoices with a tracking data ID in the database for quality control purposes.

Key Finding #4: Some of the incented lamps were not ENERGY STAR-certified.

While it is acceptable to incent lamps that are not ENERGY STAR-certified, lamps still need to be third-party tested and qualify under the ENERGY STAR requirements. To ensure only high-quality equipment is incented, the TRM calls for products to be ENERGY STAR-qualified as outlined in the latest ENERGY STAR specification. In some cases, the EM&V team found that the incented lamps were not ENERGY STAR-qualified.

Recommendation #4a: For ease of implementation, utilities should consider requiring ENERGY STAR certification for incentivized upstream lamps. In lieu of ENERGY STAR certification, utilities should collect test results or other third-party certifications.

Key Finding #5: A utility allocated five percent of upstream lighting savings to the residential sector, rather than five percent of quantity.

This utility under-claimed savings for the commercial sector by allocating savings, rather than quantity. The commercial sector can claim higher annual savings per bulb since it assumes that bulbs in a commercial setting are used for more hours.

Recommendation #5a: Review the methodology to allocate savings to the commercial sector from upstream lighting programs and verify that savings are claimed based on quantity.

Key Finding #6: The appliance recycling programs appear to be tracking and calculating savings accurately.

The EM&V team found that the appliance recycling programs are collecting and tracking data and documentation properly, leading to realization rates of 100 percent for both energy and demand savings for each program.

Recommendation #6a: Utilities should continue QA/QC practices as those appear to be working.

4.4.3 Impact Analysis

As part of the impact evaluation, the EM&V team conducted desk reviews for a sample of projects from the upstream lighting and recycling MTPs. The EM&V team applied the method prescribed in the PY2019 TRM 6.0 to verify energy savings and demand reduction for each measure sampled.

The EM&V team conducted a tracking system review on the upstream lighting MTPs. Savings adjustments were not recommended for these programs due to the new nature of the programs. The process recommendations are a result of findings during the impact analysis.

The EM&V team conducted desk reviews on the appliance recycling MTPs. Random samples of five desk reviews were drawn from each utility with appliance recycling programs. The realization rate for these programs was 100 percent for both energy and demand savings.

4.4.4 Process and Net-to-Gross Results

Next, we present detailed process findings from participating upstream retailer interviews.

4.4.4.1 Respondent Firmographics

All 13 interviewees held either a managerial or supervisory role within their company and had experience with or a responsibility for lighting stocking and sales. Experience with lighting stocking and sales varied among those interviewed, with two interviewees reporting having less than six months of experience, six reporting one to ten years of experience, and four reporting more than ten years of experience. Twelve respondents were responsible for the lighting stocking and sales for one location. The remaining respondent was responsible for 47 stores in total, all of which have participated in the 2019 upstream lighting program.

4.4.4.2 LED Stocking and Sales Trends

Retailer interviewees report that most of the shelf space for lighting is devoted to LEDs. Four retailers reported that 80 percent or more of their shelf space is devoted LEDs, three additional retailers said LEDs take up about 70 percent or more of their lighting shelf space, and the remaining retailers could not provide a breakdown. One retailer who could not provide a breakdown because it changes depending on the products coming in and out; but did indicate most of the shelf space was dedicated towards LEDs, but that also varies by bulb type. When asked if the amount of shelf space devoted to the different bulb types has changed over the past year, six of eight respondents said that it has, citing reasons such as the marketing moving towards LEDs.

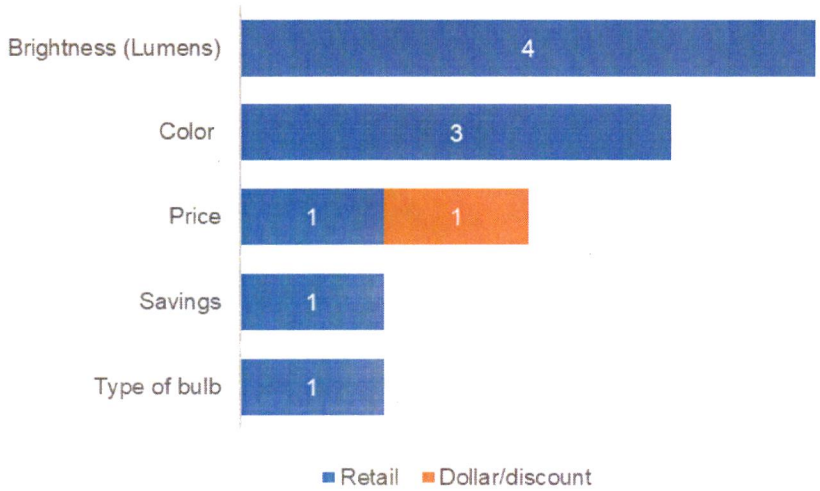
Most retailers (9 of 13 respondents) sold LED bulbs that were not discounted by the Texas upstream lighting programs, and some respondents also sell LEDs that are not ENERGY STAR-rated (6 of 12 respondents). As far as the sales of the bulbs, three respondents sold more ENERGY STAR-rated bulbs, two respondents sold more non-ENERGY STAR-rated bulbs, and one respondent indicated their sales of ENERGY STAR-rated and non-ENERGY STAR-rated bulbs were about the same.

