Public Utility Commission of Texas

Volume I—Statewide Energy Efficiency Portfolio Report Program Year 2017

TETRA TECH

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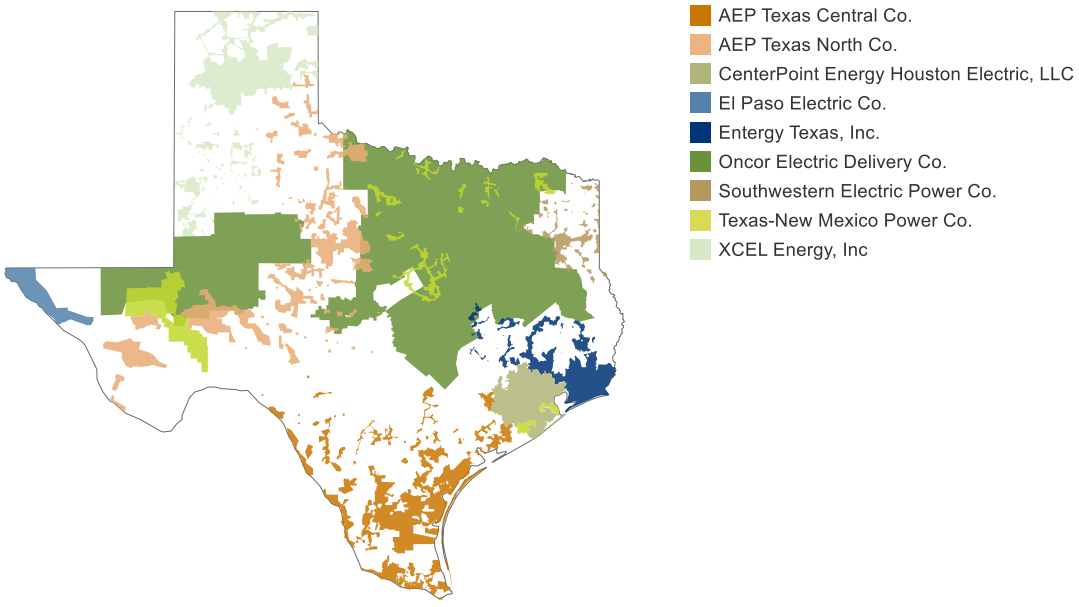
1.0 EXECUTIVE SUMMARY

The Public Utility Commission of Texas (PUCT) oversees the energy efficiency programs delivered by the state's investor-owned electric utilities: American Electric Power Texas[1] (AEP Texas), CenterPoint Energy Houston Electric, LLC (CenterPoint), Entergy Texas, Inc. (Entergy), El Paso Electric Company (El Paso Electric), Oncor Electric Delivery (Oncor), Sharyland Utilities, L.P. (Sharyland),[2] 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 1-1 below.

Figure 1-1. Territories of Regulated Electric Utilities in Texas



In program year (PY) 2017, the Texas electric utilities achieved statewide energy savings of 561,606,260 kWh and demand reductions of 465,874 kW at a lifetime savings cost of $0.009 per kWh and $20.05 per kW.

The Texas electric utilities' programs improve the energy efficiency of residential and commercial customers through standard offer programs (SOPs) and market transformation programs (MTPs). SOPs support an infrastructure of contractors ("energy efficiency service providers" (EESPs)) delivering equipment and services directly to customers. Implementation contractors selected by the utilities deliver MTPs that provide additional outreach, technical assistance, and education to customers in harder-to-reach markets (e.g., small business, health care, schools, and local governments) and/or for select technologies (e.g., recommissioning, air conditioning tune-ups, pool pumps). All utilities provide

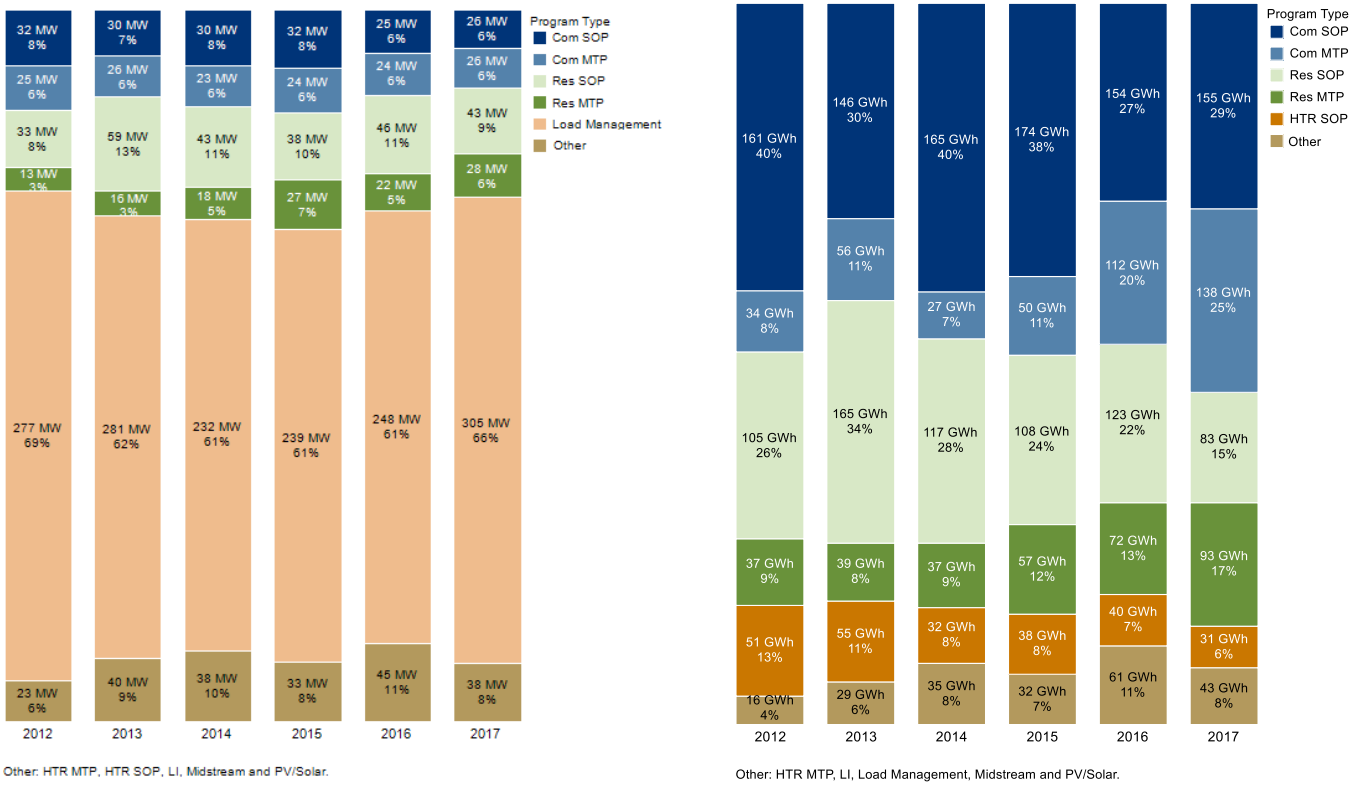
[1] Effective December 31, 2016, AEP Texas Central Company (AEP TCC) and AEP Texas North Company (AEP TNC) merged into their parent company, AEP Utilities, which was renamed AEP Texas Inc. At that time, AEP TCC and AEP TNC became divisions of AEP Texas – AEP Texas Central Division and AEP Texas North Division. This report continues the use of AEP TCC and AEP TNC to refer to the predecessor utilities of AEP Texas as well as the divisions of AEP Texas.

[2] In November 2017, Sharyland Utilities, L.P. (Sharyland) and Oncor Electric Delivery Company LLC (Oncor) successfully closed their proposed transaction. As a result, all of Sharyland's approximately 54,000 retail distribution customers are now served by Oncor. Sharyland's 2017 territory is shown as Oncor in Figure 1-1.

energy efficiency offerings to low-income customers through hard-to-reach (HTR) programs that are delivered in a way similar to the residential SOPs. Some utilities also offer targeted low-income (LI) programs that coordinate with the existing federal weatherization program. Finally, the utility portfolios include load management programs, which are designed to reduce peak demand.

As shown in Figure 1-2, commercial sector savings are slightly more than half from the statewide total (CSOP and CMTP categories comprise 54 percent of PY2017 savings) and somewhat less than half come from the residential sector (RSOP, RMTP and HTR categories comprise 38 percent of PY2017 savings). Commercial SOPs continue to be the program type that accounts for the largest percent of statewide energy savings, accounting for almost a third, although CMTP accounted for a quarter of statewide savings. PY2017 has seen a larger percent of statewide savings coming from RMTPs and less savings coming from RSOPs with LI/HTR savings holding steady over the four years. Load management programs continue to account for more than 60 percent of the statewide gross demand reduction.

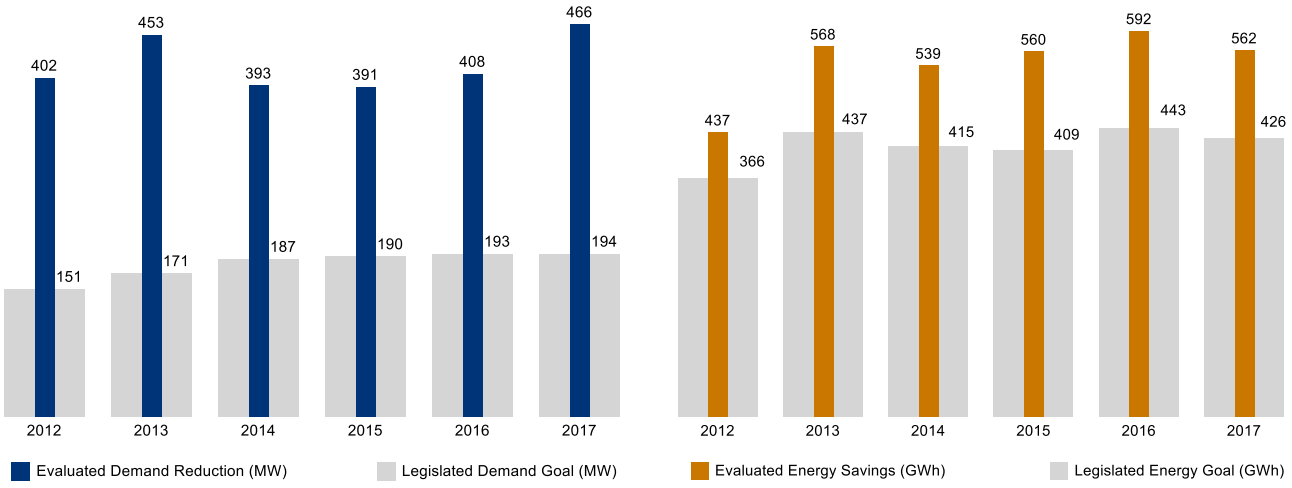
Figure 1-2. Evaluated Gross Demand Reduction Energy Savings by Program Type (PY2012–2017)



* percent of total annual statewide savings contained in bar.

As shown in Figure 1-3 below, statewide, the utilities are significantly exceeding demand reduction goals in large part due to the load management programs. The utilities also are consistently exceeding energy savings goals.

Figure 1-3. PY2012–2017 Legislated Goals and Actual Demand Reduction and Energy Savings



1.1 EM&V OVERVIEW

In 2011, the Texas Legislature enacted SB 1125, which required the Public Utility Commission of Texas (PUCT) to develop an evaluation, measurement, and verification (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 (TAC), relating to Energy Efficiency Goal (Project No. 39674).

The PUCT selected a third-party 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' PY2017 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[3]
- Provide feedback to the PUCT, utilities, and other stakeholders on program portfolio performance
- Prepare and maintain a statewide Technical Reference Manual (TRM).[4]

This Statewide Annual Portfolio Report presents the PY2017 EM&V findings and recommendations looking across all ten electric utilities' portfolios. It addresses gross and net energy and demand impacts, program cost-effectiveness, and provides feedback on program portfolio performance. In

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

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

addition, it includes findings and recommendations related to measure savings to inform updates to the TRM.

The EM&V scope targets evaluation activities (tracking system reviews, engineering desk reviews, on-site M&V, interval meter data analysis, and participant surveys) to savings areas of the highest uncertainty based on prioritization of high, medium, or low. Commercial standard offer programs (CSOP) and the largest savers of the commercial market transformation programs (MTPs) are "high" priority as these programs continue to represent the largest percentage of statewide savings and have plans to explore new customer segments and technologies. The residential standard offer programs (RSOPs) and hard-to-reach (HTR) programs as a "high" evaluation priority for PY2017 because utilities are responding to changes in the TRM for common RSOP and HTR measures. These programs also comprised a substantial percentage of overall statewide portfolio savings in PY2017, and EM&V has recommended expanding the measure mix in these programs.

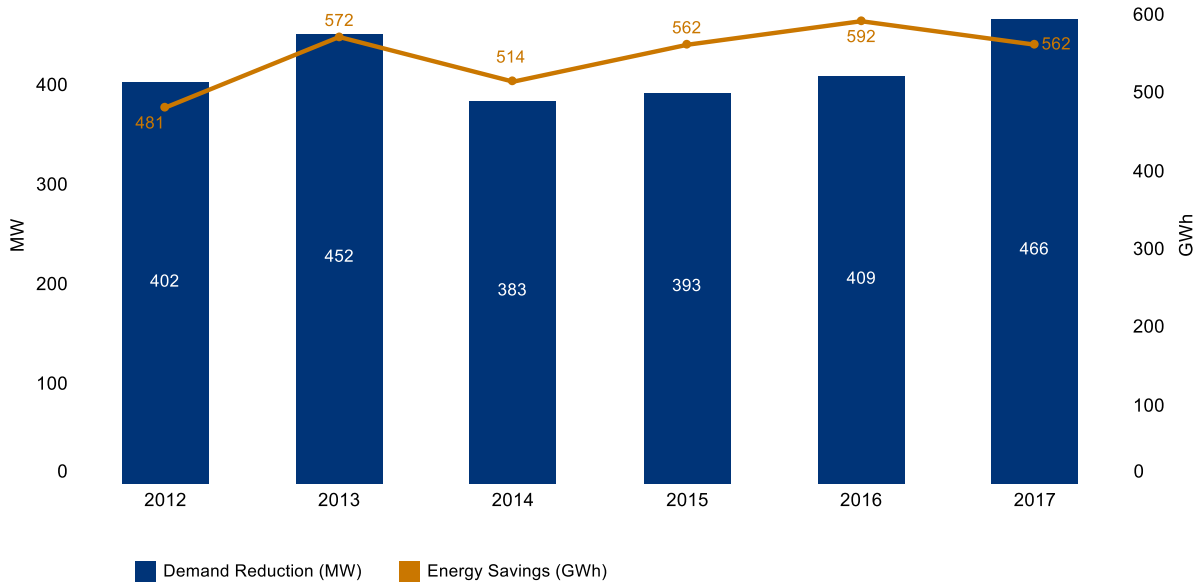
Load management programs are designated a "medium" priority due to their significant contribution to capacity (kW) savings and the new nature of the residential demand response programs, as well as recent changes in TRM methodologies for the commercial load management programs. Both commercial and residential solar projects also received a "medium" priority in PY2017 due to TRM changes in the methodology from deemed values to a M&V approach. Air conditioning tune-ups continue as "medium" priority in PY2017 as savings recommendations from the PY2014 EM&V were to be fully implemented in PY2017, but some additional changes were still identified in the PY2016 EM&V for PY2017 as the mix of tune-ups has become increasingly residential and commercial instead of primarily residential. All other program types are "low" priorities for evaluation in PY2017 because they are small contributors to portfolio savings, have little uncertainty in savings, and/or have fairly homogenous deemed savings projects that have seen healthy realization rates in the prior program years' EM&V. The one exception to this is residential new construction which is a "low" priority in PY2017 due to program changes planned for PY2018 to respond to an increased baseline and therefore a higher priority planned then.

1.2 EM&V KEY FINDINGS

Utilities' evaluation results are positive, as demonstrated by the close agreement between reported and evaluated savings and the continued cost-effectiveness of the programs. In addition, the PY2017 EM&V participant research found high-levels of customer satisfaction and that the programs are significantly influencing energy efficiency decisions, with the majority of researched program savings directly attributable to program offerings.

Evaluated gross demand reductions across all the utilities' programs were 465,874 kW. As indicated below, the demand reduction is an increase from prior years. Evaluated gross energy savings were 561,606,260 kWh and PY2017 saw a slight decrease in energy savings from PY2016 but was the same as PY2015.

Figure 1-4. Total Statewide Portfolio: Evaluated Gross Demand Reduction and Energy Savings by Program Year



The utilities' proactive engagement of the EM&V team upfront when specific project or savings question arise as well as the utilities' responsiveness to the EM&V team's recommended savings adjustments also contributed to evaluated savings being very similar to utilities' claimed savings. The EM&V recommended savings adjustments to which utilities fully responded in PY2017 are identified in Table 1-1. Unique to PY2017, adjustments also included sampled projects affected by Hurricane Harvey. While the Hurricane Harvey recommended adjustments were minimal, the applicable utilities (AEP TCC and CenterPoint) were fully responsive to these recommendations as well, as shown in Section 7.

Table 1-1. EM&V Claimed Savings Adjustments by Utility

Utility	EM&V Demand Claimed Savings Adjustments (kW)	EM&V Energy Claimed Savings Adjustments (kWh)
AEP TCC	338	-558,524
AEP TNC	40	-47,775
CenterPoint	501	-110,170
El Paso Electric	200	-72,106
Entergy	-36	-5,602
Oncor	13,651	-14,817
Sharyland	-3	-5,316
SWEPCO	-6	-33,544
TNMP	-6	-19,069
Xcel Energy	-6	-8,911

The statewide cost-effectiveness remains above a 2.0 using the program administrator cost test in PY2017. Cost-effectiveness has decreased since a high in PY2013 of 3.4. The decreased cost-effectiveness has been largely driven by lower avoided costs of energy as seen in Figure 1-5.

Figure 1-5. Statewide Evaluated Gross Cost-Benefit Ratio and Avoided Cost by Program Year

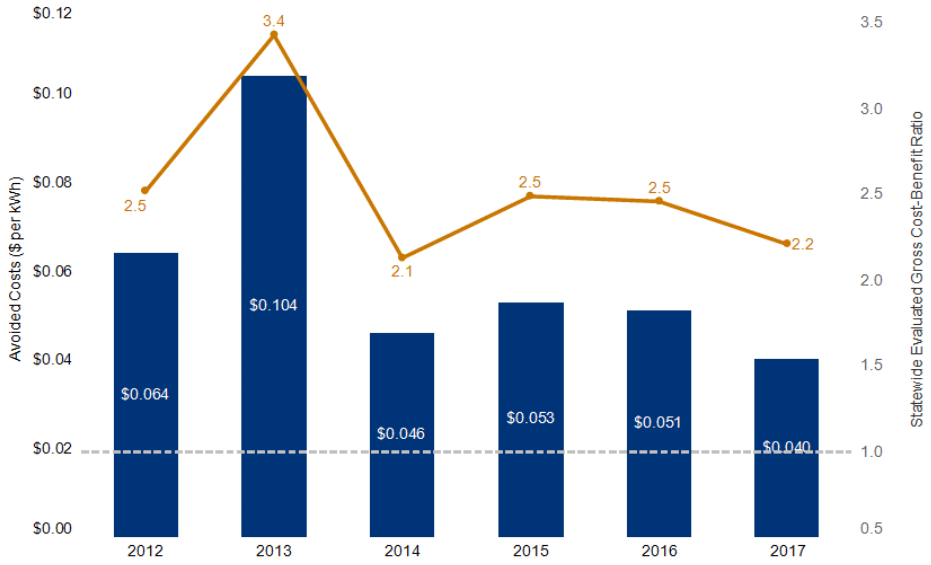
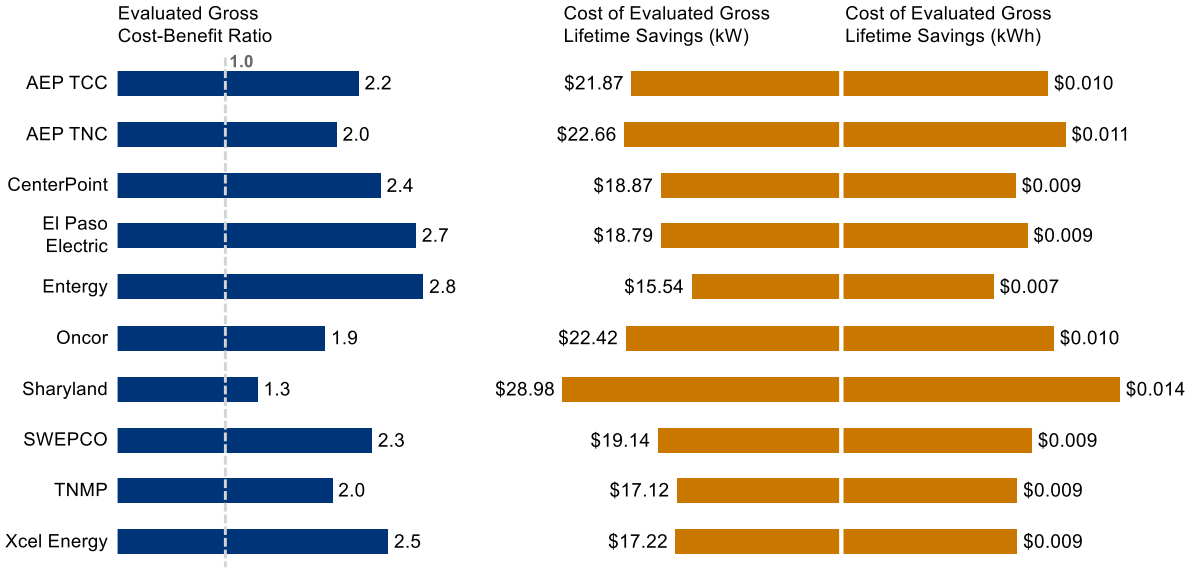


Figure 1-6 summarizes the cost-effectiveness of each utility's energy efficiency portfolio based on evaluated savings and including low-income programs. All portfolios were cost-effective, ranging from 1.3 to 2.8. The cost per kW ranged from $15.54 to $28.98 and the cost per kWh ranged from $0.007 to $0.014. These costs provide an alternate way of describing the cost-effectiveness of a portfolio of programs. Those portfolios with a higher cost-effectiveness ratio will have a lower cost to acquire savings and vice versa.