Most respondents estimated that their sales of LEDs in 2019 were not discounted by the program, which ranged from 50 percent to 90 percent. Two respondents estimated sales of LEDs discounted by the program were 10 to 20 percent, and another two respondents were between 30 and 40 percent. Two respondents felt their sales were split in half between discounted and non-discounted. Five respondents had a hard time estimating the percentage of LEDs that were discounted by the program.

All eight retailers mentioned selling a wide variety of LED bulbs in 2019, including general use, spotlight, decorative, night lights, and holiday lights. Two respondents also mentioned selling fluorescent replacements, and one additional respondent also mentioned selling tubular LEDs.

Retailers identified the biggest factors customers typically look for in shopping for lighting products as the lumens or bulb brightness (4 respondents) and the color of the bulb (3 respondents). Other factors include the *price* (2 respondents), the type of lighting product needed (1 respondent), and the savings (1 respondent). Figure 27 shows factors determining customer lighting purchases as reported by different retailers.

Figure 27. Factors Determining Customer Lighting Purchases as Reported by Retailers



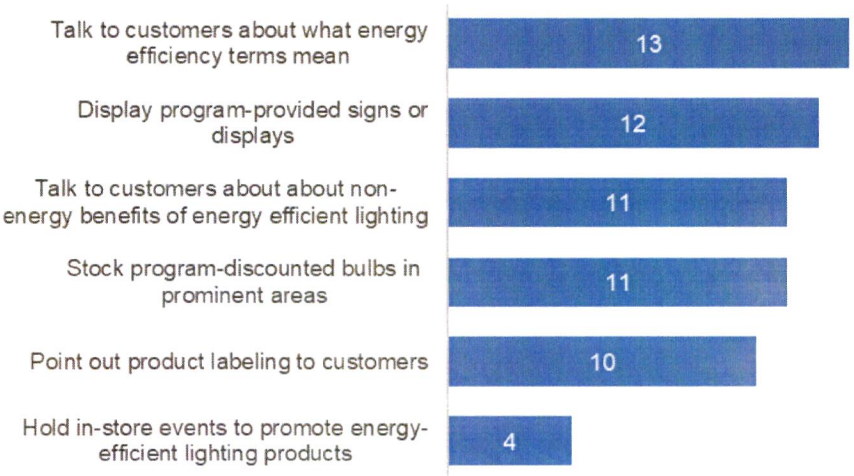
*Note: Multiple responses allowed.

4.4.4.3 Program Marketing

All but three retailers (10 of 13 respondents) mentioned receiving assistance from Texas upstream lighting programs to help sell energy-efficiency lighting by displaying program-provided signs and displays. One respondent indicated the program also aids through in-store promotional events as well as customer education via the in-store signage.

Most retailers reported taking several actions to promote and advertise program-eligible products in their stores. All 13 retailers said that they talk with customers about what energy efficiency terms such as *ENERGY STAR*, *lumens*, or *watt equivalence* mean, and all but one retailer displayed program-provided signs or displays. Most retailers also talk with customers about non-energy benefits of energy-efficient lighting such as reliability, light quality, or dimming ability, and stocking program-discounted bulbs in prominent areas such as endcaps, wings, or stack-outs (11 respondents each).