Figure 1-6. PY2017 Evaluated Savings Cost-Benefit Ratio and Cost of Lifetime Savings



1.3 RECOMMENDATIONS

The PUCT's EM&V results in recommendations 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.[5] The PUCT and EM&V team worked with the utilities to establish a process to document recommendations and utilities' responses (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 design and implementation recommendations within the next program year consistent with 16 TAC § 25.181(q)(9). Recommendations made based on PY2015 evaluation research, which was completed in calendar year 2016, were expected to be implemented in PY2017. Likewise, recommendations resulting from the PY2017 EM&V are expected to be implemented in PY2019. First, we report on utility progress in meeting recommendations that were to be implemented in PY2017 programs. Next, we summarize recommendations from the PY2017 EM&V research to be implemented in PY2019.

1.3.1 Recommendations for PY2017 Implementation

Table 1-2 summarizes the status of PY2015 EM&V recommendations that utilities were tasked with implementing in PY2017. Utilities have been fully responsive to recommended changes in their program implementation, savings calculations, and reporting.

Table 1-2. PY2015 EM&V Recommendations for PY2017 Implementation

Sector	Recommendation	Status
Commercial	Commercial behavioral programs should fully document the activities taken to achieve savings at the site-level. Consistent with other M&V projects that span program years, commercial behavioral programs should only claim 40 percent of savings the first program year with the remainder of the project savings claimed the next program year, once the M&V is complete.	The utility offering a commercial behavioral program follows the updated TRM M&V methodology and claims savings as recommended to allow the M&V to be completed with a full program year of data.
	Include in the 2017 TRM (version 4.0) the M&V Methodology for Commercial Load Management Programs to improve the consistency and transparency of savings calculations going forward and to provide additional guidance on other issues that have arisen during program implementation.	Utilities provided comprehensive and complete information about each event. Utilities documented standard practices if sponsors on interruptible tariffs have overlapping interruptions and load management program participation. Each utility provided documentation on its entire calculation approach to arrive at program level annual savings.
	Update the 2017 TRM (version 4.0) for Cool Roofs to provide consistency and improvements to the eligibility, baseline condition, and high-efficiency conditions of the measure.	The 2017 TRM was updated and utilities updated Cool Roof calculators to comply. Utilities implemented the measure consistently across their portfolio, choosing one calculator and using either field or TRM default values for this measure.

[5] The EM&V team recognizes 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.

Sector	Recommendation	Status
	Project savings for measures that did not receive an incentive should only be claimed if they can be demonstrated to be attributable to the utility program.[6]	Utilities consulted the EM&V team for guidance in cases where they were unsure if they should claim savings beyond those incentivized for an individual commercial EESP or project.
Residential	Residential new construction programs should consider new program design strategies in response to code changes.	Utilities are continuing to offer residential new construction programs and implemented program re-designs in 2017 to address the baseline code change. The PY2018 EM&V will place a high priority on residential new construction to assess how the new program design strategies are working.
	The EM&V team's consumption analysis showed RSOP and HTR programs were delivering substantial average household savings, but there is an opportunity to encourage more HVAC participation in the residential programs. Program could facilitate collaboration between contractors to encourage increased services to individual participating customers.	Utilities have engaged trade allies and program implementers to increase measures offered to residential customers, including HVAC. While there has been varying success across utilities, all utilities have strategies in place or planned to diversify their measure mix.
	Update the 2017 TRM deemed savings for duct sealing, air infiltration, and ceiling insulation measures to improve the accuracy of the savings estimates for these measures.	The 2017 TRM updated these measures and the utilities have been implementing the changes fairly successfully, with some minor improvements in documentation discussed in the PY2017 EM&V recommendations.
	For Duct Efficiency, savings should be calculated with respect to the pre-leakage cap when applicable.	Utilities who offer the Duct Efficiency measure have been calculating it correctly. The utilities also worked with the EM&V team to design a streamlined approach that may be rolled out in PY2018.
	Include in the 2017 TRM the M&V Methodology for Residential Demand Response Programs, which are new offerings in Texas, to improve the consistency and transparency of savings calculations going forward.	The 2017 TRM includes the M&V approach and the utilities have been implementing the methodology fairly successfully, with some minor improvements identified as discussed in the PY2017 EM&V recommendations.
	Utilities should strive to consistently apply either TRM stipulated efficiency levels or actual field values.	Utilities have educated EESPs on the approach they have chosen to be consistently applied for their residential programs' measure inputs and for the most part indicated in program documentation which approach they have chosen. If a utility chooses field data for a measure input and an exception is needed, the reason the default has to be used instead of a field value is documented.

[6] This recommendation does not apply to behavioral, code or other market transformation programs where the primary program strategy is technical assistance and/or education that results in behavioral or operational changes for energy and demand savings.

Sector	Recommendation	Status
Cross-sector	Utilities should transition pilots to programs after two years if cost-effectiveness is demonstrated.	Utilities followed this recommendation regarding pilot or program status starting with their 2017 plans.
	Upstream lighting programs should allocate 5 percent of savings and costs to the commercial sector and 95 percent to the residential sector, based on industry research on which customer sectors receive discounted upstream bulbs.	All three utilities offering upstream lighting programs appropriately claimed savings and costs for PY2017 in-line with this recommendation.
	Multi-family master-metered customer savings should be claimed for the commercial sector. Individually metered multi-family customer savings should be claimed for the residential sector.	All utilities claimed multi-family savings in PY2017 in-line with this recommendation.
	Utilities may want to consider requesting EM&V team early reviews of savings calculations updated in the PY2017 TRM.	Several utilities and/or their contractors requested savings reviews by the EM&V team early in PY2017 and made any recommended adjustments in savings calculations.

1.3.2 Recommendations from PY2017 EM&V Key Findings

Based on findings from the impact evaluations conducted across the ten utilities, the EM&V team provides the following key findings and recommendations for the commercial, residential and load management programs, and for issues that jointly affect both residential and commercial sector programs ("cross-sector").

1.3.2.1 Commercial Programs

HVAC Projects. In some projects, the nominal capacity of the air conditioner, heat pump, or chiller was being used instead of the rated capacity as specified by the TRM. For many air-conditioning units and heat pumps, the nominal capacity is often slightly higher than the rated capacity. This would overstate savings in the cases where the nominal capacity was used for the existing equipment, and the AHRI rated capacity was used for the new equipment due to the overstatement of the capacity for the existing unit.

Lighting projects. Fixture codes are provided on the Lighting Survey Form (LSF) lighting calculators and are used to identify lighting technology (i.e., LED, compact fluorescent, halogen), wattage, and fixture type (i.e., screw-in, fixture, tube). To ensure accurate savings calculations, it is important to select the correct fixture code based on the wattage and fixture type and ensure that the lighting product is certified and listed through a third-party qualification agency. The EM&V team found that fixture codes were in some cases incorrectly selected based on the wattage or fixture type. In addition, wattages are typically provided in lighting manufacturer's specification sheets and are also provided through third-party certification documents. The EM&V team noted that the wattage on the manufacturer's specification sheets—in some cases—did not match the wattage on the third-party certification documents.

Building type selection. Commercial 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 (EFLH), demand factor (DF)

based on the building type and HVAC system type. During the review of claimed savings, the EM&V team noted instances of improper building type selection and identified key new building type additions to the tables which could reduce improper building type selection and improve the tables' functionality. In addition, it was identified that increased flexibility for exterior lighting was needed.

On-site inspection sampling. Utilities sample commercial projects for quality assurance on-site inspections. The EM&V found instances of utility on-site sample selection that did not accurately represent the larger group of supposedly similar projects. This resulted in instances where savings from a small sample were applied to a larger group of similar projects that were later found to be significantly different during the EM&V team's on-site verification.

Table 1-3. Commercial Program Recommendations and Action Plans

Category	Recommendation	Action Plan
HVAC projects	Utilities should use rated capacities of both the existing and new equipment. If the rated capacities of the existing equipment cannot be found, use the rated capacities of the new equipment for both conditions	The EM&V team will work with the utilities to revise the PY2019 TRM to more clearly describe the capacities listed in applicable tables are to be the rated capacities.
Lighting projects	Utilities should use the third-party certification agency's tested wattage instead of the manufacturer's rated wattage.	The PY2019 TRM 6.0 will include additional language in Volume 3 Section 2.1.1– Energy and Demand Savings Methodology– Savings Algorithms and Input variables– Lamp and Fixture Wattages (kW_{pre}, $kW_{Installed}$)– to clarify that the wattage from the Standard Fixture Wattage table in the Lighting Survey Form (LSF) for $kW_{installed}$ should be chosen based on third party certification agency's tested wattage instead of the manufacturer's rated wattage.
	Fixture code lighting type suffix descriptors should be properly selected in the calculators.	Utilities will conduct QA/QC of fixture code suffix descriptors.
Building type selection	Differentiate the supermarket Building Type Codes from the other codes intended for non-food retail stores.	The PY2019 TRM 6.0 will change the Lighting Building Type Codes from "Non–24 Hour Retail", and "24-Hour Retail" to "Non–24 Hour Supermarket", and "24-Hour Supermarket "and remove "Retail" from both Building Type Descriptions and add "Food Sales."
	Revise the TRM to 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 6.0 will include an "Other" building type for lighting projects to act as a conservative estimate of operating data in lieu of site-specific monitoring.
	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 will conduct QA/QC of appropriate building type selection. In the case when building type assistance was requested from the EM&V team, utilities will keep correspondence with the EM&V team on the issue as part of project documentation.

Category	Recommendation	Action Plan
	When multiple exterior lighting control schemes exist in a single project utilize the "Custom Bldg." worksheet.	Utilities and the LSF implementer will revise the LSF calculator to enable the entry of multiple control schemes for a single project by specifying multiple hours of use and their corresponding factors through a new "Custom Bldg." worksheet in the calculator.
Onsite 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.	When sampling for site inspections from a large group of similar projects such as multiple stores with the same name or business type, utilities will verify that the projects' building type and size are also similar.
Additional savings	To establish greater consistency in the treatment of projects where claimed savings exceed incentive amounts and most accurately represent the savings results from these projects, the EM&V team recommends utilities either only claim the savings from the incentivized measures or the utilities apply the most updated net-to-gross (NTG) research to the total project savings for the claimed savings.[7]	For projects where the *claimed savings are more than 10 percent higher than the "set incentive*," utilities will apply the NTG ratio inclusive of freeridership and spillover to the total project savings. For projects where *claimed savings exceed the "incentive cap" savings up to 20 percent of incentivized savings*," the NTG ratio inclusive of freeridership and spillover should be applied to the total project savings. For projects where total *claimed savings exceed the "incentive cap" by more than 20 percent of incentivized savings*, the NTG ratio only accounting for freeridership should be applied to the total project savings.

1.3.2.2 Residential Programs

Baseline documentation. The PY2017 TRM provides specific requirements that must be met to claim the higher level of savings associated with the baseline restrictions. The EM&V team found that documentation was not collected for several projects with the affected measures, namely the ceiling insulation and air infiltration measures.

Infiltration test results. The EM&V team's on-site infiltration test results varied by more than 10 percent for some projects. Aside from cases where baseline restrictions were present as discussed in 1.3.3.1, the TRM does not require photo documentation of the contractor's test results. Because this documentation was not collected, the EM&V team could not verify the root cause of the variance in testing or that the cases in which test results varied greatly were using the correct testing methods as described in the TRM and/or deploying them correctly. Collecting photos of the manometer test results pre- and post-condition is considered an industry best practice and would provide additional QA/QC when entering test results into the system as well as verify the home has been pressurized correctly.

[7] This recommendation does not apply to behavioral, code or other market transformation programs where the primary program strategy is technical assistance and education that results in behavioral or operational changes for energy and demand savings.

Direct install measures. The PY2017 TRM provides tracking data and evaluation requirements for each measure. Documentation verifying the key parameters needed to evaluate savings should be provided to confirm the eligibility (i.e., LEDs are Energy Star qualified) and claimed savings for each measure. Examples of documentation include, but are not limited to, manufacturer cut sheets and photos of efficient measures with visible model number. Some utilities are moving away from hard copy documentation and are having EESPs enter all information electronically to streamline implementation. Those utilities moving away from paper hard copies should include model numbers in the electronic forms submitted by EESPs.

Insulation measures. The EM&V team found that for several projects, assumptions were made by contractors performing work that did not match the industry standard. For example, a substantial amount of variance between ceiling insulation R-values of the same depth was found. The Department of Energy provides guidance on the R-value of insulation compared to the type and depth. The EM&V team understands each home is unique, and due to age and degradation over time, the R-value may differ from the industry standard for the insulation type, which is why documentation is important for verification. These components could also tie into other similar measures, such as wall and floor insulation as well as measures applying the early retirement action type.

Table 1-4. Residential Program Recommendations and Action Plans

Category	Recommendation	Action Plan
Baseline documentation	Utilities should educate contractors on the documentation requirements set forth in the TRM.	Utilities will provide service provider education and examples of required documentation.
Infiltration test results	Utilities should consider collecting photos of test results to ensure accuracy and method of testing adheres to BPI standards and the methods set forth in the TRM.	Utilities will provide service provider education and request photos of test results.
Direct install measures	Utilities should collect documentation for all direct install measures, i.e., lightbulbs, showerheads, and faucet aerators, in addition to the other measures offered.	Utilities will collect requested documentation or model numbers for direct install measures.
Insulation measures	Pictures should be required where insulation levels are visible. This way, any questions related to assumptions made during the pre- or post-installation process are documented and available for the verification process.	Utilities will provide service provider education and examples of required documentation.

1.3.3 Load Management Programs

Commercial. Utilities demonstrated strong capabilities to apply the TRM calculation method to savings.PY2017 is the second year in which utilities and the EM&V team have applied the new consistent demand savings algorithm described in the TRM. However, differences in calculations for individual meters continued to be a point for ongoing collaboration and clarification. The streamlining of interval meter data and documentation to the EM&V team improved in PY2017 from previous program years.

Residential. Except for one utility of the four utilities offering residential demand response programs, the EM&V team found that it had to receive updated meter datasets or needed to resolve TRM calculation specifics with either the utility or implementer. In general, these issues were resolved with

close agreement in savings calculations but indicate an ongoing opportunity for improvement. One of the utility's implementers developed calculations that differed substantially in their result compared to the evaluated results. One utility presented, by ESIID, those cases that experienced meter failures that would affect demand response calculations, as well as inactive customers that were enrolled in the program but did not participate in one or either of the two events. This data was helpful to confirm that these conditions were present in the program and to accurately calculate savings at the ESIID level. Other utilities did not provide this level of information.

Table 1-5. Load Management Program Recommendations and Action Plans

Category	Recommendation	Action Plan
Commercial	Continue ongoing communications with the EM&V team to resolve minor calculation differences and ensure continued performance and streamlining data provision and analysis efforts.	The utilities will continue to work with the EM&V team to review their calculation systems to continue to reduce the number of individual cases with savings variances.
	Continue to provide on time and quality data to the EM&V team when requested.	The utilities will continue to provide the EM&V team all relevant program documentation and information that is needed to calculate savings as described in the Texas TRM.
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 and their implementers will continue to work with the EM&V team to review their calculation systems and supporting data.
	The utilities should provide documentation for all calculation decisions as they related to applying the TRM.	The utilities will provide adequate records for each meter, for each event, and the disposition of each ESIID to streamline calculations and reduce the cause of potential discrepancies between the EM&V team and utility calculations.

1.3.3.1 Cross sector measures

HVAC tune-ups. In the PY2016 evaluation, the efficiency loss values for Residential both with and without refrigerant charge adjustment (RCAs) were found to be much lower than the historical average. In PY2017, the efficiency losses for all four categories (Residential and Commercial, both with and without RCAs) were found to be more in alignment with the historical 2011–2015 averages. In addition, a review of the 2011 through 2017 statewide M&V datasets indicated the efficiency losses calculated for recent years has diverged from the aggregated average since PY2011.In the PY2016 evaluation, the three-year rolling average for efficiency losses for all four categories was found to be lower than the historical average since PY2011. This was found to still be the case when including the PY2017 efficiency loss data in the new three-year rolling average. In PY2017, approximately 20 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. This represented an improvement over PY2016, however M&V tune-ups for commercial projects were less than 10 percent. These M&V samples are used to calculate and calibrate efficiency losses for all tune-ups completed.

Solar PV. For PV projects, the utilities use the system design and technical specifications to create an estimate of the electricity production using the National Renewable Energy Laboratory (NREL) calculator, PV Watts®. The peak demand reduction (kW) was determined using deemed savings factors

provided in lookup tables in the TRM for various weather zones in Texas. The utilities followed the calculation approach as described in the TRM. Also, all solar PV projects sampled for evaluation review used the fixed deemed savings factors provided in the TRM for the relevant weather zone. The EM&V team recommended adjustments for several projects related to specific details, varying across the sampled projects. These included the use of incorrect weather zone for peak demand reduction, or the use of incorrect installation specification, such as location, slope, or azimuth.

Dual baselines. The EM&V team found inconsistencies between the claimed and evaluated savings for early retirement HVAC and residential lighting measures, both of which require use of the dual baseline methodology. While utilities are deploying the method in the TRM correctly, the method itself appears to not accurately represent savings and needs clarification and revision.

Table 1-6. Cross Sector Measure Recommendations and Action Plans

Category	Recommendation	Action Plan
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 that is seen in the year-to-year efficiency loss values.	Utilities and their implementers will use a three-year rolling average for HVAC tune-ups, which began in PY2017.
	Collect at least a 10 percent M&V sample for tune-up measures annually for the commercial and residential populations separately.	Utilities will work with their implementers to increase M&V samples to 10 percent by sector.
PV	Utilities should use the defaults values for Module type, Array losses, DC to AC Sizing, and Inverter efficiency in the PV Watts® to calculate the annual kWh production of a solar PV and specify in the TRM that documentation should be submitted to explain the reason for altering any of those default values.	The EM&V team will update the PY2019 TRM to clarify PV tracking and documentation requirements for projects where default values are not used, and utilities will collect and supply this documentation when applicable.
	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.
	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.
Dual baselines	Re-assess the dual baseline methodology in the TRM, which is to be reviewed by the EM&V team and Frontier.	The EM&V team will work with the utilities to update the dual baseline methodology in the PY2019 TRM.

[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.

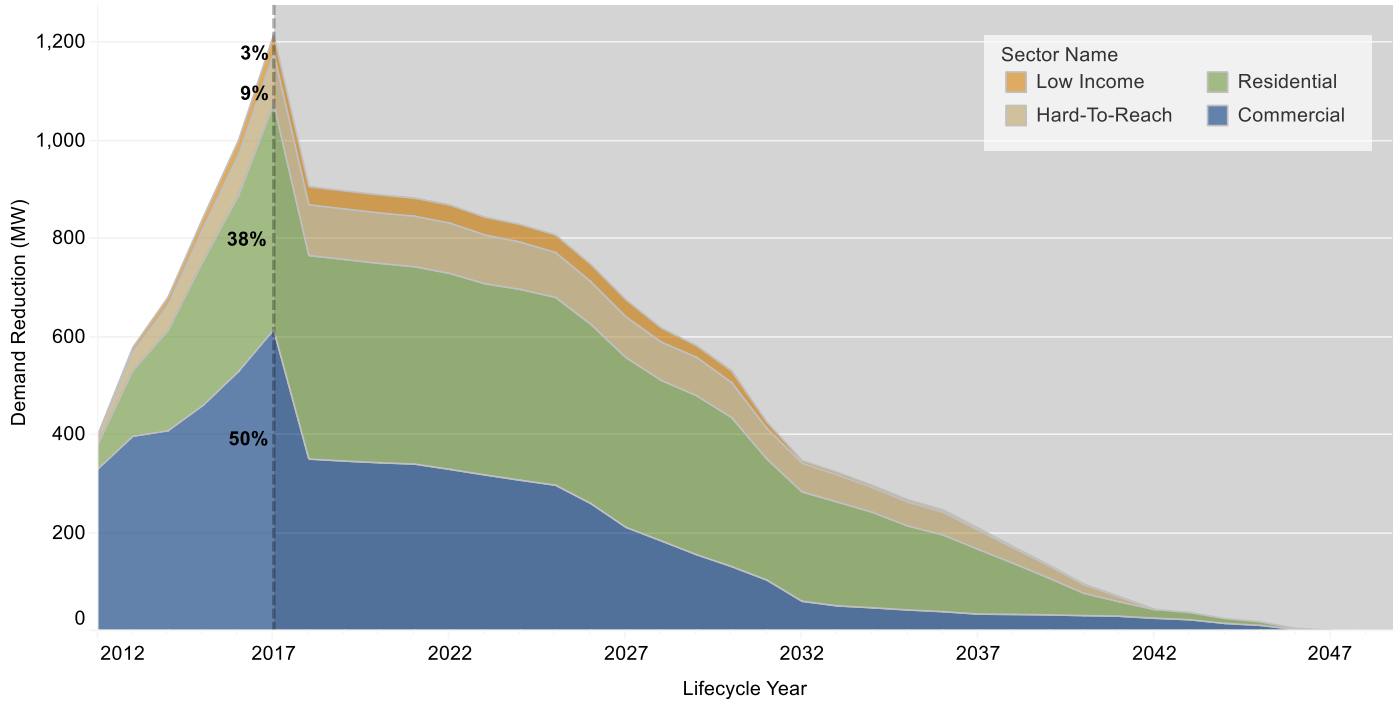
1.4 CUMULATIVE SAVINGS

While the utilities' legislated savings goals are based on first year annual savings associated with implementing energy-saving and demand-reducing measures, program measures last longer than the year they are installed. For example, the savings resulting from PY2017 program measures will last an average of 16 years.[9] Some measures such as load management and compact fluorescent lightbulbs have shorter lives while building shell and solar PV have longer lives. To understand the estimated total annualized statewide energy efficiency savings in 2017, savings from prior years need to be considered.

The Texas utilities have been offering energy efficiency programs since 2002, however program data was not captured in a centralized repository for reporting until 2012.[10] The following four figures show the cumulative demand reduction and energy savings resulting from the Texas utilities' program efforts since 2012 and the persistence of those savings into future years. In 2017, the energy efficiency programs produced an estimated annualized reduction in demand of 1,216 MW and 3,268 GWh.

Figure 1-7 and Figure 1-8 show the cumulative savings by sector. Half of all demand reductions (MW) in PY2017 are from the commercial sector. The other half are from residential (38 percent), hard-to-reach (9 percent) and low income (3 percent) programs. Energy savings (GWh) by sector are similar, with slightly more savings from the commercial sector (53 percent).

Figure 1-7. PY2012—PY2046 Lifecycle Demand Reduction by Sector (MW)



[9] The average, kWh-weighted lifetime of savings estimated across all measures installed in 2017 is 16.3 years.
[10] As part of the PUCT EM&V effort, all utility program tracking data has been gathered since 2012.

Figure 1-8. PY2012—PY2046 Lifecycle Energy Savings by Sector (GWh)

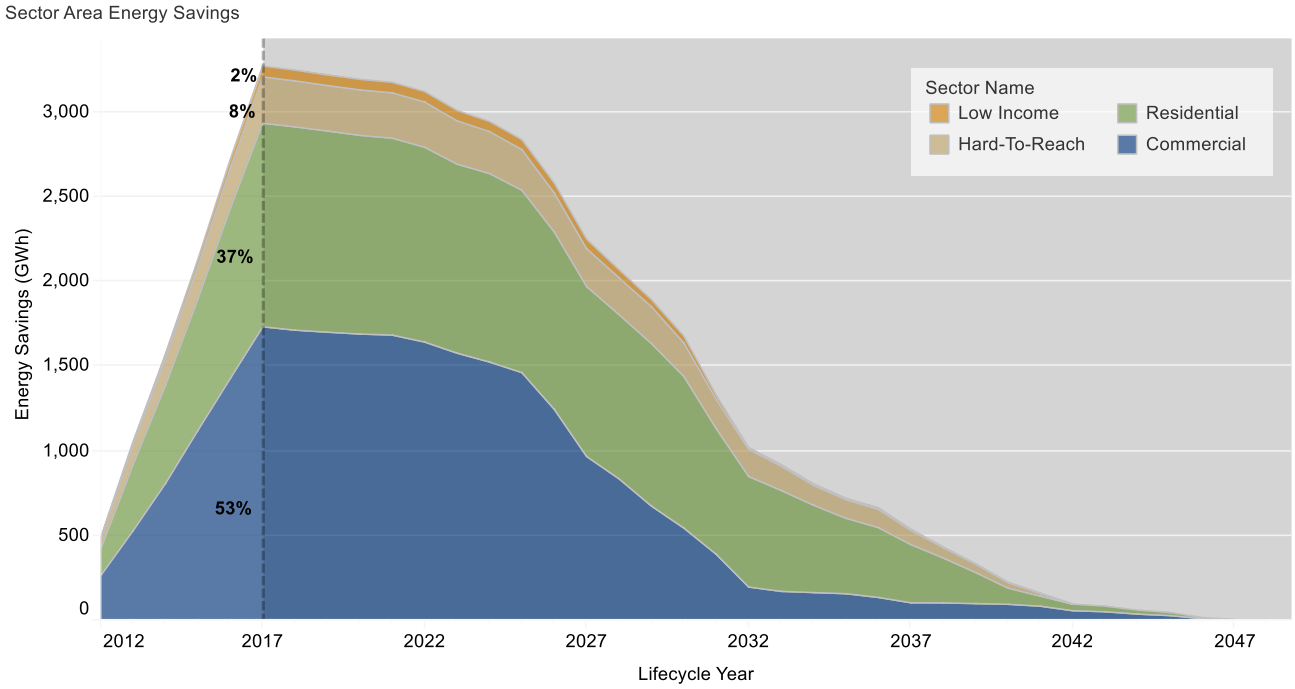
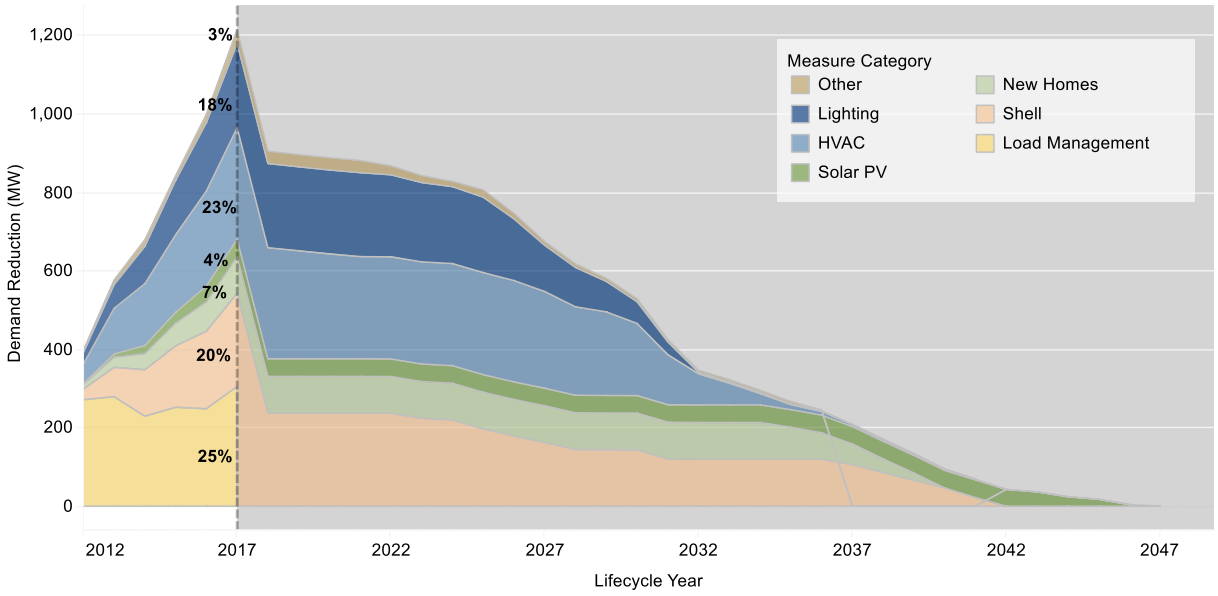


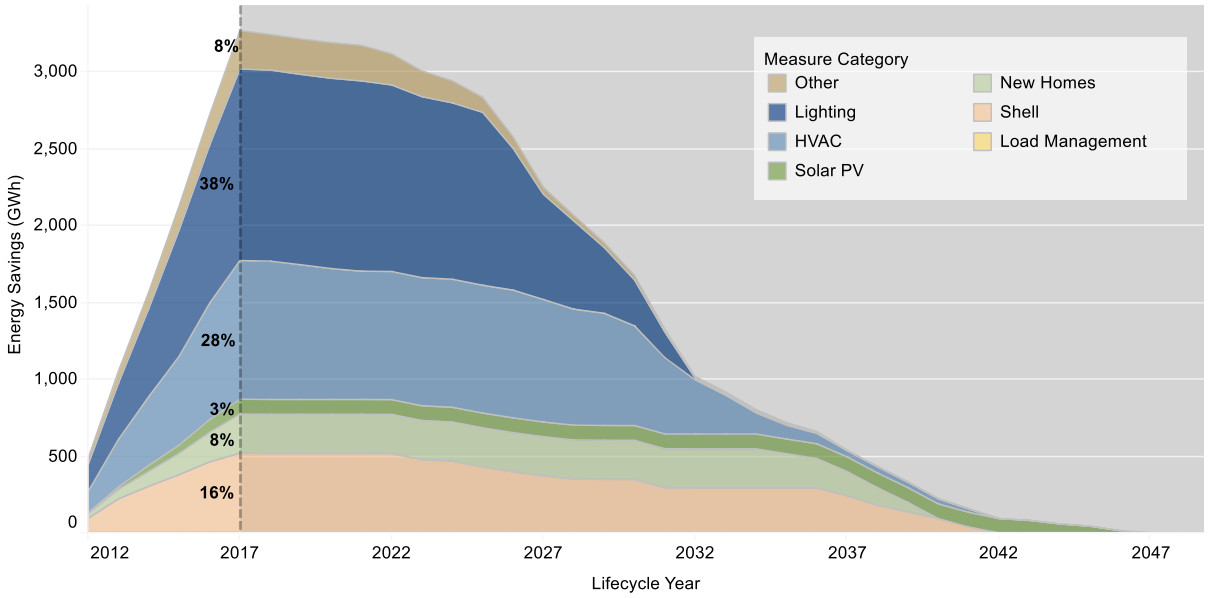
Figure 1-9 and Figure 1-10 show the cumulative savings by measure category. PY2017 total demand reductions are from load management (25 percent), HVAC (23 percent) and shell improvements (20 percent). PY2017 total energy savings are from lighting (38 percent), HVAC (28 percent) and shell improvements (16 percent).

Figure 1-9. PY2012–2046 Lifecycle Demand Reduction by Measure Category (MW)



Other: AC/HP Tune Up, Appliance, Behavior, Custom M&V, Food Service, Motors, Refrigeration, Roofing, Water Heat, Whole Building, Windows.

Figure 1-10. PY2012–2046 Lifecycle Energy Savings by Measure Category (GWh)



Other: AC/HP Tune Up, Appliance, Behavior, Custom M&V, Food Service, Motors, Refrigeration, Roofing, Water Heat, Whole Building, Windows.

Figure 1-11 below shows the estimated first-year annualized energy savings by residential and nonresidential sector as a percentage of each utility's PY2017 retail sales, which range from 0.03 percent to 0.46 percent by utility. The statewide average is .19 percent. In some cases, first-year savings as a percent of retail sales were fairly equal across residential and commercial sectors, but in most cases commercial savings were higher. The PY2017 cumulative annualized savings since 2012 as a percentage of retail sales are much higher as seen in Figure 1-12. The statewide average is 1.11

percent of annual retail sales and ranges across utilities from a low of .24 percent to a high of 2.46 percent of annual retail sales.

Figure 1-11. PY2017 Annual Energy Savings Share of 2017 Retail Sales (kWh)

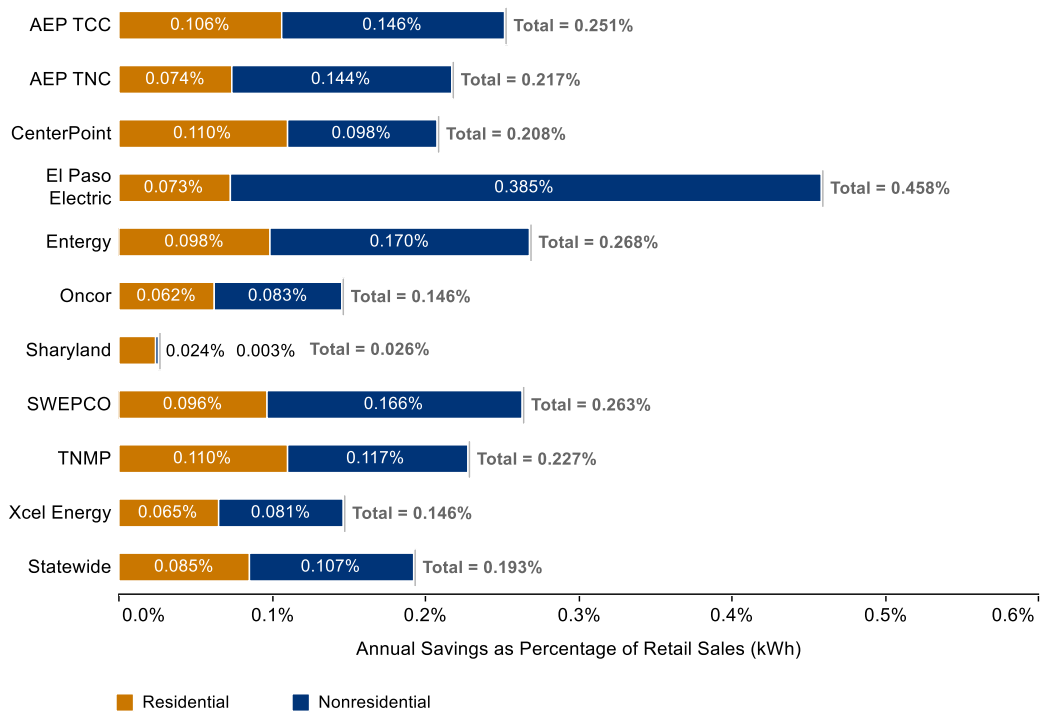
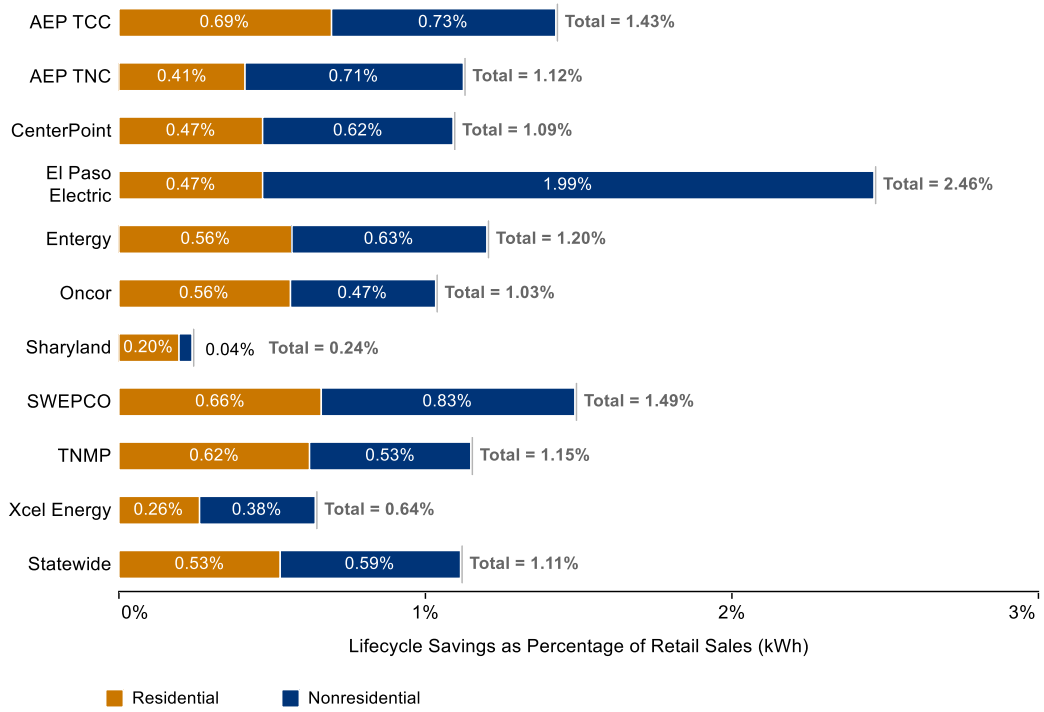
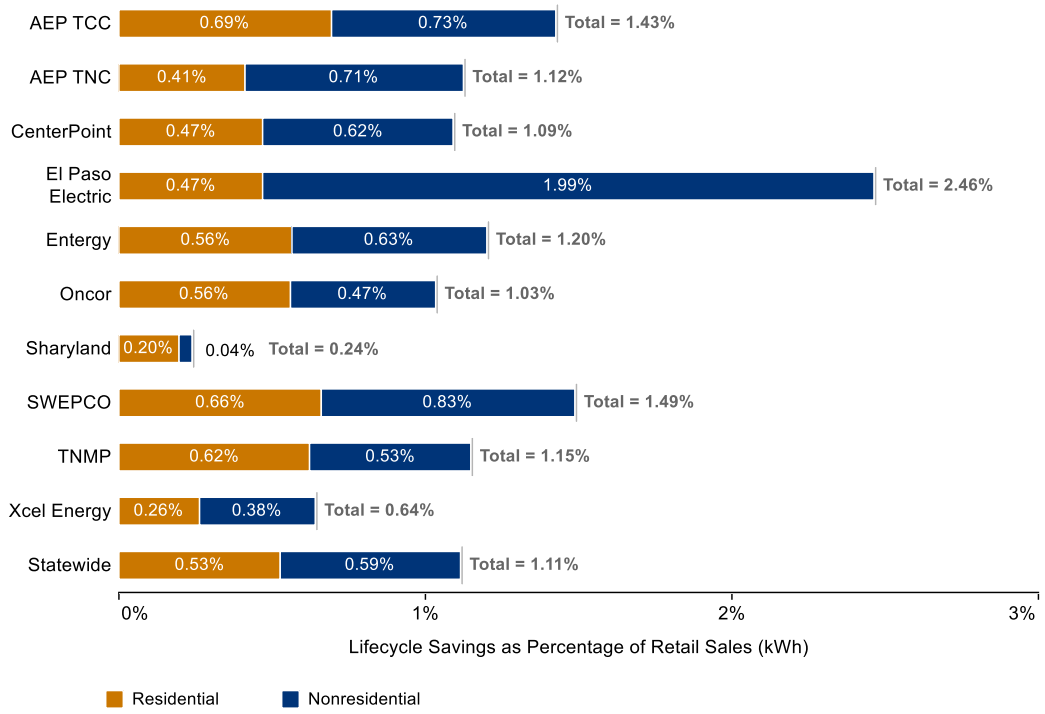


Figure 1-12. PY2012-PY2017 Lifecycle Energy Savings Share of 2017 Retail Sales (kWh)





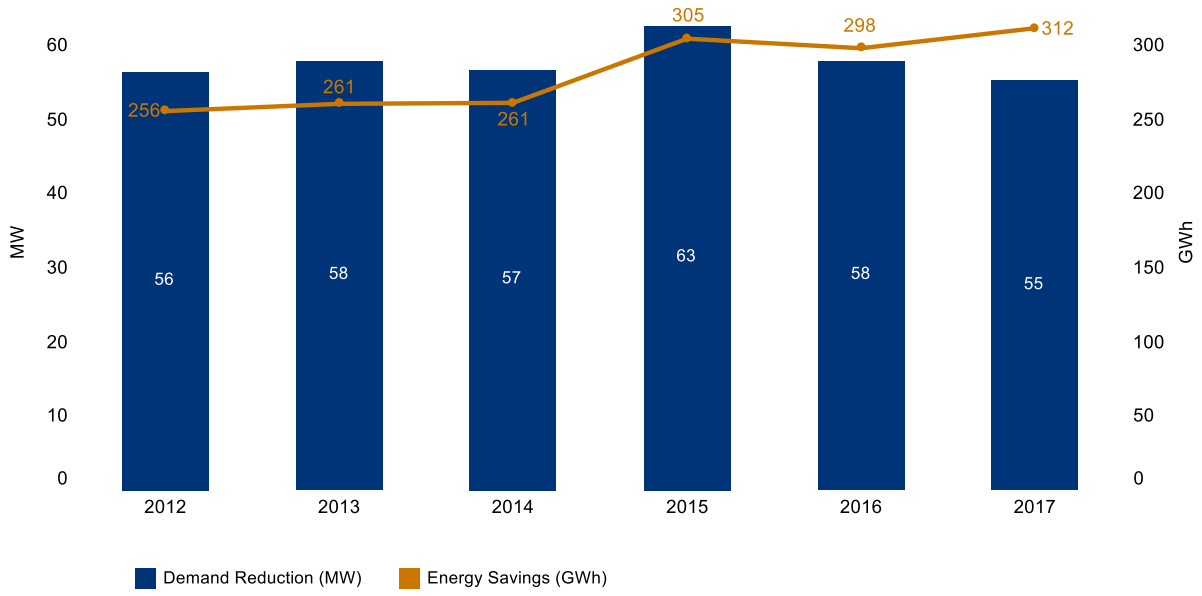
1.5 SECTOR EVALUATION RESULTS

Next, we detail evaluated savings and cost-effectiveness results by the commercial sector, residential sector, load management programs, and pilot programs.

1.5.1 Commercial Sector Results

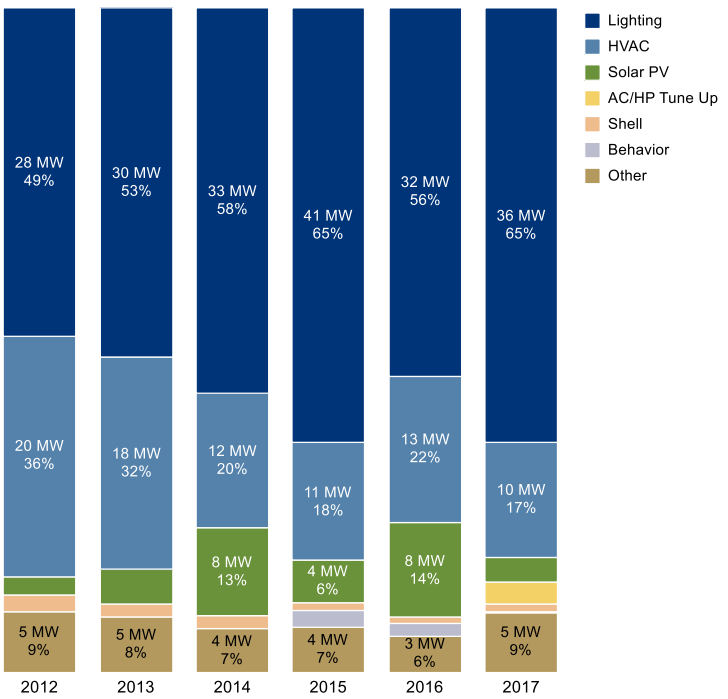
The statewide evaluated gross savings from commercial sector programs were demand reduction of 55,201 kW and energy savings of 311,670,731 kWh. These savings reflect a decrease in demand reduction of approximately three MW from PY2016 for commercial programs and an increase in energy savings of approximately 14 GWH from PY2016 for commercial programs (Figure 1-13).