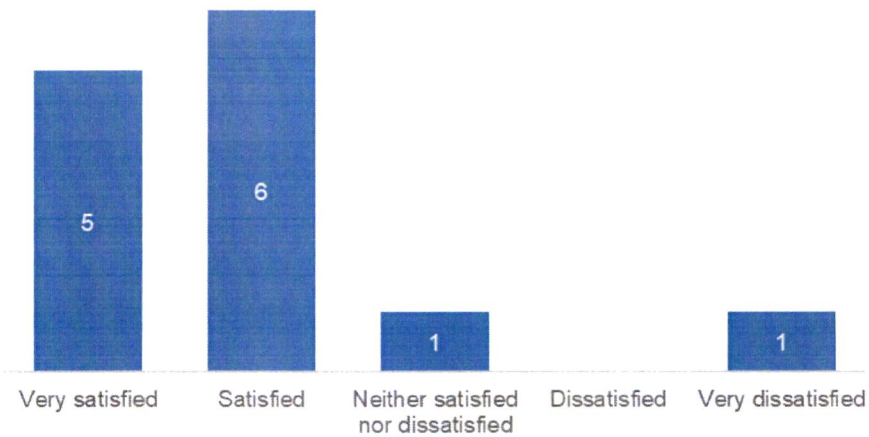
Figure 28. Activities Retailers do as Part of Program Participation (n=13)



4.4.4.4 Participant Experience and Satisfaction

Retailers reported high satisfaction with the program overall. Interviewees were asked to rate their satisfaction using the following scale: very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied, or very dissatisfied. Eleven of the 13 retailers interviewed said they were *very satisfied* or *satisfied* with the program. Interviewees most commonly mentioned that customers received a discount (5 respondents), that the program helped increase sales (3 respondents), and that program staff was helpful (2 respondents). Other reasons mentioned included the availability of signage and that customers are drawn to the bulbs (1 respondent each).

Figure 29. Retailer Satisfaction with the Program (n=13)



The one respondent, who indicated they were *very dissatisfied* with the program overall, indicated they did not have any information or education about the program, and that the only reason the respondent knew about Oncor is because of, "the little stickers," and the respondent thought they were, "not very explanatory." The one interviewee who said they were *neither*

satisfied nor dissatisfied with the program noted that they were not familiar with anyone coming in to discuss the program.

Four of the 13 respondents mentioned no changes were needed to the program. Of the remaining nine respondents who had a recommendation, the most common recommendation by retailers was the need for more or better signage or promotional materials (4 respondents). Three respondents mentioned more support from the project team by coming to the store to talk with the staff. Other responses included the need for training or better packaging due to products being broken upon arrival (1 respondent each).

Most retailers who indicated there were barriers to selling LEDs, identified the greatest barrier as understanding the technology (4 of 7 respondents). The aesthetic, price, and availability were also factors that prevented retailers from selling LEDs (1 respondent each).

Net-to-Gross Results

To support the LED NTG analysis, the EM&V team used a triangulated approach using telephone interviews with participating upstream retailer stores, a review of proprietary manufacturer sales data and benchmarking from similar utility programs.

For each of the evaluation activities, free-ridership rates were estimated, and NTG ratios were calculated using the following equation:

$$NTG\ Ratio = 1 - Free\text{-}Ridership$$

Based on the collective results of the evaluation activities, the EM&V team recommends an NTG ratio of 50 percent. Table 24 shows the free-ridership and NTG result estimates by analysis activity. The retailer interviews, when weighted by the number of bulbs sold, yielded the highest free-ridership (70 percent), while the retailer interview not weighted by bulbs sold also yielded the lowest free-ridership (42 percent). It is important to consider both given the limited sample size. The EM&V team also believes manufacturer sales data is an accurate gauge of market transformation and NTG. The EM&V team reviewed proprietary sales data from manufacturers and found the retailer 50 percent NTG recommendation is supported by recent data of halogen and LED sales. Interesting, further supporting this recommendation is very recent data of sales during the pandemic suggesting an uptick in halogen sales.

Table 24. LED Free-Ridership and Net-to-Gross Result Estimates

Method	Free-ridership estimate	Net-to-gross estimate
Retailer NTG* weighted	70%	30%
Retailer NTG* unweighted	42%	58%
Manufacturer data	40 to 50%	50% to 60%
Utility program benchmarking	33% to 81%	19% to 67%
Final recommendation	**50%**	**50%**

*NTG results are weighted by program savings at the retailer level and ranged between 8 percent and 100 percent between CenterPoint, Oncor, and Xcel Energy. Overall unweighted NTG results were 58 percent.

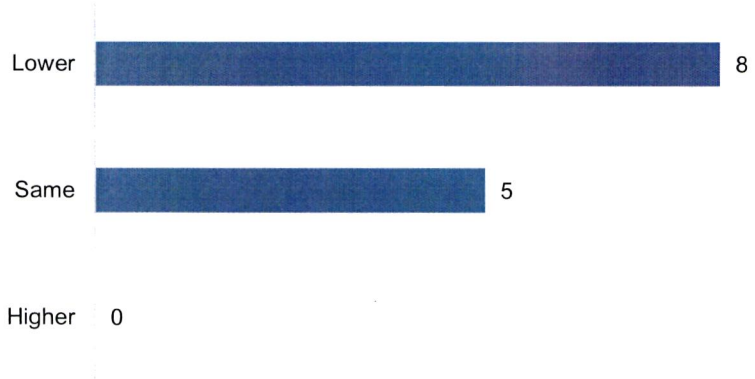
The following sections detail the NTG result estimates by evaluation activity.

4.4.4.5 Retailer Interviews

To assess free-ridership for participating retailers, thirteen retailers were asked to estimate what the change in their 2019 sales of program-qualifying equipment would have been if the program discounts had not been available. The survey asked, "If the price discounts and other assistance from the program had not been available, do you think your sales of these LED bulbs would have been the same, lower, or higher in 2019?" If the response was *the same* or *higher*, then the program did not influence sales, and free-ridership is 100 percent.

Eight of the 13 participating retailers reported program influence on LED sales in 2019 (see Figure 30below). After weighing the results using the retailer's annual savings, free-ridership was estimated to be 70 percent for an NTG ratio of 30 percent.

Figure 30. 2019 Sales Effect in the Absence of the Program (n=13)



Retailers that said LED sales would have been the same indicated this was because LEDs are now the primary option available for lighting purchases and because people already come in knowing what type of bulb they want. Comments from the retailers:

"I can point out that the sticker says these bulbs are at this price due to [utility]. I don't have one customer I can remember asking me, 'where are those light bulbs that are discounted by [utility]?' The general consumer that comes in here looking for bulbs, one way or another, they don't care about the [utility] discount. I mean, you can point it out to them, but they just want cheapness and a certain color. If they see an LED light bulb that costs $15 and one that costs $5, they're going to take the $5 one. GE makes three different bulbs: basic, classic, and HD. The people will often buy the basic because it's the cheapest."

"I'm not saying they're not looking at the price; they want a certain type of bulb the one they have in their house. They don't care about the price; they want to get the same thing that they already have."

"Because everything is going to LED. What really makes me think it would be the same is because you come in now, and the only selection that you have is LED. If 90 percent of our selection is LED, they're going to pick up LED, and almost all of our LEDs are ENERGY STAR-rated."

4.4.4.6 Review of Manufacturer Sales Data

The EM&V team reviewed proprietary sales data from manufacturers and found halogen and LED sales data supports the 50 percent NTG recommendation. During the pandemic, manufacturers are also showing an additional uptick in halogen sales and suggest there may be longer-term effects from the pandemic.

4.4.4.7 Net-to-Gross Benchmarking

Benchmarking of other utility LED upstream lighting programs was conducted. The EM&V team looked at NTG results from nine utility programs with research from either PY2018 or PY2019. NTG results ranged between 19 percent and 67 percent. The benchmarking research supports the reasonableness of the EM&V team's NTG recommendation of 50 percent.

Table 25. LED Upstream Lighting Program Net-to-Gross Benchmark

Utility	State	Year	NTG Ratio	Program Type	Net-to-Gross Summary
Entergy Arkansas, LLC	AR	2019	53%	Lighting and appliances retailer programs	Price elasticity model found 77 percent free-ridership, retailer surveys yielded 47 percent free-ridership.
Southwest Electric Power Company (SWEPCO) Arkansas	AR	2018	67%	Lighting and appliances retailer programs	Price elasticity model found 33 percent free-ridership, recommended NTG ratio higher as spillover included.
Massachusetts Program Administrators	MA	2019	35%	PAs, EEAC consultants, and evaluators to review and discuss retrospective and prospective NTG estimates	Prospective results recommended an NTG of 30 percent in 2020 and 25 percent in 2021.
PECO Energy Company	PA	2019	51%	Lighting, appliances, and HVAC programs (standard LEDs)	Free-ridership for standard LEDs is 53 percent with a spillover ratio of 4 percent.
PECO Energy Company	PA	2019	46%	Lighting, appliances, and HVAC programs (specialty LEDs)	Free-ridership for specialty LEDs is 58 percent with a spillover ratio of 4 percent.
Duquesne Light Company	PA	2018	43%	Energy efficient products programs (standard and specialty LEDs)	Also had a free kit component (8 bulbs), estimated an installation rate of 75 percent.
FirstEnergy Met-Ed	PA	2019	32%	Energy efficient products programs (retailer survey)	Including results from a general population survey, NTG is 29 percent.