Figure 1-13. Total Statewide Evaluated Demand Reduction and Energy Savings by Program Year—Commercial Programs

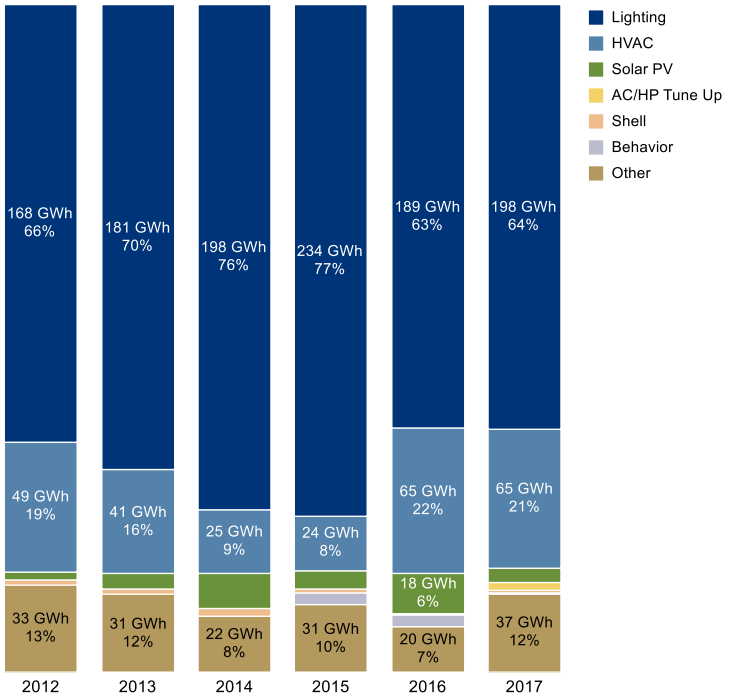


As indicated below, lighting measures still account for the majority of the energy savings (64 percent) and demand reduction (65 percent), which is consistent with commercial programs throughout the country. PY2017 saw HVAC and lighting measures making up approximately 82 percent and 85 percent of demand reduction and energy savings respectively.

Figure 1-14. Distribution of Statewide Evaluated Gross Demand Reduction and Evaluated Gross Energy Savings by Measure Category—Commercial Programs PY2017 Excluding Load Management



Other: Appliance, Custom MV, Food Service, Refrigeration, Roofing, Water Heat, Variable Frequency Drive, Airflow Optimization, Thermal Storage, Direct Digital Controls, Pump Controls and Retre-Commissioning.

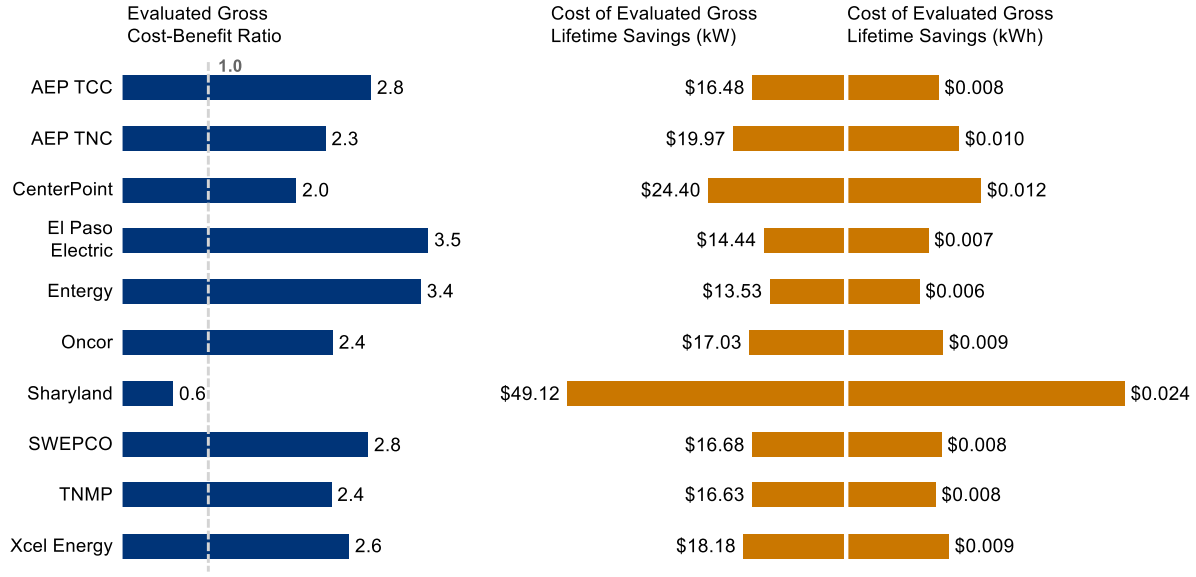


Other: Appliance, Custom MV, Food Service, Refrigeration, Roofing, Water Heat, Variable Frequency Drive, Airflow Optimization, Thermal Storage, Direct Digital Controls, Pump Controls and Retre-Commissioning.

Figure 1-15 summarizes the cost-effectiveness of each utility's commercial energy efficiency portfolio. Commercial sector programs were the most cost-effective programs with an overall cost-effectiveness of 2.5 statewide based on evaluated savings and 2.2 based on net savings. Utilities' results ranged from 0.6 to 3.5 based on evaluated gross savings and 0.5 to 3.2 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 1-15 also summarizes the cost of lifetime kWh and kW for each utility's commercial sector programs. The cost per kWh ranges from $0.006 to $0.024, and the cost per kW ranges from $13.53 to $49.12. 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.

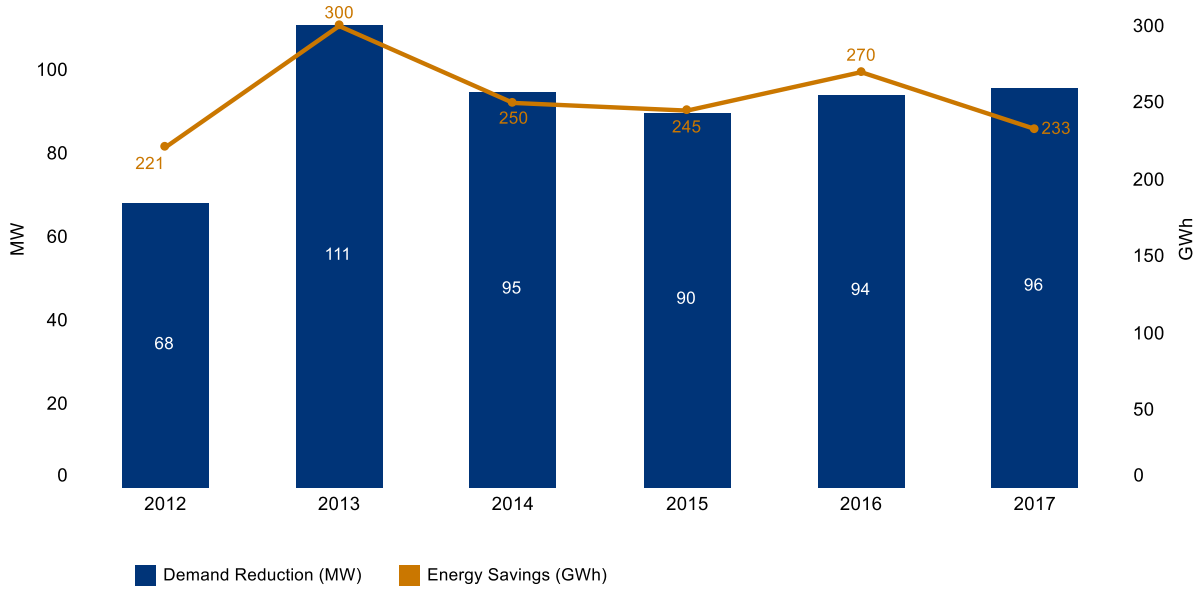
Figure 1-15. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Commercial Programs PY2017



1.5.2 Residential Sector Results

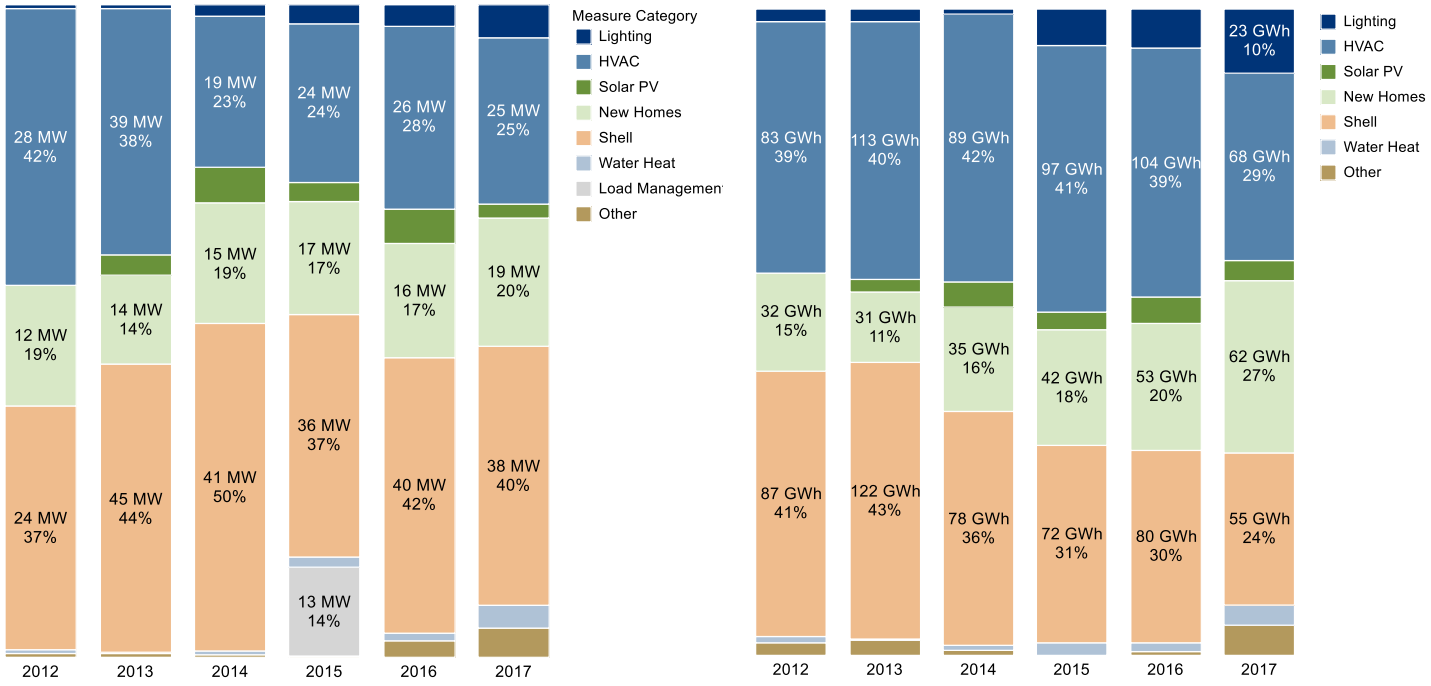
Statewide PY2017 evaluated demand reduction from residential sector programs was 96,440 kW and the evaluated energy savings was 233,425,485 kWh. The demand reduction achieved in PY2017 increased slightly from PY2016 and is the highest amount saved at a statewide level since PY2014. Conversely, PY2017 saw a decrease in energy savings compared to previous program years with the amount saved in PY2017 being the lowest achieved since PY2013.

Figure 1-16. Total Statewide Evaluated Gross Demand Reduction and Energy Savings by Program Year—Residential Programs



The majority of residential demand reduction derived from shell measures at 40 percent and the majority of energy savings was from HVAC at 29 percent with new homes and shell coming in slightly behind at 27 and 24 percent respectively. The figure below presents the breakdown of savings by measure category and demonstrates that the utilities have been successful in diversifying their residential savings.

Figure 1-17. Distribution of Statewide Evaluated Gross Demand Reduction and Gross Energy Savings by Measure Category—Residential Programs PY2017



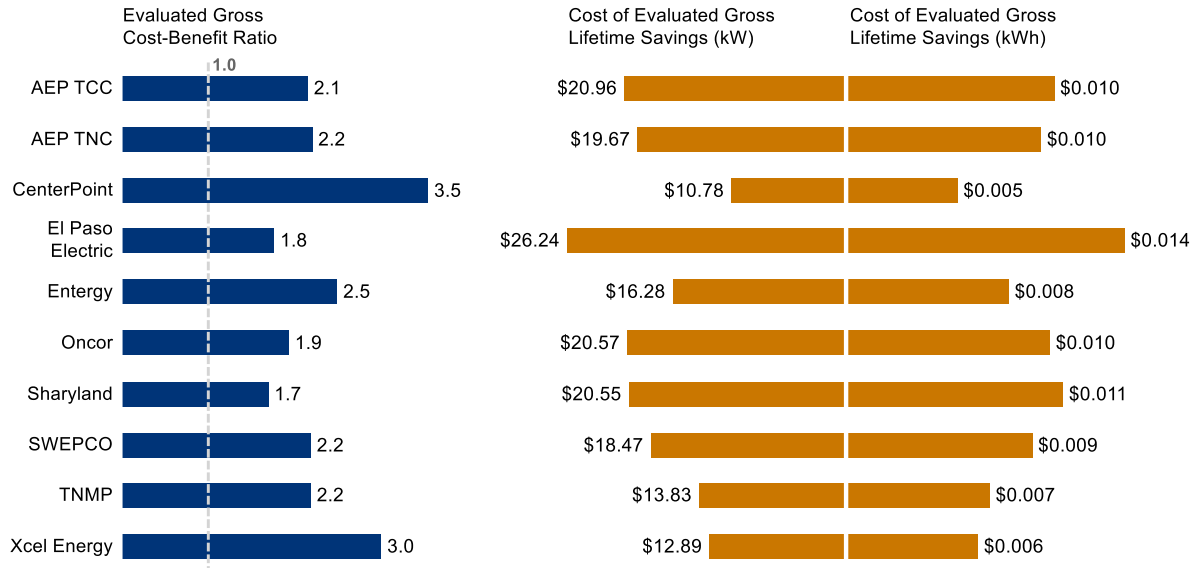
Other: AC/HP Tune up, Windows, Toolkit Incentive, Variable Speed Pump and Space-Water Heating Systems.

Other: AC/HP Tune up, Windows, Toolkit Incentive, Variable Speed Pump and Space-Water Heating Systems.

Residential sector programs' cost-effectiveness statewide is 2.4 based on evaluated gross savings and 2.1 based on evaluated net savings. Similar to the commercial sector, the residential sector varied between utilities, with evaluated gross savings results ranging from 1.7 to 3.5 and evaluated net savings results ranging from 1.5 to 2.7. As with the commercial sector, this is in part due to the differences in the types of programs offered by different utilities.

Figure 1-18 below summarizes the cost-effectiveness of each utility's energy residential efficiency portfolio and the cost of lifetime kWh and kW for each utility's residential sector programs. The cost per kWh ranges from $0.005 to $0.014, and the cost per kW ranges from $10.78 to $26.24. 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.

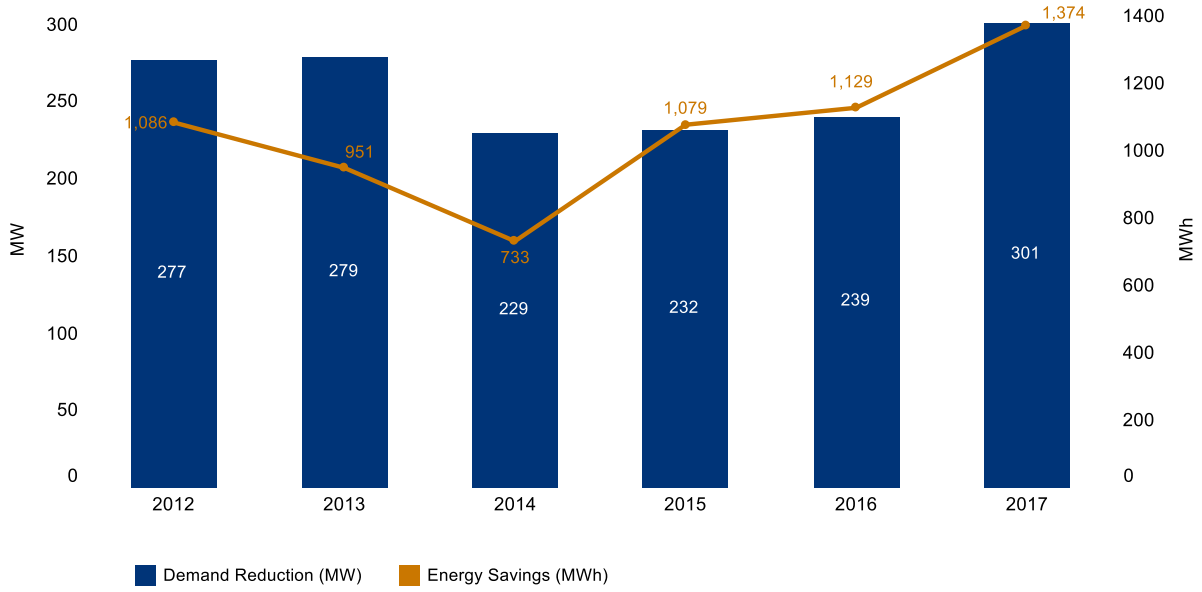
Figure 1-18. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Residential Programs PY2017



1.5.3 Load Management Results

Statewide evaluated demand reduction from load management programs were 300,680 kW and evaluated energy savings were 1,373,768 kWh. Load management programs' demand reduction and energy savings increased over years past with the statewide portfolio achieving the highest savings of all evaluated program years.

Figure 1-19. Total Statewide Evaluated Gross Demand Reduction and Energy Savings by Program Year—Load Management Programs

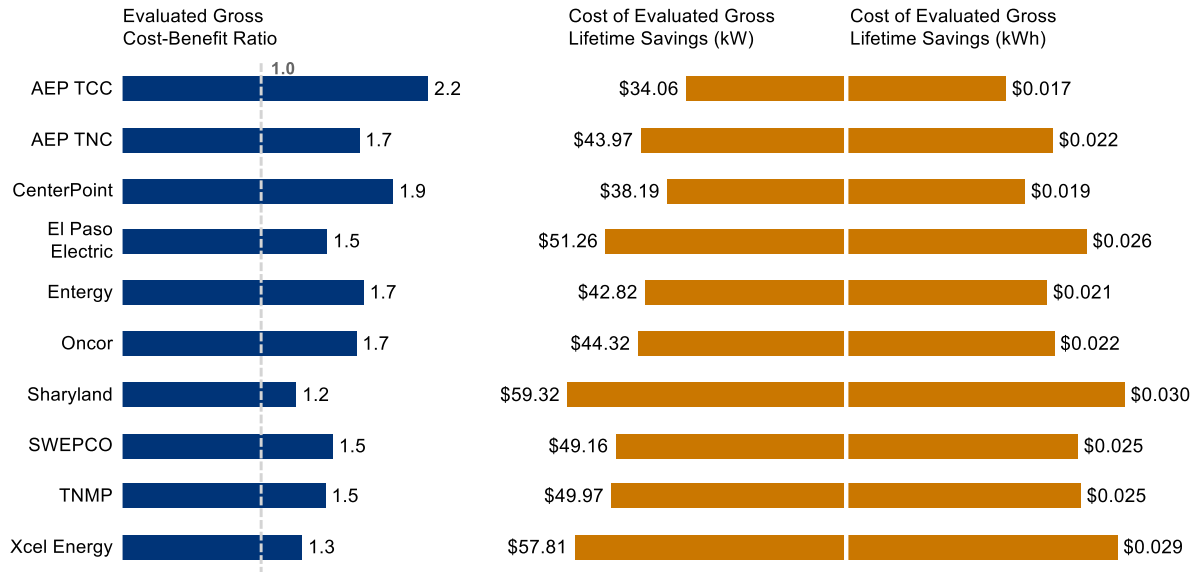


Load management programs had the lowest cost-effectiveness of non-low-income or pilot programs at 1.8 based on evaluated savings. However, load management programs serve a different purpose in the

utilities' energy efficiency portfolio, as they are a supply-side resource to be used when peak demand reduction is needed due to capacity constraints. There is some variation in the utilities' results, ranging from 1.2 to 2.2 based on evaluated savings. There are no separately reported net evaluated savings for load management programs since the programs require participation in a curtailment event that would not happen without the program and therefore no freeridership is assumed.

Figure 1-20 summarizes the cost-effectiveness of each utility's load management energy efficiency portfolio and the cost of lifetime kWh and kW for each utility's load management programs. The cost per kWh ranges from $0.017 to $0.030, and the cost per kW ranges from $34.06 to $59.32. 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 1-20. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Load Management Programs PY2017



1.5.4 Pilot Results

The statewide evaluated demand reduction from pilot programs were 4,808 kW and the evaluated energy savings was 711,628 kWh. PY2017 saw the least amount of energy savings for all evaluated program years given that two of the five pilot programs were residential demand response programs with another being a midstream CoolSaver program. Figure 1-21 shows statewide evaluated gross demand reduction and energy savings, respectively, for pilot programs from PY2012 through PY2017.