5.0 CROSS-SECTOR PROGRAMS

This section presents results found in the evaluation of the commercial and residential programs that apply to measures that are offered to both sectors as follows: multifamily and HVAC tune-ups.

HVAC tune-ups continued as *medium* evaluation priorities in PY2019 as savings recommendations from the PY2017 EM&V were to be fully implemented in PY2019. However, some additional changes were still identified in PY2019 as the mix of tune-ups has become increasingly residential and commercial instead of primarily residential.

This section summarizes the key findings and recommendations from the PY2019 evaluation of AC and HP tune-ups. The recommendations in this report are to be considered by the utilities for PY2021 implementation and will also be incorporated into the PY2021 Texas TRM 8.0.

5.1.1 Background

One of the key recommendations from the PY2016 Statewide Portfolio Report was that calibration of the model used to develop the stipulated efficiency losses[20] should be conducted annually by including the most recent year's M&V data. Additionally, the report also recommended using a three-year rolling average to include changes in the efficiency loss over time while also preventing drastic changes in program savings that can result from using a single year's values. The PY2016 efficiency loss values for the residential population were unexpectedly low, and recommendations were made to monitor the efficiency loss values on an annual basis to determine if (1) PY2016 reflected a decreasing trend over time or (2) if it was an outlier. Monitoring the efficiency loss values remained important because PY2016 data was still used within PY2019 calculations using a rolling average of the previous three years of program data. Since PY2016, efficiency loss values have been on an upward trend for all sectors and refrigerant charge adjustment status.

In PY2019, over 10,000 tune-ups were provided to residential and commercial customers through four Texas utilities across five different programs, as shown below in Table 26.

[20] Efficiency loss is the ratio of the air conditioner's measured efficiency before and after a tune-up.

Table 26. PY2019 Tune-Up Summary by Utility and Program

Utility	Market Transformation Program	Energy Savings		Tune-Up Count
		Reported kW	Reported kWh	
AEP Texas – Central Division	CoolSaver	3,845	9,162,373	4,057
CenterPoint	Retail Electric Provider CoolSaver	3,962	10,064,848	6,193
El Paso Electric	Residential Solutions	12	21,848	15
	Small Commercial Solutions	1	1,486	2
Entergy Texas	CoolSaver	38	95,744	63
Total		**7,859**	**19,346,299**	**10,330**

5.1.2 Key Findings and Recommendations

Key findings and applicable recommendations are presented below based on the information gathered in reviews across multiple utilities as well as discussions with the implementation contractor.

Key Finding #1: Test-in energy efficiency ratio (EER), on average, is lower than in previous years.

Recommendation #1a: Continually monitor all trade allies' test-in data to identify low EER trends from specific contractors.

Key Finding #2: M&V data from both Texas and New Mexico was used to develop the efficiency loss values used in reported savings calculations.

During the review of the PY2019 M&V plan, 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 requested that all efficiency loss factors be developed using only data from the state of Texas to avoid any influence from other outside regions and weather zones. The EM&V team re-calculated the efficiency loss values using only the 2016—2018 Texas M&V data, which was then used in the evaluated savings calculations. The Texas-only efficiency loss values were nearly identical to the Texas and New Mexico values presented in the M&V plan due to the small sample size of the New Mexico M&V data, which resulted in a minimal evaluated savings adjustment. The EM&V team recommends using only M&V data from the state of Texas to determine efficiency loss values in future evaluations.

Recommendation #2a: Utilize only M&V data from Texas to determine efficiency loss values.

Key Finding #3: Greater than 10 percent of tune-ups received both test-in and test-out M&V field measurements across all stratifications.

In PY2019, approximately 17 percent of tune-up measures in Texas collected both test-in and test-out M&V field measurements by the programs—referred to as *full M&V*—which is a slight decrease in percentage from the last evaluation in PY2017, but still well beyond the ten percent M&V goal. Despite the slight overall decrease in M&V percentage, the total commercial project percentage increased from 6 percent in PY2017 to 11 percent in PY2019. Both residential and

commercial sectors achieved beyond their 10 percent goal, which imparts confidence in the calculated efficiency loss values for both sectors. The EM&V team recommends continuing to monitor M&V data collection quantities across sectors to maintain the ten percent M&V sample across both commercial and residential.

Table 27. Measurement and Verification Tune-Up Counts by Sector

Utility	Sector	Tune-Up Count	Measurement and Verification Count	Measurement and Verification Percentage
AEP Texas – Central Division	Commercial	2,144	249	12%
	Residential	1,913	320	17%
CenterPoint	Commercial	407	23	6%
	Residential	5,786	1,153	20%
El Paso Electric	Commercial	2	2	100%
	Residential	15	3	20%
Entergy Texas	Residential	63	7	11%
Total	**Commercial**	**2,553**	**274**	**11%**
	Residential	**7,777**	**1,782**	**23%**

Recommendation #3a: Tune-up measures should continue to collect a robust M&V sample for both commercial and residential projects.

5.1.3 Reported Tune-Up Savings Methodology

As part of the PY2016 evaluation, the M&V team recommended using a three-year rolling average of efficiency loss data obtained from tune-ups statewide in Texas by sector (residential and commercial), and by whether a refrigerant charge adjustment was applied. In PY2019, the implementer used data from both Texas and New Mexico tune-ups to develop the efficiency loss factors. After a discussion with the Texas PUC, tune-up data exclusively from Texas was required to be used for the evaluation. The reported PY2019 efficiency loss analysis is presented in Table 28. The reported efficiency loss factors include M&V data from both Texas and New Mexico, and the evaluated efficiency loss factors include M&V data from only Texas. When compared to the reported efficiency loss values, the residential sector—without a refrigerant charge adjustment—was the only sector whose efficiency loss value changed when analyzing data from only Texas. In discussion with the implementer, this was due to a small sample size from New Mexico, which did not impact the evaluated efficiency loss vales much when removed from consideration.

Table 28. Reported Efficiency Loss Values (PY2016–2018 Averages)

Sector	Refrigerant Charge Adjusted	Reported Efficiency Loss Factor	Evaluated Efficiency Loss Factor
Commercial	No	0.143	0.143
	Yes	0.204	0.204
Residential	No	0.110	0.109
	Yes	0.175	0.175

Approximately 10 percent of tune-ups are anticipated by the CoolSaver program to receive full M&V in a given year for use in the annual efficiency loss updates. Table 29 shows the total tune-ups and M&V quantities by utility that were completed in PY2019. All four utilities were above 10 percent on their tune-up projects, which helped bring the statewide average to 17 percent.

Table 29. PY2019 Measurement and Verification Summary by Utility

Utility	Tune-Up Count	Measurement and Verification Count	Measurement and Verification Percentage
AEP Texas – Central Division	4,057	569	14%
CenterPoint	6,193	1,176	19%
El Paso Electric	17	5	29%
Entergy Texas	63	7	11%
Total	**10,330**	**1,757**	**17%**

5.1.4 Evaluation, Measurement, and Verification Approach

As a first step, the EM&V team conducted a complete tracking system review for all four utilities that reported tune-ups in 2019. The review was then followed by an in-depth review of the M&V sample collected in the field by the programs and an analysis of the current program year's efficiency losses. The implementer provided a combined M&V dataset for tune-ups in Texas from 2016 through 2018. The efficiency loss factors calculated by the EM&V team were the key savings assumption for this measure.

As part of the EM&V team's evaluation, a comprehensive review of the full M&V sample from 2016 through 2018 was completed. The tracking datasets from 2016 through 2018 were combined into a single dataset for analysis. The combined M&V dataset included 5,229 individual tune-ups collected by the programs over the previous three program years. Each tune-up measure was tested to assure data validity before analysis of the efficiency loss values. Before the analysis of the full M&V sample, the EER_{pre} and EER_{post} values were validated as appropriate when they were greater than zero for both values. Seven tune-ups were found invalid per the EER check and were excluded from further analysis.

A total of 5,222 tune-up measures passed data checks and were considered valid. Next, the dataset was separated for tune-ups with an refrigerant charge adjustment (RCA) and without an RCA. This resulted in identifying 1,929 tune-ups without an RCA and 3,293 tune-ups with an RCA.

Both datasets were reviewed for outliers. Outliers can occur for various reasons, but one of the most common reasons is due to a unit that is not tested at full-load conditions in either the pre- or post-tune-up case. The outlier review was accomplished by calculating and comparing the pre- and post-tune-up compressor powers using the data fields for *CompressorVolts* and *CompressorCurrent*. Since all testing is supposed to occur at or near full-load conditions, a difference in the compressor power between pre- and post-tune-up measurements indicates one of the two measurements may not have been conducted at full load conditions. The differences between the compressor power values were then divided by the nominal tonnage of the units to normalize the differences by capacity. Finally, the statistical ranges of the resulting values were analyzed, and any value that was more than three standard deviations from the

mean was excluded from the efficiency loss calculations. A total of 137 tune-ups were identified as outliers from the compressor power test and excluded from the analysis.