Figure 1-21.Total Statewide Evaluated Demand Reduction and Energy Savings by Program Year—Pilot Programs

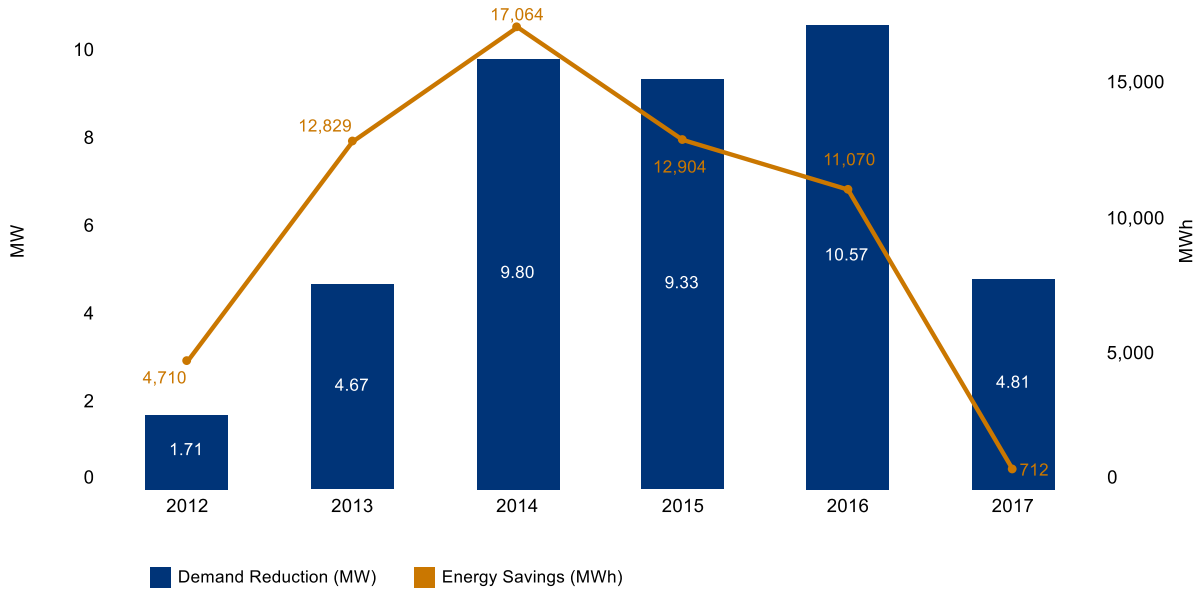
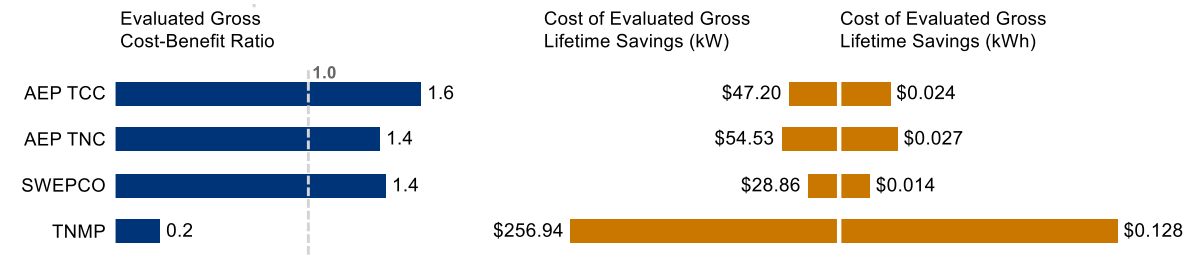


Figure 1-22 summarizes the cost-effectiveness of each utility's pilot energy efficiency portfolio. The pilot programs' statewide cost-effectiveness is 1.2 based on evaluated savings and 1.1 based on net evaluated savings. As discussed with PUCT staff, to recognize program start-up costs, pilots are not required to pass the cost-effectiveness test their first year of implementation but are expected to pass during the second year. Allowing time to pass cost-effectiveness is industry standard, as pilot programs serve an important function in energy efficiency portfolios by exploring the feasibility of programs designed to increase market penetration of new technologies, reach underserved customer segments, and/or explore new distribution channels.

Figure 1-22. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Pilot Programs PY2017

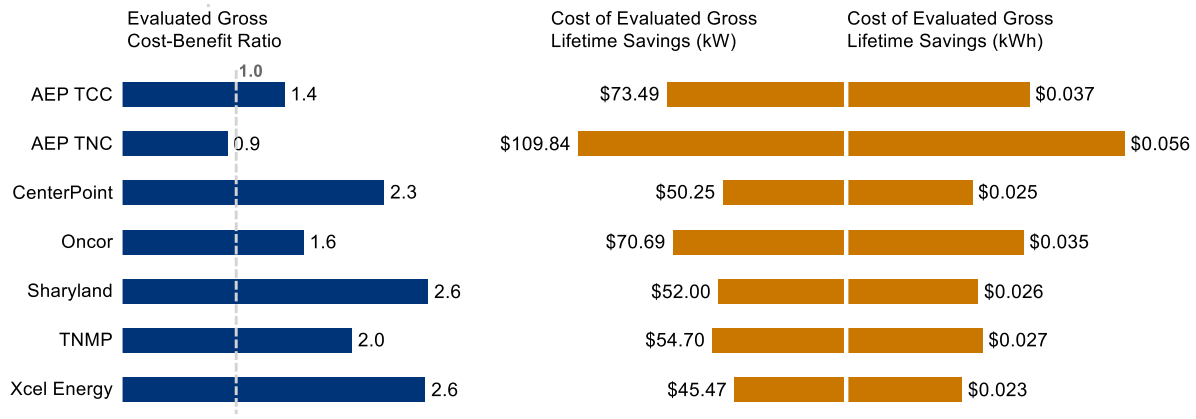


1.5.5 Low-Income Results

Figure 1-23 summarizes the cost-effectiveness of each utility's low-income energy efficiency portfolio.

As expected due to the higher program costs associated with serving this residential sector, low-income programs had a statewide cost-effectiveness ratio of 1.8.

Figure 1-23. Evaluated Cost-Benefit Ratio and Cost of Lifetime Savings—Low Income Programs PY2017



1.6 CONCLUSION

The positive evaluation results are due largely to well-established program design and delivery processes, tracking systems, documentation, and savings tools coupled with the utilities' collaboration with and responsiveness to the EM&V effort and improvements in the TRM. The utilities have demonstrated a willingness to work with the EM&V team when EM&V results identify an adjustment to claimed savings that is needed; upfront when M&V reviews or additional technical assistance or input can reduce uncertainty in savings estimates; and in implementing several process improvements. At the same time, the PY2017 EM&V research identified some additional improvements in program processes, project documentation and savings calculations. PUCT Staff and the EM&V team are working with the utilities to integrate updates from the PY2019 TRM 6.0 and programs.

2.0 INTRODUCTION

This document presents the third-party evaluation, measurement, and verification (EM&V) results for the Texas electric investor-owned utilities' energy efficiency portfolios implemented in Program Year 2017 (PY2017). Program-level results are presented in Sections 3 through 5 for the commercial, residential and load management programs respectively. Section 6 includes cross-sector measure-specific results. Section 7 discusses the effects of Hurricane Harvey on affected utilities. A separate report volume (Volume II) details the EM&V results for each utility's portfolio.

2.1.1 EM&V Overview

PY2017 is the sixth program year evaluated as part of the statewide EM&V effort. The PY2017 scope is targeted impact evaluations for the savings areas of the highest uncertainty identified in the prior EM&V results or changes in programs and/or technologies. The targeted impact evaluations are concentrated on particular commercial programs and end-uses. At the same time, a combination of interval meter data analysis and tracking system reviews provide a due-diligence review of claimed savings for each utility portfolio.

The reviews provided an independent assessment of claimed savings and the accuracy of the program data. The documentation reviewed were tracking data, interval meter data, project files, energy savings calculations (including a review of input assumptions and algorithms to verify claimed program savings), and utilities' existing M&V information.

The PY2017 EM&V plans[11] are based on the prioritization of the EM&V effort. To briefly summarize, the EM&V team identified program types across utilities that have similar program design, delivery, and target markets. We reviewed each program type and prioritized (high, medium, low) based on the following considerations:

- Magnitude of savings— percentage of contribution to the portfolio of programs' impacts
- Level of relative uncertainty in estimated savings
- Level and quality of existing quality assurance and verification data from on-site inspections completed by utilities or their contractors
- Stage of program or programmatic component (e.g., pilot, early implementation, mature)
- Importance to future portfolio performance
- PUCT and Texas utilities' priorities
- Prior EM&V results
- Known and anticipated changes in the markets in which the programs operate.

[11] Tetra Tech. Public Utility Commission of Texas Evaluation, Measurement, and Verification (EM&V) Plans for Texas Utilities' Energy Efficiency and Load Management Portfolios—Program Year 2017, July 2017.

2.1.2 EM&V Activities

The EM&V activities:

- Confirmed that the measures installed are consistent with those listed in the tracking system
- Verified 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 PY2017 TRM 4.0 or measurement and verification (M&V) methods used to estimate project savings
- Reviewed 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
- Recommended update to project-level claimed savings if EM&V results indicate variation in savings of at least ± 5 percent
- Informed updates for the PY2019 TRM 6.0.

Table 2-1 below shows the EM&V activities completed by program type and evaluation priority.

Table 2-1. PY2017 EM&V Priorities and Activities

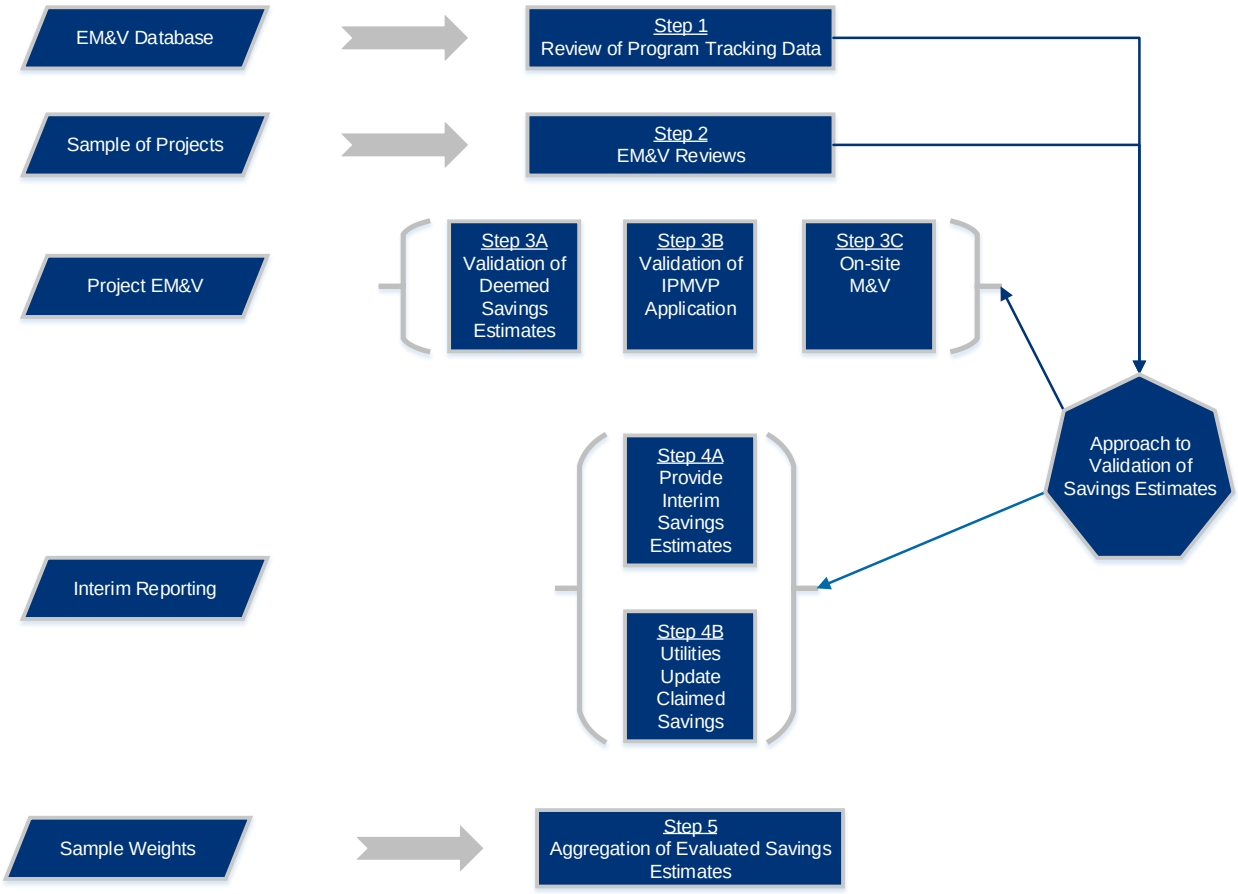
Program Type	Evaluation Priority	Tracking Data Verification of Claimed Savings	Participant Surveys	Project Desk Reviews	On-site M&V	Interval Meter Data Analysis
Commercial SOPs and largest commercial MTPs	High	Census	487 customers/ 92 service providers	131	64	N/A
Commercial mid-size and smaller MTP programs (e.g., CoolSaver AC Tune-Up and Solar)	Medium	Census	N/A	22	10	N/A
Load management	Medium	Census	N/A	N/A	N/A	Census
Residential SOPs, hard-to-reach, and low-income	High	Census	465 customers	142	67	N/A
Residential MTPs (e.g., CoolSaver, Solar PV) and smaller low-income and hard-to-reach programs	Medium	Census	76[12] customers	38	34	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-level, sector-level, and portfolio-level realization rates. These realization rates incorporate any adjustments for incorrect application of deemed savings values and any equipment

[12] The EM&V team conducted focused participant surveys with CoolSaver participants in Harvey impacted territories to assess the effects of Harvey on participating units as discussed in Section 7 of the full report.

details determined through the tracking system and 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 2-1.

Figure 2-1. 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 utility.

The EM&V team conducted cost-effectiveness testing using the program administrator cost test for PY2017 claimed and evaluated results. Low-income programs were also calculated using the Savings-to-investment ratio (SIR).

3.0 COMMERCIAL ENERGY EFFICIENCY PROGRAMS

Commercial standard offer programs (CSOP) and the largest savers of the commercial market transformation programs (MTPs) were “high” priority in PY2017. These programs continue to represent the largest percentage of statewide savings and have plans 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, which was found to again be the case in PY2017. The “high” PY2017 evaluation priority also included participant and energy efficiency service provider (EESP) surveys to collect process information as well as update net-to-gross (NTG) values as the last research was conducted in PY2013.

This section first presents key findings and recommendations from the impact evaluations. This is then followed by process evaluation and net-to-gross research results.

3.1 IMPACT EVALUATION KEY FINDINGS AND RECOMMENDATIONS

Key findings and recommendations are presented for the following commercial topics:

- HVAC
- Lighting
- Building type selection
- Sampling for site inspections
- Additional savings.

3.1.1 HVAC

This section summarizes the key findings and recommendations from the PY2017 evaluation of the commercial HVAC projects (e.g., Split System/Single Packaged Air Conditioners, Heat Pumps, and HVAC Chiller replacement).

The commercial HVAC evaluation is based on data collected and reviewed during the engineering and onsite M&V activities completed by the EM&V team as part of the project level impact reviews for PY2017. During the review process, the EM&V team typically receives a deemed calculator (e.g., Air Conditioning Evaluator (ACE), E2, N2) to simplify the savings estimation process for prescriptive HVAC based energy efficiency projects. These excel based calculators are developed and maintained by either the respective utility or implementer. For example, Frontier Associates maintains the ACE and Oncor maintains the E2/N2 calculators. The calculators and other project documentation that the EM&V team receives as part of the claimed savings project documentation requires entry of the key equipment parameters and assumptions. One key parameter is the capacity of air conditioning units. The EM&V team found some projects used the nominal capacity in place of the rated capacity as guided by the TRM savings methodology. Care should be taken to make sure the capacities entered match those of the AHRI. Projects with a copy of the AHRI certificate provided as part of the project file documentation were generally found to include correct equipment information within project calculators.

Key Finding #1: In some project's ACE calculators, the nominal capacity of the air conditioner, heat pump, or chiller was being used instead of the rated capacity as specified by the TRM.

This primarily was found to be an issue for existing air conditioning units, heat pumps, and chillers baseline capacity where the manufacturers specification sheets, nameplate data, or unit level rated capacity may have been difficult to obtain. Often, the nominal capacity is provided as part of the unit's model number and was found to be used as the nominal capacity for the baseline equipment, but then the AHRI rated capacity was being used for the new equipment. For many air-conditioning units and heat pumps, the nominal capacity is often slightly higher than the rated capacity. This would overstate savings in the cases where the nominal capacity was used for the existing equipment and the AHRI rated capacity was used for the new equipment due to the overstatement of the capacity for the existing unit.

Concern was raised about being able to find rated capacities in a simple and timely manner for existing equipment which is often old where internet research for spec sheets and model data can be a challenge.

Recommendation #1: Always use rated capacities of both the existing and new equipment. If the rated capacities of the existing equipment cannot be found, use the rated capacities of the new equipment for both conditions. Notes should be added to the TRM tables (Section 2.2.2 - Tables 2-13 thru 2-19 and Section 2.2.3 - Tables 2–28 thru 2-40) to clearly describe that the capacities listed in those tables are to be the rated capacities. Additionally, the capacities should be converted from tons to BTU/h to make this clearer since capacities in tons are often associated with nominal capacity rather than rated capacity.

3.1.2 Lighting

While commercial lighting has decreased from about three-quarter of savings in PY2014 and PY2015 to about two-thirds in PY2016 and PY2017, it is still the single largest end-use contributing to commercial sector savings. Key findings and recommendations from the PY2017 EM&V of prescriptive and custom commercial lighting projects is provided below.

3.1.2.1 Fixture Codes

The commercial lighting evaluation is based on data collected from commercial participants through tracking system, desk reviews, and on-site M&V visits. During the desk review process, the EM&V team verified the fixture codes for each lighting project. Fixture codes are provided on the Lighting Survey Form (LSF) lighting calculators and are used to identify lighting technology (i.e., LED, compact fluorescent, halogen), wattage, and fixture type (i.e., screw-in, fixture, tube). An example of a fixture code is "LED009-SCRW" which represents a 9W LED light with a screw in base.

To ensure accurate savings calculations, it is important to select the correct fixture code based on the wattage and fixture type and ensure that the lighting product is certified and listed through a third-party qualification agency. The EM&V team found that fixture codes were in some cases incorrectly selected based on the wattage or fixture type.

In addition, wattages are typically provided in lighting manufacturer's specification sheets and are also provided through third-party certification documents. The EM&V team noted that the wattage on the manufacturer's specification sheets, in some cases did not match the wattage on the third-party certification documents. As noted in the PY2017 TRM 4.0 Volume 3, all new linear fluorescent lighting

products must be qualified though the Consortium for Energy Efficiency (CEE), and all LED lighting products must be qualified though Design Lights Consortium (DLC), ENERGY STAR®, or Lighting Design lab (LDL). The TRM does not specify which documents should be referenced for gathering wattage information for savings calculations. These agencies provide an independent process for lighting products that meet or exceed certain lighting characteristics regarding performance. The wattage consumed of each lighting product is provided as tested by the agency and is included in the certification documents for each lighting product.

Qualification agencies are regarded as unbiased organizations with trusted tested wattages. The EM&V team believes that these tested wattages are the most accurate representations of the lighting characteristics as opposed to those reported by the lighting manufacturer.

When selecting a fixture code, the fixture type is also an important consideration. Fixture codes for screw in lights end in "-SCRW", lighting fixtures end in "-FIXT" and linear lights end in "-TUBE." While these suffix descriptors do not impact any energy savings calculations, they act as a reference to quickly understand the type of fixture that was installed and helps group similar lights together which can help determine metrics such as the number of screw-in lights that were installed versus the number of linear lights that were installed across the program.

Key findings and applicable recommendations are presented below based on the information gathered in reviews of commercial lighting projects across multiple utilities.

Key Finding #1: Claimed savings calculations used both manufacturers rated wattage and third party tested wattage of lighting products.

In some cases, a difference was noted by the EM&V team between the manufacturer's rated wattage and third-party qualification agency's wattage. Table 3-1 shows differences between manufacturer's rated wattage and qualification agency's tested wattage for three lighting products that were discovered during desk reviews.

Table 3-1. Comparison between Manufacturer's Rated and Third Party Tested Wattages

Lighting Description	Manufacturer's Rated Wattage	Qualification Agency's Tested Wattage
4 ft. T8 linear LED light	17W	19.6W
Parking garage downlight	80W	79W
Parking lot pole light	380W	395W

Recommendation #1: Additional language should be included in the TRM Section 2.1.1—Energy and Demand Savings Methodology—Savings Algorithms and Input variables—Lamp and Fixture Wattages (kW_{pre}, $kW_{Installed}$)—to clarify that the wattage from the Standard Fixture Wattage table in the Lighting Survey Form (LSF) for $kW_{installed}$ should be chosen based on third party certification agency's tested wattage instead of the manufacturer's rated wattage.

Key Finding #2: The EM&V team found that LSF calculators sometimes used incorrect fixture code lighting type suffix descriptors.

LSF calculators in some cases used incorrect fixture code lighting type suffix descriptors. Most often, "-SCRW", "-FIXT", "-TUBE" were used without discretion for what type of light that fixture code was intended to represent. For example, the fixture code "LED009-FIXT" which is designated for a lighting fixture was used for a 9W screw-in LED light. No savings adjustments resulted from corrections to

fixture code suffixes, but more attention should be given to the type of light that is being installed when selecting the proper fixture code.

Recommendation #2: Fixture code lighting type suffix descriptors should be properly selected in the calculators.

3.1.2.2 Building Types

The TRM has building types for lighting and HVAC equipment based on the average use of the typical building in the various categories. Correct selection of building type is important for the accuracy of savings estimates. This section summarizes the key findings and recommendations from the PY2017 evaluation of commercial lighting and HVAC projects in relation to building type selection and provides recommendations for building type codes, descriptions for retail stores, and multiple exterior lighting controls.

Commercial 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 (EFLH), demand factor (DF) based on the building type and HVAC system type. Table 2-19 within the HVAC tables in the PY2017 TRM 5.0 Volume 3 also provides definitions of building types which can be used to guide building type selection for both HVAC and Lighting projects. During the review of claimed savings, the EM&V team noted instances of improper building type selection and identified key new building type additions to the tables which could reduce improper building type selection and improve the tables' functionality.

In addition, during the PY2017 evaluation, the issue of varying schedules for exterior lighting was a topic that came up multiple times. Varying schedules typically result from the installation of one or more lighting controls at a site which leads to different runtimes. A specific project example included a site where all of the lighting equipment was controlled by a photocell, but some of the fixtures were additionally controlled by a timeclock to shut off the lights completely after a certain time at night. To solve this issue, the EM&V and the implementer agreed on adding a "Custom Bldg." worksheet to the LSF calculator that enables the entry of multiple control schemes for a single project.