5.1.5 Results

The number of M&V tune-ups validated by year, including all M&V data, is presented in Table 30. PY2016 and PY2017 were the two years with the lowest exclusion rates since 2011 when data was available. PY2018 however, saw a substantial uplift in the number of exclusions and represents the highest exclusion rate since data collection began in PY2011. This uplift was primarily driven by one trade ally who completed 114 of the 126 projects and noted by the EM&V team.

Table 30. All Measurement and Verification Tune-Ups Validated by Year

Year	Total Measurement and Verification Projects	Passed Data Checks	Total Projects Excluded	Exclusion Rate
2016	1,265	1,255	10	0.8%
2017	1,614	1,606	8	0.5%
2018	2,350	2,224	126	5.7%
Total	**5,229**	**5,085**	**144**	**2.8%**

Table 31 below shows the average test-in and test-out EERs by program year along with the standard deviation. Average test-out EERs remained similar across all three program years. Test-in EERs for PY2018, however, saw a drastic decrease compared to PY2016 and PY2017. The PY2018 average test-in EER was 15.9 percent lower than the weighted average between PY2016 and PY2017. This decrease in average test-in EER was present across all participating utilities.

Table 31. Average Test-In and Test-Out Energy Efficiency Ratio by Year

Year	Total M&V Projects	Average Test-In EER (AHRI Corrected)	Test-In Standard Deviation	Average Test-Out EER (AHRI Corrected)	Test-Out Standard Deviation
2016	1,265	9.86	3.14	10.77	2.39
2017	1,614	9.42	2.80	10.71	2.25
2018	2,350	8.08	2.59	10.62	2.24
Total	**5,229**	**8.92**	**2.90**	**10.68**	**2.28**

Table 32 shows the PY2018 average test-in and test-out EERs by trade ally along with the standard deviation. The trade ally names have been removed to remain anonymous. The EM&V team identified trade ally #1 as being an outlier, which is the previously mentioned trade ally that completed 114 of the 126 projects that were initially excluded from the sample. They completed a large number of projects with a low average test-in EER.

Table 32. PY2018 Average Test-In and Test-Out Energy Efficiency Ratio by Trade Ally

Trade Ally	Total Measurement and Verification Projects	Average Test-In EER (AHRI Corrected)	Test-In Standard Deviation	Average Test-In EER (AHRI Corrected)	Test-Out Standard Deviation
1	369	6.53	2.00	10.19	1.82
2	31	9.08	1.43	10.50	1.38
3	259	7.95	2.84	10.62	2.85
4	265	8.74	1.75	10.52	1.49
5	5	9.79	2.37	12.71	1.67
6	25	6.86	2.51	10.82	1.74
7	47	7.36	2.51	9.40	1.54
8	8	4.90	3.05	9.26	2.76
9	3	10.86	1.08	12.13	1.53
10	5	10.42	2.71	13.08	1.33
11	1	12.18	N/A	12.50	N/A
12	1	7.44	N/A	8.19	N/A
13	35	8.93	1.74	11.00	1.67
14	188	9.68	2.16	11.65	2.38
15	3	11.93	2.90	12.22	1.95
16	268	6.46	2.32	10.29	1.98
17	69	8.42	2.26	10.29	2.05
18	54	9.20	2.42	11.20	2.53
19	7	7.61	2.60	10.02	1.65
20	2	9.30	0.91	10.17	0.09
21	2	9.39	1.33	14.17	2.57
22	1	9.05	N/A	9.68	N/A
23	4	8.69	4.26	11.92	3.11
24	316	8.71	2.22	10.78	2.11
25	56	8.14	1.82	10.38	1.60
26	23	5.98	2.82	9.17	2.22
27	7	10.43	2.76	11.91	2.29
28	4	10.81	4.49	11.58	4.66
29	5	7.74	0.88	10.51	2.19
30	2	8.49	1.29	9.27	2.29
31	1	8.87	N/A	10.20	N/A
32	72	9.47	2.33	11.41	2.33

Trade Ally	Total Measurement and Verification Projects	Average Test-In EER (AHRI Corrected)	Test-In Standard Deviation	Average Test-In EER (AHRI Corrected)	Test-Out Standard Deviation
33	212	8.92	3.13	10.73	3.01
Total	**2,350**	**8.08**	**2.59**	**10.62**	**2.24**