Key Finding #1: Incorrect selection of building type for non-supermarket type retail stores.

For commercial lighting projects, the EM&V team found consistent incorrect use of the Non–24 Hour Retail, and 24-Hour Retail Building Type Codes. Claimed savings calculations were using these codes for non-supermarket retail stores while these categories were specifically intended for supermarket type retail stores.

Table 2-4 in TRM 4.0 Volume 3 lists building type codes, a building type description, annual operating hours, and the summer peak coincidence factor for each building type for use in lighting projects savings calculations. Two building types given by the codes "Non–24 Hour Retail", and "24-Hour Retail" are intended to be used for lighting and HVAC projects that take place in supermarket food stores. During the desk review process, the EM&V team noticed that these building type codes were often being used for other retail type stores not related to supermarket type retail stores. This is likely due to misleading Building Type Code names and subsequent Building Type Description.

The EM&V team believes that the improper application of the building type codes in claimed savings was a result of the Building Type Codes and Building Type Descriptions not being explicitly clear that

they were indented to be used only for supermarket type retail establishments and not inclusive of other retail stores.

Recommendation #1: The Building Type Codes should be changed from "Non–24 Hour Retail", and "24-Hour Retail" to "Non–24 Hour Supermarket", and "24-Hour Supermarket." This would better describe the Building Type Codes designated application and differentiate the supermarket Building Type Codes from the other codes intended for non-food retail stores. The EM&V team also recommends removing the term "Retail" from both Building Type Descriptions and adding "Food Sales–" to the 24-Hour Supermarket Building Type Description for clarity (*Table 3-2*).

Table 3-2. Current and Proposed Building Type Codes and Descriptions

Current Building Type Code	Current Building Type Description	Proposed building Type Code	Proposed Building Type Description
Non–24 Hour Retail	Food Sales– Non–24 Hour Supermarket/Retail	Non–24 Hour Supermarket	Food Sales– Non–24 Hour Supermarket
24-Hour Retail	24 Hour Supermarket/Retail	24-Hour Supermarket	Food Sales– 24 Hour Supermarket
Retail Non-Mall/Strip	Retail (Excl. mall and strip center)	Retail Non-Mall/Strip	Retail (Excl. mall and strip center)
Enclosed Mall	Retail (Enclosed Mall)	Enclosed Mall	Retail (Enclosed Mall)
Strip/Non-Enclosed Mall	Retail (Strip Center and non-enclosed mall)	Strip/Non-Enclosed Mall	Retail (Strip Center and non-enclosed mall)

Key Finding #2: The TRM does not offer guidance on building type selection for lighting projects when building type is not listed.

The EM&V team found that in the case of lighting projects, the TRM does not offer any guidance for building type selections when the building type is not known.

Recommendation #2: The building type "Other" should be added to Table 2-4 of the TRM for use when the building type is not known. This building type would use the lowest operating hours and summer peak coincidence factor found in the existing table to act as a conservative estimate of operating data in lieu of site-specific monitoring. In Table 2-4 of the TRM, the Religious Building Type Code has the lowest operating hours and is recommended to be used as a reference for the recommended building type "Other" (*Table 3-3*).

Table 3-3. Recommended Additional Building Type

Building Type Code	Building Type Description	Operating Hours	Summer Peak CF
Other	Unknown building type	1,824	53%

Key Finding #3: For non-lighting projects and when a building type is not explicit, other building types were assumed instead of using the building type "Other."

When a building type is not explicit, the EM&V found that projects opted to assume what they felt was a similar building type versus using the "Other" building type guided in the TRM. This tended to result in higher AOH/CF than what was found by the EM&V team who chose the building type "Other."

When a project does not fit into any building description found on the table as it exists now, one option is to follow a custom savings approach where on-site monitoring of lighting is conducted before and after the new lighting products are installed. This allows for a review of any building to be conducted but is a costly approach. Using a conservative "Other" building type likely outweighs any additional savings benefits that could be realized using a custom approach. The EM&V team does, however, recognize there will be instances when a similar building type might be appropriate to use. In these cases, utilities should consult the EM&V team to discuss the use of a similar building type as opposed to the other category.

Recommendation #3: No change to the TRM is necessary, but it should be noted in calculations to utilize the building category "Other" properly. If the EM&V team is consulted to use a similar building type, the correspondence on this issue should be kept in project documentation.

Key Finding #4: Projects with multiple exterior lighting controls might incorrectly state savings when using the same building type as for interior lighting.

Previously, the EM&V team recommended that the same building type should be selected for interior and exterior aspects of a project. This presented some limitations for projects with complex exterior lighting controls since it assumed a default control scheme (or hours of use). In some cases, exterior lighting projects with multiple types of lighting and controls overstated their savings using the default control scheme for the building type.

Consequently, utilities and a LSF implementer requested to change the LSF calculator so that it enables the entry of multiple control schemes for a single project by specifying multiple hours of use and their corresponding factors through a new "Custom Bldg." worksheet in the calculator. The EM&V team agreed with this methodology, which supersedes the previous guidance issued for exterior lighting building types.

Recommendation #4: When multiple exterior lighting control schemes exist in a single project utilize the "Custom Bldg." worksheet.

3.1.3 Sampling for On-site Inspections

This section summarizes the key findings and recommendations from the PY2017 evaluation of commercial projects in relation to implementer or utility selected site inspections.

In some cases, multiple store franchises or branches of the same business completed the same energy efficiency upgrades such as new energy efficient lighting. In many of these cases, the projects were very similar in size across multiple business locations and the lighting or other energy efficient measures that were installed were nearly identical. In these cases, the implementer or utility selected on-site inspections for a small sample across the large family of identical businesses. The small sample of on-sites was then used to inform and estimate the savings for the rest of the businesses that did not

receive on-site inspections. This estimation was done under the expectation that all identical business or store locations that participated in the program were nearly identical in square footage, building use type, and completed the same measures and thus would claim the same energy and demand savings.

The EM&V team completed on-site inspections as part of the evaluation process. Like the utility or implementers sampling strategy, when many businesses of the same name were identified in a program, a sample of the businesses were selected for on-site visits. In one case, an on-site visit was completed by the EM&V team which did not receive an on-site visit by the implementer or utility but was identified as being an identical retail store to other retail stores that completed lighting upgrades through a program. This project claimed the same savings as the rest of the retail stores by the utility or implementer. However, the EM&V team's inspection revealed that this retail store also contained a distribution warehouse which made this project much larger and a different building type than the rest of the retail stores that also participated in the program. Since this additional distribution warehouse did not receive an on-site visit by the implementer or utility, the implementer or utility only claimed savings associated with the assumed sole retail portion or the store, consequently the claimed savings were smaller than the evaluated savings for this building. The EM&V team corrected the savings for this site to include the lighting upgrades for the distribution warehouse.

Key Finding #1: On-site sample selected by implementer or utility was not representative of larger group of projects, which were assumed to be similar due to the business name or type.

The EM&V team found instances of on-site sample selection that did not accurately represent the larger group of supposedly similar projects. This resulted in instances where savings from a small sample were applied to a larger group of similar projects that were later found to be significantly different during the EM&V team's on-site verification.

Recommendation #1: When sampling for site inspections from a large group of similar projects such as multiple stores with the same name or business type, the projects business type and size should be verified for a more representative sample.

3.1.4 Additional Savings

To meet various program objectives, it is common practice for utilities to set a ceiling or cap for the financial incentive any one energy efficiency service provider (EESP) or project can receive. These 'incentive caps' are set as an overall percent of total incentive budget or as a dollar amount. The established caps vary by utility and are noted in their program manuals.

This is a different situation from a "set incentive." During the application phase, utilities calculate a project incentive based on pre-installation estimated savings, the incentive funds are reserved at this time. There may be some variation in the initial savings estimates that were agreed upon in setting the incentive and the actual post-installation savings once the project is completed. This is due to changes in efficiency levels, quantities, or equipment type that take place from the project planning phase to the project implementation phase.

Prior to program year (PY) 2016, the EM&V team observed projects where additional savings were claimed beyond those incentivized. The additional savings were not incentivized because either the 'incentive cap' or 'set incentive'. In some cases, the savings claimed beyond the incentivized measures were substantial. The EM&V team discussed two concerns resulting from this occurrence with PUCT Staff:

- Since all of the project savings are not being incentivized at the project planning phase, claiming all of the project savings may result in increased free-ridership. A free-rider is, "a program participant who would have implemented the program measure or practice in the absence of the program." (16 TAC § 25.181 (c) (24)).[13]
- Spillover could be claimed incorrectly during post-project inspections. Spillover is, "reductions in energy consumption and/or demand caused by the presence of an energy efficiency program, beyond the program-related gross savings of the participants and without financial or technical assistance from the program." ((16 TAC § 25.181 (c) (53)).

Both free-riders and spillover are a component of net savings. Claimed savings are based on gross savings. Including spillover in claimed savings (an addition to gross savings) would bias claimed savings upward without also accounting for free-riders (a reduction to gross savings).

In response to this situation, the EM&V team worked with PUCT staff to distribute a guidance memo to the utilities, *Incentive and Claimed Savings Guidance Memo*, January 5, 2016. The recommendations from that guidance memo are as follows:

> **Individual incentive caps.** If utilities are planning to claim savings beyond those incentivized for an individual EESP or project, they are requested to inform the EM&V team and supply project documentation for the specific project. The EM&V team may conduct additional research to determine the influence of the program on the total project savings. The EM&V team's recommendation should be used to adjust the utilities' claimed savings for the project(s).
>
> **Set incentives.** The EM&V team recommends utilities educate internal staff, implementation contractors and EESPs on spillover to help ensure it is not included in claimed savings if found during post-project inspections. However, documenting spillover may be beneficial when net-to-gross ratios are updated.

The PY2015 Statewide Energy Efficiency Report also included the recommendations from the guidance memo and utilities were expected to fully implement these recommendations in PY2017.

Key Finding #1: While utilities are responsive to the PY2015 incentive recommendations, a more streamlined, consistent, and transparent approach is needed.

The EM&V team receives several projects to review annually to determine if additional savings should be claimed beyond an incentive cap or set incentive. In August 2018, a utility submitted an additional set of projects for EM&V team review. In the EM&V team and PUCT Staff review of these projects, it was discussed that a more streamlined course of action to accomplish the objective of the recommendations to most accurately report savings when incentives are exceeded could be beneficial to the utilities, PUCT Staff, and the EM&V team.

As detailed immediately following, the PY2017 EM&V research updated net-to-gross (NTG) ratios for the Commercial Standard Offer (CSOP) and Market Transformation Programs (CMTPs). The PY2017

[13] In addition to the incentive caps or set incentives at the individual EESP or customer-level, utilities may also set caps on incentives a customer can receive at the measure level. For example, a utility may cap lighting incentives at 50 percent of the total project incentive. The EM&V team does not have the same concerns regarding freeridership for measure-level caps and the recommendations in this memo do not apply to these situations.

NTG research accounts for both free-riders and spillovers. The CSOP NTG ratio is 91 percent for kWh and 89 percent for kW. The CMTP NTG ratio is 86 percent for kWh and 99 percent for kW.

Table 1. PY2017 Commercial Statewide NTG Ratios by Program Type

Program Type/Weighting	Freeridership	Spillover	NTG
CSOP kWh	33%	24%	91%
CSOP kW	32%	21%	89%
CMTP kWh	36%	22%	86%
CMTP kW	33%	32%	99%

Recommendation #1 To establish greater consistency in the treatment of projects where claimed savings exceed incentive amounts and most accurately represent the savings results from these projects, the EM&V team recommends utilities either only claim the savings from the incentivized measures or the utilities apply the most updated net-to-gross (NTG) research[14] to the total project savings for the claimed savings.[15]

NTG ratios should be applied as follows:

For projects where the *claimed savings are more than 10 percent higher than the "set incentive*", the NTG ratio inclusive of freeridership and spillover should be applied to the total project savings. No NTG ratio should be applied for projects where the set incentive and claimed savings differ by 10 percent or less to allow for normal variation between project planning and implementation.

For projects where *claimed savings exceed the "incentive cap" savings up to 20 percent of incentivized savings*, the NTG ratio inclusive of freeridership and spillover should be applied to the total project savings.

For projects where total *claimed savings exceed the "incentive cap" by more than 20 percent of incentivized savings*, the NTG ratio only accounting for freeridership should be applied to the total project savings. Applying the NTG ratio that is also inclusive of spillover to projects that exceed incentive amounts by this large of a percent of incentivized savings would likely result in double-counting spillover.

3.2 COMMERCIAL PROCESS AND NET-TO-GROSS

This section presents the key findings from the Commercial programs participant survey, followed by more detailed results.

[14] The use of a net to gross adjustment to account for free-riders is addressed in § 25.181 (e)(5)(B)(ii).

[15] This recommendation does not apply to behavioral, code or other market transformation programs where the primary program strategy is technical assistance and education that results in behavioral or operational changes for energy and demand savings.

3.2.1 Key Findings

Key Finding #1: The Commercial programs are generating high satisfaction among participants.

Customer respondents rated their overall satisfaction on a 0 to 10 scale in the Commercial survey, where 0 was equal to "very dissatisfied" and 10 was equal to "very satisfied." Mean satisfaction overall among Commercial respondents was 9.4, as more than 90 percent of the overall respondents rated their satisfaction an 8, 9, or 10 out of 10 points. These high satisfaction levels suggested that the programs are being delivered according to customer expectations.

Key Finding #2: Results from Customer and EESP surveys indicate the Commercial programs are influencing customers' energy efficiency decisions.

Several pieces within the PY17 evaluation survey data suggest the Commercial programs continue to have moderate to high influence on customer decisions. When customers and EESPs are presented a 10-point importance scale, were 0 is "not at all important" and 10 is "very important", customers rated 10 of 12 Commercial program factors a 6 or higher (on a 10-point importance scale). Meanwhile, market actors rated all six programs technical and training components a 6 or higher on a similar scale. EESPs also rated the importance of the program in influencing their energy efficiency measure recommendations an average of 8 of 10.

Key Finding #3: The commercial programs are resulting in "spillover"—additional energy efficiency improvements, not incentivized through the programs.

This spillover reported in EESP research is a positive occurrence as additional savings are occurring because of the programs. Higher spillover rates were seen in the PY2017 research compared to the PY2013 research, which may be due to program changes. Previously, a program participant could receive an incentive for a portion of a project because the participant reached an incentive cap, but the program claimed savings for the entire project. This changed in PY16 in response to an EM&V guidance memo. Since 2016, programs primarily only claim savings for portions of their energy efficiency project that were directly incented by the program. The EM&V team suspects that participants still complete the full scope of these projects and EESPs recognize the utility's influence on the entire project.

3.2.2 Commercial Process Observations

3.2.2.1 Survey Overview

The EM&V team conducted a Commercial participant telephone survey to inform the evaluation effort. While the main objective of this survey this evaluation year was to assess measure persistence and collect information used to calculate net-to-gross, the survey did collect limited process information. The survey ran from January 30, 2018 to February 26, 2018. Table 3-4 shows the number of completed surveys by utility and program type.

Table 3-4. Commercial Surveys Completed by Utility and Program Type

Utility	SOP	MTP	Total
AEP TCC	14	72	86
AEP TNC	5	34	39
CenterPoint	46	58	104
EPE	0	57	57
Entergy	0	82	82
Oncor	40	0	40
SWEPCO	45	12	57
TNMP	0	17	17
Xcel Energy	32	0	32
Total	**182**	**332**	**514**

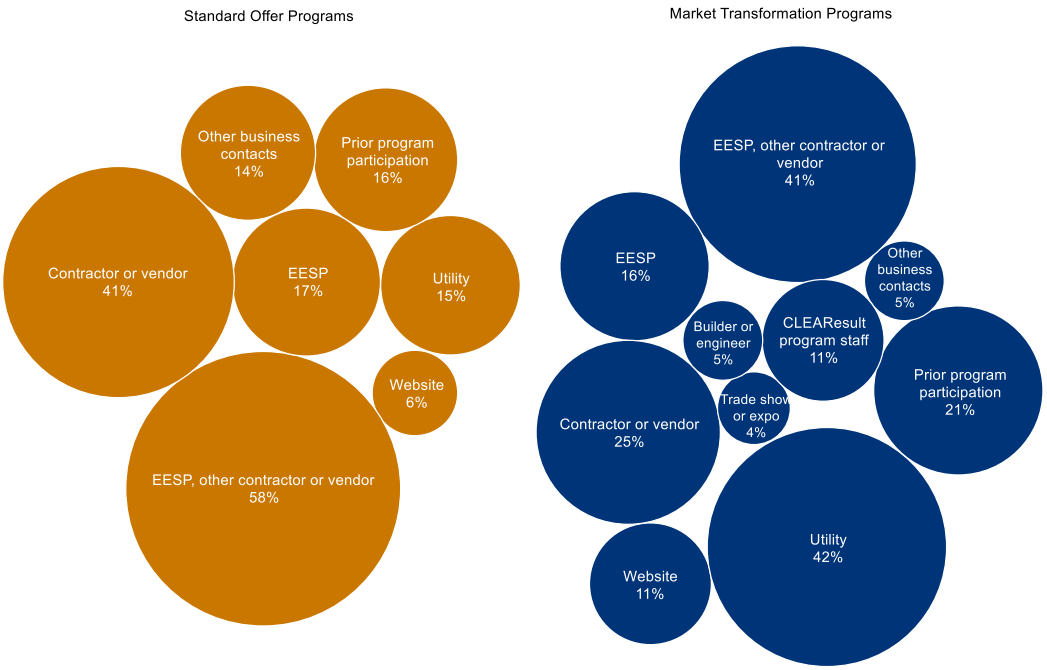
The survey asked questions to inform installation and persistence rates, net-to-gross ratios, and customer satisfaction, and it collected limited information about the participants' business. The survey included feedback from Commercial SOP and MTP participants.

3.2.2.2 Program Awareness

The survey was structured to ask the Commercial SOP and MTR program participants how they first heard about the energy efficiency program. Participant responses—which were slightly different by program—are displayed in Figure 3-1. Participants could report more than one answer.

Commercial Standard Offer program participants most commonly reported that they heard about the program through their EESP vendor (58 percent), but "Contractor or Vendor" was also reported by 41 percent of the SOP respondents. Commercial MTP respondents most frequently reported that they heard about their program through their utility (42 percent), while another 41 percent reported that their EESP vendor was their source of program awareness. Twenty-five percent of MTP respondents reported hearing about the program through a "Contractor or Vendor."

Figure 3-1: Program Awareness: Commercial SOP vs. MTP Respondents



3.2.2.3 Program Satisfaction

The programs are generating high satisfaction among participants. Respondents rated their overall satisfaction on a 0 to 10 scale in the Commercial survey, where 0 was equal to “very dissatisfied” and 10 was equal to “very satisfied.” Mean satisfaction overall among Commercial respondents was 9.4. Sixty-eight percent of overall respondents reported their satisfaction at a 10, or indicated they were “very satisfied” with the program. More than 90 percent of the overall respondents rated their satisfaction an 8, 9, or 10 out of 10 points. Looking at satisfaction by program, 89 percent of CSOP respondents rated their satisfaction an 8, 9, or 10 out of 10 points, while 93 percent of CMTP respondents rated their satisfaction at similar levels.

Table 3-5. Satisfaction with Programs

	Program Type		
	CSOP	CMTP	Statewide Total
0 - Very dissatisfied	0.8%	0.0%	0.0%
1	0.0%	0.0%	0.0%
2	0.0%	0.0%	0.0%
3	0.0%	0.0%	0.0%
4	1.8%	0.0%	0.8%
5	0.8%	3.1%	2.1%
6	0.0%	1.6%	0.8%
7	1.8%	2.3%	2.1%
8	6.2%	12.5%	9.5%
9	8.8%	17.2%	13.3%
10 - Very satisfied	73.5%	63.3%	68.0%
Mean	9.0	9.3	9.4
Respondents (n)	103	128	221

Source: Question SA2, 2017 Commercial Participant Survey.

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

3.2.2.4 Program Influence

We reviewed the customer and market actor responses to key program influence indicators. These statistics, presented below, indicate moderate to high program influence.

First, we examined the responses of market actors were asked to rank the importance of the program in influencing their decision to recommend energy efficiency measures on a scale from 0 to 10 where 0 is "not at all important" and 10 is "very important." Market actors gave the program importance an average rating of 8.0.

Table 3-6. Market Actor Ratings of Program Importance

Scale	Market Actors Responses
0 - Not at all important	0
1	0
2	2
3	2
4	0
5	8
6	2
7	9
8	18
9	9
10 - Very important	40
Mean	8.0
Respondents (n)	90

When asked about the importance of 12 different factors in influencing their decision to purchase or implement energy efficiency upgrades, the highest rated factor among both CSOP and CMTP consumers was payback on investment and the lowest rated factor was financial assistance or a rebate from another organization (not the utility). Table 3-7 includes the average rating for each of the 12 factors on a scale from zero to 10, where zero means “not at all important” and 10 means “very important.”

Table 3-7. Rating of Importance of Factors that Influenced Customers' Energy Efficiency Upgrades

Factor	CSOP Average Rating	CSOP Number of Respondents	CMTP Average Rating	CMTP Number of Respondents
Payback on investment	9.1	168	8.7	189
Information provided through a study, energy assessment, or other technical assistance	7.9	53	7.8	117
Availability of the markdown or financial assistance	7.8	113	7.9	113
Recommendation from a vendor or supplier	7.1	153	6.7	185
Standard practice or corporate policy regarding equipment installation	6.9	161	7.2	158
The age or condition of the old equipment	6.8	160	8.0	163
General concerns about the environment	6.7	169	7.4	188
Information or recommendations provided program staff	6.7	146	7.4	179
Previous experience with a utility energy efficiency project	6.4	127	6.4	121
Information from a service provider or utility program informational materials	6.3	158	7.0	174
Information from a training course or seminar offered by a service provider	4.6	100	5.6	124
Financial assistance or rebate from another organization	4.4	120	5.0	116

Market actors were asked to rate the importance of six different program offerings in their decisions to recommend equipment upgrades. As can be seen in Table 3-8, the most important factor was the program incentive.