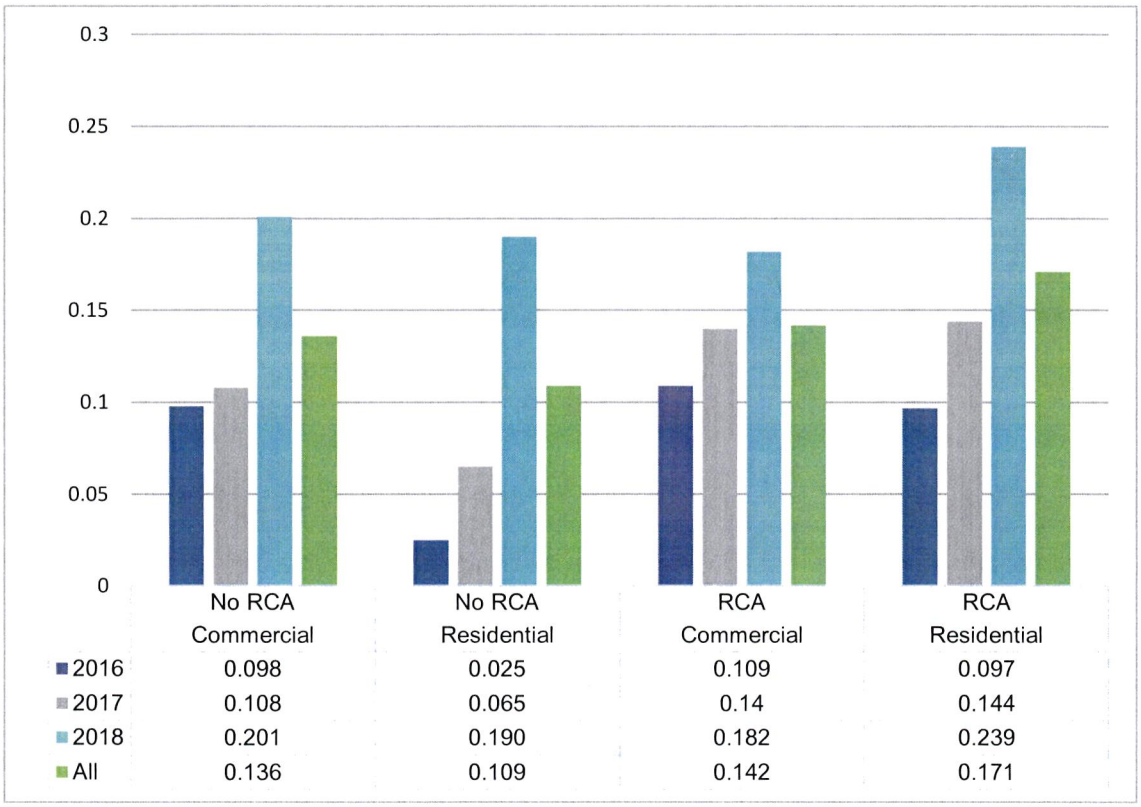
Because trade ally #1 was found to have an average test-in EER lower than the population average with a relatively small standard deviation, removing this trade ally reduced the total M&V projects in PY2018 to 1,981. The impact of removing this trade ally can be seen in Table 33. Removing this one trade ally impacted the mean and standard deviation of the entire PY2016 thru PY2018 sample, which impacted exclusions from all years.

Table 33. Final Measurement and Verification Tune-Ups Validated by Year

Year	Total M&V Projects	Passed Data Checks	Total Projects Excluded	Exclusion Rate
2016	1,265	1,249	16	1.3%
2017	1,614	1,598	16	1.0%
2018	1,981	1,945	36	1.9%
Total	**4,860**	**4,792**	**68**	**1.4%**

The 4,860 Texas tune-ups that passed the data checks were then analyzed by year, by sector (i.e., residential, commercial), and status. The results are shown in Figure 31. In all sectors and RCA status, the average loss value increased every year, with the largest increase observed in PY2018. This increase is attributed primarily to the lower average test-in results than observed in previous years.

Figure 31. Texas Average Efficiency Losses by Sector, Year, and Refrigerant Charge Adjustment



5.2 MULTIFAMILY

5.2.1 Program Overviews

Multifamily buildings receive incentives from both residential and commercial incentive programs using the residential and HTR SOP and MTP delivery. Multifamily buildings receive incentives for a wide range of measures similar to single-family homes. If the buildings are master metered, the energy savings and incentives are provided by the commercial programs, while units that are individually metered are included in the residential programs. The measures provided to any multifamily units are identical and include, but are not limited to, lighting, water-saving, envelope, and HVAC measures.

The evaluation of multifamily buildings this year was completed through the residential consumption analysis methodology described in Section 4 and through the commercial programs method described in Section 3.