Table 3-8. Importance of Technical and Training Components on Market Actor Recommendations

Factor	Average Rating	Number of Respondents
The program incentive provided by the utilities	8.8	92
Your firm's past participation in a rebate or audit program sponsored by the utilities	8.1	81
Information provided by representatives of the program	7.6	87
Information provided by the Utilities websites	7.5	84
Training seminars provided by the program	6.9	72
Technical support provided by the program	6.9	78

Participants and market actors were also asked to rate the likelihood that they would have bought and sold the program qualifying equipment in the absence of the program incentive on a 0 to 10 scale where 0 is “not at all likely” and 10 is “very likely.” The average ranking among CSOP consumers was 6.6 and 6.2 among CMTP consumers, while market actors gave an average ranking of 7.0.

Table 3-9. Likelihood that Consumers and Market Actors Would Have Bought and Sold Energy Efficient Equipment in the Absence of the Program

Scale	Market Actors Responses	CSOP Participant Responses	CMTP Participant Responses
Not at all likely	7	12	31
1	2	6	1
2	4	6	2
3	3	8	9
4	5	4	13
5	9	11	26
6	3	21	7
7	7	19	11
8	9	34	16
9	2	6	19
Very likely	39	41	52
Mean	7.0	6.6	6.2
Respondents (n)	90	168	187

3.2.3 Net-to-Gross

This section presents the methodology and key findings from the commercial NTG research. The EM&V team used surveys to calculate freeridership, spillover, and NTG ratios for both Commercial Standard Offer and Market Transformation program types, where primary data collection was used to estimate NTG. Table 3-10 presents the number of customer and market actor surveys completed for NTG analysis within the commercial sector. Customer survey counts are shown by utility and program type, while market actor counts are at the statewide level by program type, as some market actors operate in multiple utility service territories.

Table 3-10. Commercial NTG Research Primary Data Collection Completes By Program Type and Utility

Utility	CSOP Customer Surveys	CSOP Market Actor Interviews	CMTP Customer Surveys	CMTP Market Actor Interviews
Commercial Completes	**169**	**64**	**184**	**19**
AEP TCC	14		17	
AEP TNC	5		28	
CenterPoint	44		36	

Utility	CSOP Customer Surveys	CSOP Market Actor Interviews	CMTP Customer Surveys	CMTP Market Actor Interviews
El Paso Electric	NA		30	
Entergy	NA		58	
Oncor	35		NA	
SWEPCO	45		1	
TNMP	NA		14	
Xcel Energy	26		NA	

The commercial NTG analysis differed slightly by program type; in particular, how it used market actor data. Within the CSOP analysis, in cases where the EM&V team surveyed a market actor that was mentioned by a participant customer as being influential in their decision-making process, the lower of the customer and market actor freeridership scores were used for final freeridership rate for that project (customer responses for self-sponsored participants were not averaged with market actor responses). The EM&V team used market actor interviews alone to calculate CSOP spillover.

The CMTP analysis used input from customer surveys that sampled from participants of the Commercial Solutions, Large Commercial and Industrial, and SCORE/CitySmart programs within this sector. Only customer results were used for the recommended NTG ratio. Market actor survey data were not used in NTG computations for CMTP programs, as the small number of completes within this sector did not impact NTG ratios.

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

3.2.3.1 Freeridership Results

Table 3-11 reports the program level kWh and kW freeridership rates by program type, respectively, along with the relative precision associated with each estimate.

Table 3-11. Freeridership Results for CSOP and CMTP

Program Type	Customer kWh freeridership rate	Customer kWh Precision at 90 percent CI	Customer kW freeridership rate	Customer kW Precision at 90 percent CI
CSOP (n=169)	33%	3%	32%	3%
CMTP (n=184)	36%	3%	33%	3%

3.2.3.2 Spillover Results

The EM&V team calculated the spillover rate for CSOP at 24 percent for kWh savings and 21 percent for kW savings. This is higher than the spillover rates in our PY13 evaluation, which came in at 7

percent for kWh and 19 percent for kW, respectively. The level of precision at 90 percent confidence is 19 percent for kWh and 19 percent for kW. Seven market actor reported disproportionately high spillover rates, which were capped at 250 percent. Only lighting (n=48) had sufficient sample to report spillover rates by measure category. The kWh and kW weighted spillover rates for lighting were both 21 percent.

The EM&V team calculated the spillover rate for CMTP at 22 percent for kWh savings and 32 percent for kW savings. These levels of spillover also trended slightly higher than the values within our PY13 for Market Transformation programs. The level of precision at 90 percent confidence is 36 percent for kWh and 36 percent for kW.

Commercial program spillover among both program types trends higher in this PY2017 evaluation than in our previous analysis (PY13). One possible driver for higher spillover is a change in the way Commercial Programs are paying incentives and claiming savings. Previously, a program participant could receive an incentive for a portion of a project because the participant reached an incentive cap, but the program claimed savings for the entire project. This changed in PY16 after Tetra Tech offered program implementation guidance on this topic. Currently, the program claims savings only for portions of their energy efficiency project that were directly incented by the program. The EM&V team suspects that participants still complete the full scope of these projects and recognize the utility's influence on the entire project, so the portion of the project that did not qualify for an incentive is being reported as spillover.

3.2.3.3 Net-to-Gross Results

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

$$NTG\ Ratio = (1 - Freeridership\ Rate) + Spillover\ Rate$$

The final CSOP NTG ratio, accounting for freeridership and spillover, is 91 percent for kWh and 89 percent for kW as reported in Table 3-12. The KW NTG ratio for CSOP programs, in particular, is extremely comparable to the 88 percent kW ratio in the last NTG analysis performed on these programs in PY13. The PY13 kWh ratio was 78 percent.

The final CMTP NTG ratio, accounting for freeridership and spillover, is 86 percent for kWh and 99 percent for kW. These ratios are comparable to the by-program ratios calculated in PY13 for SCORE/CitySmart/Educational Facilities/Government Facilities Market Transformation programs at 93 percent kWh and 85 percent kWh for the PY13 Commercial Solutions programs.

Table 3-12. Final Commercial Statewide NTG Ratios by Program Type

Program Type/Weighting	Freeridership	Spillover	NTG
CSOP kWh	33%	24%	91%
CSOP kW	32%	21%	89%
CMTP kWh	36%	22%	86%
CMTP kW	33%	32%	99%

4.0 RESIDENTIAL ENERGY EFFICIENCY PROGRAMS

The residential standard offer programs (RSOPs) and hard-to-reach (HTR) programs were a "high" evaluation priority for PY2017 because utilities are responding to changes in the TRM for common RSOP and HTR measures. These programs comprised a substantial percentage of overall statewide portfolio savings in PY2017 as they are responding to substantial TRM updates to the envelope measures. Moreover, EM&V has recommended expanding the measure mix in these programs starting with PY2017. The EM&V team also updated the NTG ratio along with prioritized process information for the RSOP program since it was last estimated in PY2013. HTR and low-income programs have deemed NTG ratios of one due to the significant affordability issues this customer segment faces, but process information was collected in PY2017 for HTR programs.

Residential market transformation programs[16] were "low" priorities for evaluation in PY2017 because they are small contributors to portfolio savings, have little uncertainty in savings, and/or have fairly homogenous deemed savings projects that have seen healthy realization rates in the prior program years' EM&V. The one exception to this is new homes which is a "low" priority in PY2017 due to program changes planned for PY2018 to respond to an increased baseline and therefore a higher priority planned then.

This section first presents key findings and recommendations from the impact evaluations. This is followed by process evaluation and net-to-gross research results.

4.1 IMPACT EVALUATION KEY FINDINGS AND RECOMMENDATIONS

This section summarizes the key findings and recommendations from the PY2017 impact evaluation of the residential programs resulted in several recommendations regarding documentation that can improve the QA/QC of program implementation and the evaluation of savings.

4.1.1 Background

As part of the impact evaluation, the EM&V team conducted desk reviews and on-site M&V for a sample of projects from the Residential Standard Offer (RSOP), Hard-to-Reach SOP (HTR), and Low Income programs. The EM&V team applied the method prescribed in the PY2017 TRM 4.0 to verify energy savings and demand reduction for each measure sampled. Comparing the evaluated savings to the utility claimed savings showed agreement in most cases. The aggregated desk review realization rates across all RSOP, HTR, and Low Income programs were 98.2 percent and 97.8 percent for demand and energy savings respectively[17]. The two main drivers of these realization rates were baseline restrictions due to insufficient documentation and M&V onsite results that differed from reported results. Based on the results of the evaluation, the EM&V team has formulated a list of key findings and corresponding recommendations described below.

From the RSOP and HTR programs from each utility, the EM&V team drew a stratified sample from the three prioritized measures for evaluation—air infiltration, ceiling insulation, and duct efficiency—to complete desk reviews. These three measures were prioritized because they accounted for the largest portion of the savings across these program types. Stratum sample sizes for each utility reflected the proportion of savings derived from each of the three measures. Thus, the sample for each utility

[16] The one exception is El Paso Electric's Residential Solutions program, which is included in the RSOP category given the similar program delivery method.

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

represented the savings from that utility, and the combined sample reflected the distribution of savings across utilities.

For Low Income programs from each utility, the EM&V team drew a sample defined by the targeted measure for the PY2017 evaluation—central heat pumps—to complete desk reviews. Central heat pumps were prioritized because they accounted for the majority of the savings in the low-income programs. While the central heat pump measure was the focus of the sample, additional rebated measures for these participants were also evaluated.

For these three residential program types, the onsite sample was nested within the desk review sample, meaning that desk reviews were conducted for each of the completed site visits. The EM&V team also collected data for other rebated measures while on site beyond the prioritized measures to provide an additional check on installation rates.

4.1.2 Baseline Documentation

Key Finding #1: Savings were claimed despite insufficient documentation collected where baseline restrictions were present.

The PY2017 TRM 4.0 provides specific requirements that must be met in order to claim the higher level of savings associated with the baseline restrictions. The EM&V team found that documentation was not collected for several projects with the affected measures, namely the ceiling insulation and air infiltration measures. The ceiling insulation measure requires additional pictures in order to claim savings for baseline under R5. This is due to the substantial increase in savings from category R5-R8 to R4 and below. The air infiltration measure also requires additional pictures for homes that achieve a CFM reduction percentage of 30-40 percent.

Recommendation #1: Utilities should educate contractors on the documentation requirements set forth in the TRM.

4.1.3 Infiltration Test Results

Key Finding #2: EM&V onsite test results varied from reported test results.

There were several cases where the EM&V team's onsite testing results for the air infiltration and duct efficiency measures varied substantially from the reported test results. We understand that due to the potential differences in conditions during testing the test results will vary, which is why a +/- 10 percent threshold was considered when conducting the desk reviews for the site visits. Aside from cases where baseline restrictions were present, the TRM does not require photo documentation of the contractor's test results. Because this documentation was not collected, the EM&V team could not verify the root cause of the variance in testing or that the cases in which test results varied greatly were using the correct testing methods as described in the TRM and/or deploying them correctly. Collecting photos of the manometer test results pre- and post-condition is considered an industry best practice and would provide additional QA/QC when entering test results into the system as well as verify the home has been pressurized correctly.

Recommendation #2: Utilities should consider collecting photos of test results to ensure accuracy and method of testing adheres to BPI standards and the methods set forth in the TRM.

4.1.4 Direct Install Measure Documentation

Key Finding #2: Documentation verifying direct install measures is not being collected.

The PY2017 TRM 4.0 provides tracking data and evaluation requirements for each measure. Documentation verifying the key parameters needed to evaluate savings should be provided to confirm the eligibility (i.e., LEDs are Energy Star qualified) and claimed savings for each measure. Examples of documentation include, but are not limited to, manufacturer cut sheets and photos of efficient measures with visible model number. Those utilities moving away from paper hard copies should include model numbers in their electronic forms submitted.

Recommendation #3: Utilities should collect documentation for all direct install measures, i.e., lightbulbs, showerheads, and faucet aerators, in addition to the other measures offered.

4.1.5 Pictures for Insulation Measures

Key Finding #4: Site-specific assumptions are not being documented.

The EM&V team found that for several projects, assumptions were made by contractors performing work that did not match the industry standard. For example, during our desk review process we found a substantial amount of variance between ceiling insulation R-values of the same depth. The Department of Energy provides guidance on the R-value of insulation compared to the type and depth. The EM&V team understands each home is unique, and due to age and degradation over time, the R-value may differ from the industry standard for the insulation type, which is why documentation is important for verification. Please note that these components could also tie into other similar measures, such as wall and floor insulation as well as measures applying the early retirement action type.

Recommendation #4: Pictures should be required where insulation levels are visible. This way, any questions related to assumptions made during the pre- or post-installation process are documented and available for the verification process.

4.2 PROCESS AND NET-TO-GROSS

4.2.1 Key Findings

Key Finding #1: Participants are satisfied with their program experience.

Ninety-two percent of PY17 residential energy efficiency program participants rated their satisfaction a ‘4’ or a ‘5’ on a 5-point scale. Overall mean satisfaction across residential respondents was 4.7.

Key Finding #2: Residential energy efficiency programs are most often introduced to customers through other people.

More than half of the residential program participants we surveyed indicated they heard about the energy efficiency program they ultimately

participated in through word of mouth like a relative, friend, or their EESP / contractor.

Key Finding #3: The NTG ratio for Residential Offer Programs has increased slightly over time.

The final PY2017 Residential SOP NTG ratio, accounting for freeridership and spillover, is 86 percent weighted by kW and 92 percent weighted by kWh. This result is slightly higher than the previous round of research from PY2013, which estimated NTG of 78 percent for both kW and kWh. Participants rated program influence factors, and scored "*Availability of program rebate, incentive or free equipment*" an average of 9.1 on a 10-point scale, further supporting the importance of the programs to the residential customer decision making process and participation experience.

4.2.2 Residential Process Observations

4.2.2.1 Survey Overview

The EM&V team conducted a residential participant telephone survey to inform the evaluation effort. While the main objective of this survey this evaluation year was to assess measure persistence and collect information used to calculate net-to-gross, the survey did collect limited process information. The survey ran from November 29, 2017 to January 12, 2018. Table 4-1 shows the number of completed surveys by utility and program type.

Table 4-1. Residential Surveys Completed by Utility and Program Type

Utility	SOP	HTR	Total
AEP TCC	62	15	77
AEP TNC	20	10	30
CenterPoint	5	36	41
EPE	28	4	32
Entergy	61	11	72
Oncor	40	19	59
SWEPCO	28	13	41
TNMP	60	11	71
Xcel Energy	26	13	39
Total	**330**	**132**	**462**

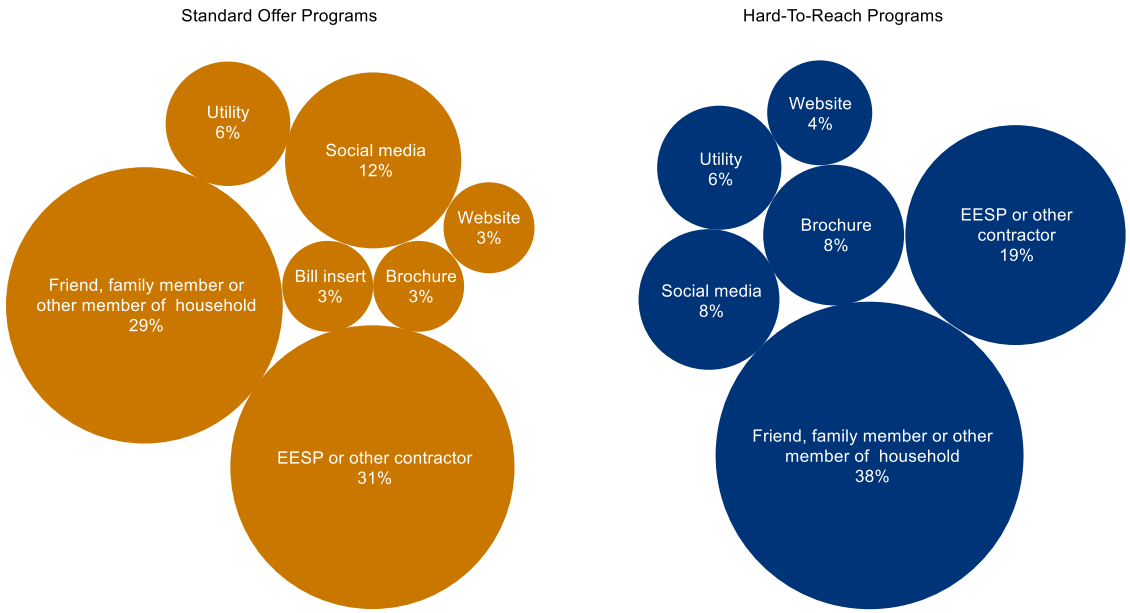
The following section summarizes key findings from the Residential customer participant survey. This survey asked questions to inform installation and persistence rates, net-to-gross ratios, and customer satisfaction, and it collected information about the participants' households. The survey focused on feedback from participants of the SOP and HTR programs.

4.2.2.2 Program Awareness

The survey asked the SOP and HTR program participants how they first heard about the energy efficiency program. Their responses are displayed in Figure 4-1. The most common response given by

32 percent of respondents overall, regardless of program type, was that they heard about it through word of mouth from a friend, family member, or other household. Another twenty-three percent of respondents confirmed they heard about their Residential energy efficiency program from the EESP or contractor, which was more common for SOP participants than HTR respondents. It's worth noting that 11 percent of the overall respondents indicated that they heard about the program from social media; however, nearly 77 percent of those responses were provided by participants of the SOP program.

Figure 4-1: Program Awareness: Residential SOP vs. Hard-to-Reach Respondents



4.2.2.3 Program Satisfaction

The survey included a short series of questions to gauge customer satisfaction with their participation experience. The programs are generating high satisfaction among participants. Respondents rated their overall satisfaction on a 1 to 5 scale, where 1 was "very dissatisfied" and 5 was "very satisfied", 79 percent of respondents confirmed they were "very satisfied" with the program. Mean satisfaction overall among residential respondents was 4.7. Further, when respondents of the SOP and HTR programs were asked what they would change about the program if they could, nearly three-quarters of them (74 percent) reported "nothing." Among those who chose one of our survey categories about program change, 3 percent of respondents indicated they would like "more types of qualifying equipment available."

Table 4-2. Satisfaction with Programs

	Program Type		
	SOP	HTR	Statewide Total
1 - Very dissatisfied	1.2%	0.0%	0.8%
2	1.2%	0.9%	1.1%
3	6.0%	5.4%	5.8%
4	12.4%	15.2%	13.2%
5 - Very satisfied	79.3%	78.6%	79.1%
Mean	4.7	4.7	4.7
Respondents (n)	251	112	363

Source: Question SA1, 2017 Residential Participant Survey.
Note: Totals may not sum to 100 percent due to rounding. Don't know and not applicable answers and multiples were excluded from this analysis.

4.2.2.4 Program Influence

We reviewed the customer responses to key program influence indicators. These statistics, presented below, indicate program influence.

When asked about the importance of six different factors in influencing their decision to purchase or implement energy efficiency upgrades, the highest rated factor among participants was the availability of the rebate, incentive or free equipment followed by the information from the energy efficiency service provider or utility. Table 4-3 includes the average rating for each of the six factors on a scale from 0 to 10, where 0 means "not at all important" and 10 means "very important."

Table 4-3. Participant and Ratings of Program Importance

Program Aspects	Average Influence Rating	Number of Respondents
Age or condition of old equipment	6.9	304
Availability of program rebate, incentive or free equipment	9.1	345
Information provided through an energy assessment	8.7	158
Information from an EESP or utility	8.8	175
Previous experience with an EESP project	8.3	219
Previous experience with a utility energy efficiency program	7.4	180

Source: Question FR14. Don't know and Refused responses excluded.

4.2.3 Net-to-Gross

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

The EM&V team used a self-report approach (SRA) implemented through customer surveys to collect responses for use in calculating freeridership and spillover. The survey sample was designed to meet the industry standard of ±10% precision at 90% confidence, which the results achieved. Table 4-4 documents the number of customer surveys completed for the Residential SOP (RSOP) survey by utility.

Table 4-4. RSOP NTG Research Primary Data Collection Completes[18]

Utility	Number of Customer Survey Completes
AEP TCC	62
AEP TNC	20
CenterPoint	5
El Paso Electric	28
Entergy	61
Oncor	40
SWEPCO	28
TNMP	60
Xcel Energy	26
Total	**330**

Customer responses were weighted to account for several factors, including survey non-response, disproportionate sampling, and variation in project size. A sample weight accounts for non-response and disproportionate sampling, representing the difference between the sampled projects and the population. Cases are also weighted by the measure's energy savings (kWh) or demand reduction (kW) to account for differences in the size of projects represented in the survey.

4.2.3.1 Freeridership Results

Freeridership analysis attempts to estimate the proportion of savings that stem from customer actions that would have happened in the absence of the program. Customers who would have completed the same project at the same time without the program's intervention are considered free-riders. The freeridership rate takes into consideration the scope of the project (size or quantity of measures installed), the efficiency of the equipment installed, and the timing of the project. These components are combined into a customer-level freeridership score, and then the customer-level scores are weighted and aggregated to a produce a program freeridership rate.

[18] The evaluation team excluded customers who installed HVAC measures for the PY17 RSOP NTG final report analysis due to limited sample size. HVAC projects and measures will be included in the PY18 NTG analysis through the inclusion of market actor surveys within that upcoming NTG analysis. Market actors are expected to more accurately represent the interplay between cost and efficiency within this measure group.

The statewide freeridership rates for RSOP are 16 percent weighted by kWh and 17 percent weighted by kW. All customers who were aware they received a markdown or incentive for the measures installed were included in the analysis.

4.2.3.2 Spillover Results

Spillover refers to additional energy-savings actions taken by participants; in particular, installing additional energy-saving equipment, because of the program's influence but without direct intervention from the utility. The EM&V team calculated spillover savings by asking customers about any additional equipment they installed and applied the savings values in the Texas technical reference manual. These savings were attributed to the program based on customer responses, and the spillover rate is the ratio of spillover savings to gross program savings.

The EM&V team calculated spillover for RSOP of 8 percent for kWh and 2 percent for kW.

4.2.3.3 Net-to-Gross Results

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

$$NTG\ Ratio = (1 - Freeridership\ Rate) + Spillover\ Rate$$

The final NTG ratio, accounting for freeridership and spillover is 86 percent weighted by kW and 92 percent weighted by kWh. Table 4-5 shows the final RSOP statewide freeridership rate, spillover rate, and NTG ratio. These final statewide NTG ratios are slightly higher than the previous round of research from 2013, which estimated NTG of 78 percent for both kW and kWh.

Table 4-5. Final PY2017 RSOP Statewide NTG Ratio

Savings Type	Freeridership	Spillover	NTG Ratio
kW	17%	2%	86%
kWh	16%	8%	92%

5.0 LOAD MANAGEMENT PROGRAMS

Load management programs were designated a “medium” evaluation priority in PY2017 due to their significant contribution to capacity (kW) savings and the new nature of the residential demand response programs, as well as recent changes in TRM methodologies for the commercial load management programs. This section documents key findings and recommendations from the EM&V team’s results for both commercial and residential load management programs.

5.1 COMMERCIAL LOAD MANAGEMENT

This section summarizes the key findings and recommendations from the PY2017 evaluation of the Commercial Load Management programs offered by the ten Texas utilities.

5.1.1 Background

The EM&V team applied the method prescribed in the PY2017 TRM 4.0 on a census of records to calculate energy savings and demand reductions. The total evaluated savings of all ten programs were 259,336 kW and 1,125,705 kWh. These results show a rebound compared to PY2016, by roughly 31 MW (31,000 kW).

Demand savings calculations from each utility were calculated largely the same as the evaluation calculations. In several cases, adjustments were made to address individual meter differences or due to understanding the reported savings compared to calculated savings. For example, Oncor initially reported kW savings about 20 percent less than those calculated by the EM&V Team, but in discussion with Oncor, the difference was one of a policy to not report savings in excess of planned savings. Most other meter level adjustments were associated with baseline day selection differences, an issue of individual meter and event analyses. For El Paso Electric, the EM&V team collaborated with the utility to confirm the correct approach to handling the savings calculation for two customers that also participated in a curtailment tariff that experienced an overlapping load management event and curtailment. The EM&V team collaborated with the utilities to ensure meter data covered the appropriate baseline days and that meter-level participation in events were understood and confirmed by all parties. The result was a statewide kW savings realization rate of 100.7 percent.

Adjustments to the kWh savings were based on the same underlying changes made during the process to adjust kW savings, described above. The result was a statewide kWh savings realization rate of 100.7 percent.

5.1.2 Key Findings and Recommendations

Key findings and applicable recommendations for commercial load management programs are presented below.

Key Finding #1: Utilities demonstrated strong capabilities to apply the TRM calculation method to savings.

PY2017 is the second year in which utilities and the EM&V team have applied the demand savings algorithm described in TRM 4.0. Now that the difficulties have been worked through in PY2016, and there is a mutual understanding of the high five of ten approach, the utility companies, implementers, and EM&V team were largely in agreement on final demand savings calculations. However, differences

in calculations for individual meters continued to be the main point for ongoing collaboration and clarification.

Recommendation #1: Continue ongoing communications with the EM&V team to resolve minor calculation differences and ensure continued performance and streamlining data provision and analysis efforts. The EM&V team can work with utilities to review their calculation systems to continue to reduce the number of individual cases with savings variances.

Key Finding #2: The EM&V team received on time and quality interval meter data. The EM&V team received clear and concise data documentation.

The streamlining of interval meter data to the EM&V team improved in PY2017 from previous program years. Utilities and implementers provided clear documentation as to when events were called, meters that did not participate or were damaged at the time of the event, and other relevant program information.

Recommendation #2: Continue to provide on time and quality data to the EM&V team when requested. Continue to provide the EM&V team all relevant program documentation and information that is needed to calculate kW savings as described in the Texas TRM.

5.2 RESIDENTIAL LOAD MANAGEMENT

This section summarizes the key findings and recommendations from the PY2017 evaluation of the Residential Load Management programs offered by four Texas utilities (AEP TCC, AEP TNC, CenterPoint and Oncor). Other utilities did not offer a residential load management program.

5.2.1 Background

The EM&V team applied the method prescribed in the PY2017 TRM 4.0 to calculate energy savings and demand reduction for each utility. The total evaluated savings for the four programs were 45,968 kW and 257,678 kWh. Oncor's and CenterPoint's programs were in their third year of implementation in PY2017. AEP's were offered for the second time in PY2017.

Comparing the evaluated savings to the utility claimed savings shows agreement in most cases. In the case of Oncor, the EM&V team worked with Oncor at a detailed level over the past two program years and, as a result, calculations matched extremely close in PY2017. In addition, Oncor provided valuable documentation of how they addressed meters requiring specific treatment. In the case of CenterPoint, the EM&V team worked with the utility to resolve calculation differences, finding that the two could not come to an agreement on savings from the first round of meter data that was sent to the EM&V team. After brief communication between the EM&V team and CenterPoint regarding the data, CenterPoint provided a new set of meter data that proved to be comprehensive and of good quality. After the second data set was evaluated with a 100 percent realization rate.

For AEP TCC and AEP TNC, the EM&V team worked with the utilities and found that program calculated savings were initially understated. There appeared to be different approaches to calculations taken by the implementer than the EM&V team. In collaboration with AEP and their implementer, updated meter data was provided, and calculation methods were largely resolved. The remaining differences were not resolved with AEP, with the EM&V team's final results being slightly higher than AEP's.

The EM&V team calculated kWh savings with results aligning with kW savings. kWh savings are calculated as the sum of the individual hour kW savings across all event hours.

In working with the four utilities offering residential demand response programs, the EM&V team was able to apply the PY2017 TRM 4.0 method to the interval meter data supplied by each utility. The process of working with the utilities enabled all parties to confirm the approach to applying the TRM 4.0 calculation method. The EM&V team continues to work with each utility on its residential load management calculation methods and approaches.

5.2.2 Key Findings and Recommendations

Key findings and applicable recommendations are presented below.

Key Finding #1: Some utilities appear to have ongoing challenges with managing the data or analysis of residential load management programs.

With the exception of Oncor, the EM&V team found that it had to receive updated meter datasets or needed to resolve TRM calculation specifics with either the utility or implementer. In general, these issues were resolved with close agreement in savings calculations but indicate an ongoing opportunity for improvement. The EM&V team has had a good dialog with the utilities and implementers to address the issues of data or analysis, with the outcome posing little risk to final evaluated results.

Recommendation #1: 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.

Key Finding #2: The EM&V team did not receive documentation from some utilities regarding the handling of special-case meters.

Although not specifically requested, the EM&V team does request “Other relevant information (e.g., unique analytic situations or exceptions to TRM calculations)” for load management programs as part of its larger data request. In PY2017 the EM&V team received data from Oncor that presented, by ESIID, those cases that experienced meter failures that would affect demand response calculations, as well as, inactive customers that were enrolled in the program but did not participate in one or either of the two events. This data was helpful to confirm that these conditions were present in the program and to accurately calculate savings at the ESIID level. Other utilities did not provide this level of information. While it’s difficult for the EM&V team to anticipate all possible situations that would lead to exceptions to the standard TRM calculation, having utilities provide this information proactively helps streamline the EM&V process and collaboration with utilities to resolve calculation differences.

Recommendation #2: The utilities should provide documentation for all calculation decisions as they related to applying the TRM. Keeping adequate records for each meter, for each event, and the disposition of each ESIID, will not only streamline calculations but reduce the cause of potential discrepancies between the EM&V team and utility calculations.

Key Finding #3: Non-utility implementers may not always be as familiar with the TRM calculations as the EM&V and utility staff.

One of the utility's implementers developed calculations that differed substantially in their result compared to the evaluated results. The TRM approach used by the EM&V team resulted in higher savings than the implementer. In inspecting the implementer's calculation workbooks, it was unclear exactly what method the implementer was using to calculate meter-level results but did not appear to be the TRM method. It behooves the EM&V team, utilities, and implementers for all parties to use the same calculation methods and to communicate when and why those methods may differ. For PY2017, the issue is muted by what appears to be a conservative calculation on the part of the implementer.

Recommendation #3: Implementers should use the EM&V team as a resource to ensure a full understanding of the TRM calculation method prior to reporting savings.

6.0 CROSS-SECTOR MEASURES

Air conditioning tune-ups continued as “medium” evaluation priority in PY2017 as savings recommendations from the PY2014 EM&V were to be fully implemented in PY2017, but some additional changes were still identified in PY201& as the mix of tune-ups has become increasingly residential and commercial instead of primarily residential. Both commercial and residential solar projects also received a “medium” priority in PY2017 due to TRM changes in the methodology from deemed values to a M&V approach. This section also presents results found in the evaluation of the commercial and residential programs that apply to measures that are offered to both sectors.

6.1 HVAC TUNE-UPS

This section summarizes the key findings and recommendations from the PY2017 evaluation of air-conditioning and heat pump tune-ups. The recommendations in this report are to be considered by the utilities for PY2018 implementation and will also be incorporated into the PY2019 TRM 6.0.

6.1.1 Background

The PY2016 Statewide Portfolio Report detailed findings and recommendations from a census review of CoolSaver heat pump and air conditioning tune-ups in Section 4.1. One of the key recommendations was that calibration of the model used to develop the stipulated efficiency losses[19] 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 annual basis to determine if PY2016 reflected a decreasing trend over time or if it was an outlier. Finally, the ratio of projects receiving full M&V in PY2016 was found to be lower than 10 percent for three of the four utilities overall and a recommendation was made to increase the tune-ups receiving M&V to at least 10 percent by utility and sector.

In PY2017, over 7,000 tune-up measures were provided to residential and commercial customers through four Texas utilities across six different programs as shown below (Table 6-1).

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

Table 6-1. PY2017 Tune-Up Summary by Utility and Program

Utility	Market Transformation Program	Energy Savings		Tune-Up Count
		Reported kW	Reported kWh	
AEP TCC	CoolSaver[1]	2,612	6,677,954	3,740
CenterPoint	Retail Electric Provider[2]	1,749	4,355,462	3,895
El Paso Electric	Large C&I Solutions	1	3,788	7
	Small Commercial Solutions	1	1,924	5
	Residential Solutions	26	45,926	56
TNMP	CoolSaver Pilot	52	132,380	134
Total		**4,443**	**11,221,025**	**7,837**

[1] AEP TCC's CoolSaver reported kW, reported kWh, and tune-up counts do not include 65 HVAC replacement measures reported in PY2017 as part of the program.

[2] CenterPoint's Retail Electric Provider reported kW, reported kWh, and tune-up counts do not include 88 lighting measures reported in PY2017 as part of the program.

6.1.2 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 to efficiency loss values by sector (residential and commercial), and for whether a refrigerant charge adjustment was conducted. The results of the PY2016 efficiency loss analysis is presented in Table 6-2.

Table 6-2. Calculated Efficiency Loss Values (PY2014–2016 Averages)

Sector	Refrigerant Charge Adjusted	Efficiency Loss Factor
Commercial	No	0.078
	Yes	0.123
Residential	No	0.060
	Yes	0.139

Approximately 10 percent of tune-ups are anticipated by the CoolSaver program to receive M&V in a given year for use in the annual efficiency loss updates. Table 6-3 shows the total tune-ups and M&V quantities by utility that were completed in PY2017. All four utilities were well above 10 percent on their tune-up projects which helped bring the statewide average to 20 percent.

Table 6-3. PY2017 M&V Summary by Utility

Utility	Tune-Up Count	M&V Count	M&V percent
AEP TCC	3,740	522	14%
CenterPoint	3,895	960	25%
El Paso Electric	68	58	85%
TNMP	134	25	19%
Total	**7,837**	**1,565**	**20%**

6.1.3 EM&V Approach

As a first step, the EM&V team conducted a complete tracking system review for all four utilities that reported tune-ups in 2017. This 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 EM&V team added the M&V dataset to the full tune-up M&V dataset from 2011 through 2016 that was analyzed in PY2016, to analyze the efficiency losses, which are 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 2011 through 2017 was completed. The tracking datasets from 2011 through 2017 were combined into a single dataset for analysis. The combined M&V dataset included 13,575 individual tune-up measures collected by the programs over the last seven years. Each tune-up measure was tested to assure data validity before analysis of the efficiency loss values. The test included the following two procedures.

- **First, projects were checked for acceptable energy efficiency ratios (EER).** The EER_{pre} and EER_{post} values were validated as appropriate when they were greater than 0 for both values. Seven tune-ups were found invalid per the EER check and were excluded from further analysis. There was one PY2017 data point that was excluded by this data check.
- **Second, the validity of the refrigerant charge adjustment was checked for appropriateness.** There was no single database field available for the status of the Refrigerant Charge Adjustment (RCA), so the EM&V team analyzed multiple fields that reflected the RCA which included the Condition and percentChange fields for refrigeration circuits 1 and 2 for all projects. Where conflicting data was present, such as a Condition of "Add" with a percentChange of "0", the data was excluded from the analysis. This review resulted in the exclusion of 85 tune-ups. There were no PY2017 projects excluded by this data check.

A total of 13,483 tune-up measures passed both data checks and were considered valid. Next, the dataset was separated for tune-ups with an RCA and without an RCA. This resulted in identifying 5,546 tune-ups without an RCA and 7,937 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 3 standard

deviations from the mean was excluded from the efficiency loss calculations. A total of 245 tune-ups were identified as outliers from the compressor power test and excluded from the analysis.

6.1.4 Results

In the PY2016 evaluation, the EM&V team also found that the PY2016 efficiency loss values for the Residential sector deviated substantially from the PY2011–2015 averages and from the PY2015 efficiency losses, which were described in the PY2016 Annual Report. One of the recommendations from the PY2016 evaluation was to evaluate the efficiency loss values annually to determine if the change in the efficiency loss rates observed in PY2016 were persistent over time.

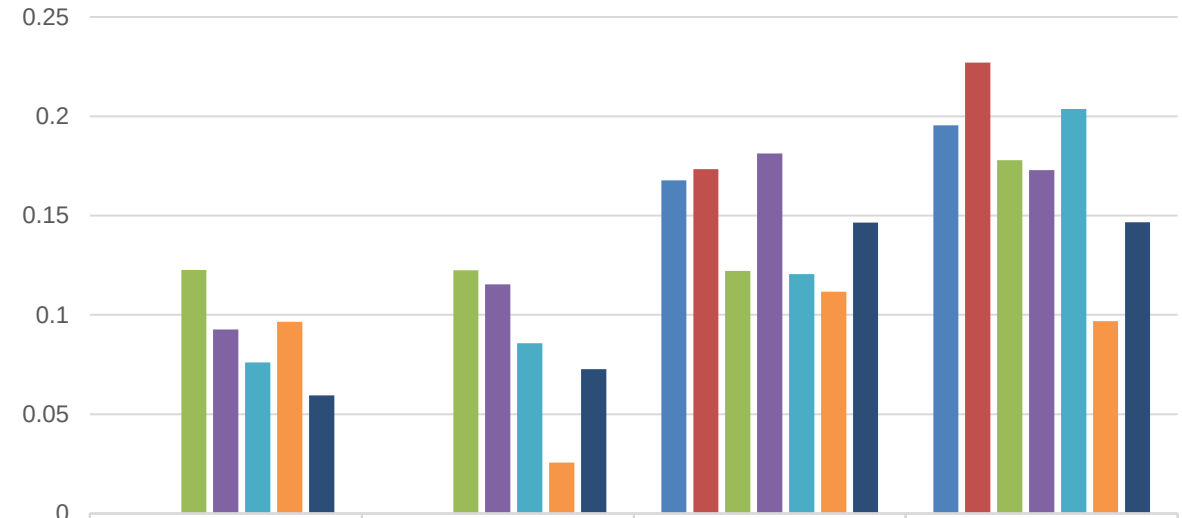
The number of M&V tune-ups validated by year is presented in Table 6-4. The exclusion rate for projects was lower from 2014–2017 (1.3–2.1 percent) compared to 2011–2013 (2.5-4.9 percent). The lower exclusion rate likely reflects the accuracy of the software testing suites, such as iManifold, that have increased in use among trade allies and provides for more accurate data collection.

Table 6-4. M&V Tune-Ups Validated by Year

Year	Total M&V Projects	Passed Data Checks	Passed Compressor Power Test	Total Projects Excluded	Exclusion Rate
2011	1,163	1,143	1,105	58	5.0%
2012	638	629	606	32	5.0%
2013	6,063	6,010	5,909	154	2.5%
2014	2,065	2,064	2,028	37	1.8%
2015	819	819	802	17	2.1%
2016	1,262	1,254	1,244	18	1.4%
2017	1,565	1,564	1,544	21	1.3%
Total	**13,575**	**13,483**	**13,238**	**337**	**2.5%**

The 13,238 Texas tune-ups that passed the data checks were then analyzed by year, by sector (i.e., residential, commercial), and RCA status. The results are shown in Figure 6-1. The PY2017 Residential efficiency losses (with and without RCAs) were found to be more in-line with the averages from PY2011–2015 than the unusually low values that were seen in PY2016.

Figure 6-1. Texas Average Efficiency Losses by Sector and Year



	No RCA		RCA	
	Commercial	Residential	Commercial	Residential
2011			0.168	0.195
2012			0.173	0.227
2013	0.123	0.123	0.122	0.178
2014	0.093	0.115	0.181	0.173
2015	0.076	0.086	0.121	0.204
2016	0.097	0.026	0.112	0.097
2017	0.060	0.073	0.146	0.147

6.1.5 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 #1a: The efficiency losses determined from M&V measurements for PY2017 appear to be in alignment.

In the PY2016 evaluation, the efficiency loss values for Residential both with and without RCAs were found to be much lower than the historical average. In addition, the PY2016 efficiency loss value for residential tune-ups without a refrigerant charge adjustment (0.026) was lower than the deemed value in the TRM (0.050). In PY2017, the efficiency losses for all four categories were found to be more in alignment with the historical 2011–2015 averages, indicating that the PY2016 efficiency loss results are an outlier. In the PY2016 recommendations, the M&V team made the recommendation to use a three-year rolling average that would reflect changes over time in the efficiency loss rates but reduce the volatility that would occur from using the previous year's efficiency loss results alone. The results of the three-year rolling average, after removing the identified outliers, is presented in Table 6-5.

Table 6-5. PY2014–2016 Texas Efficiency Losses

Sector	Refrigerant Charge Adjusted	Efficiency Loss
Commercial	No	0.078
	Yes	0.123
Residential	No	0.060
	Yes	0.139

Key Finding #1b: A review of the 2011 through 2017 statewide M&V datasets indicated the efficiency losses calculated for recent years has diverged from the aggregated average since PY2011.

In the PY2016 evaluation, the three-year rolling average for efficiency losses for all four categories (Residential and Commercial, both with and without RCAs) was found to be lower than the historical average since PY2011. This was found to still be the case when including the PY2017 efficiency loss data in the new three-year rolling average. The averages for each category declined by 14-50 percent when compared to the PY2011–2014 averages.

Recommendation #1: The EM&V team recommends using a rolling three-year average[20] of the efficiency losses to reflect potential changes over time and reduce the volatility from year-to-year that is seen in the year-to-year efficiency loss values.

Key Finding #2: Tune-Up measures should continue to collect a robust M&V sample for both commercial and residential projects.

In PY2017, approximately 20 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. This represented an improvement over PY2016, where the statewide average was close to 10 percent, however M&V tune-ups for commercial projects were less than 10 percent. These M&V samples are used to calculate and calibrate efficiency losses for all tune-ups completed. Since there were more tune-ups collected statewide in PY2017 for residential, the M&V team has more confidence in the calculated efficiency loss values for residential than for commercial.

[20] 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.

Table 6-6. M&V Tune-Up Counts by Sector

Utility	Sector	Tune-Up Count	M&V Count	M&V percent
AEP TCC	Commercial	1,948	89	5%
	Residential	1,792	433	24%
CenterPoint	Commercial	250	24	10%
	Residential	3,645	936	26%
EPE	Commercial	12	9	75%
	Residential	56	49	88%
TNMP	Residential	134	25	19%
Total	**Commercial**	**2,210**	**122**	**6%**
	Residential	**5,627**	**1,443**	**26%**

Recommendation #2: Collect at least a 10 percent M&V sample for tune-up measures annually for the commercial and residential populations separately.

6.2 SOLAR PV

This section summarizes the key findings and recommendations from the PY2017 evaluation of residential and commercial Solar PV projects. The recommendations are to be considered by the utilities for PY2018 implementation and will also be incorporated into the PY2019 Texas Technical Reference Manual (TRM) 6.0 as appropriate.

6.2.1 Results

Solar PV project calculations were based upon the application data and documentation submitted by the installation contractor or updated documentation following a utility's QA/QC site visit. The documentation included technical specifications of the proposed equipment, system design parameters, and an estimation of the electricity production. The utilities used the system design and technical specifications to create an estimate of the electricity production using the National Renewable Energy Laboratory (NREL) calculator, PV Watts®. The peak demand reduction (kW) was determined using deemed savings factors provided in lookup tables in the TRM for various weather zones in Texas. In some cases, the documentation also included a shading study, and QA/QC post-installation inspection findings.

In the PY2017 evaluation, the EM&V team noted that the utilities followed the calculation approach as described in the TRM. Also, all solar PV projects sampled for evaluation review used the fixed deemed savings factors provided in the TRM for the relevant weather zone. The EM&V team recommended adjustments for several projects related to specific details, varying across the sampled projects. These included the use of incorrect weather zone for peak demand reduction, or the use of incorrect installation specification, such as location, slope, or azimuth.

The EM&V team also found that several solar PV projects deviated from the original application, potentially due to change in field conditions or equipment availability at the time of installation. In several cases, the project savings calculations were not updated to reflect the final project outcome.

6.2.2 Key Findings and Recommendations

Key findings and applicable recommendations are presented below based on the information gathered in reviews of solar PV projects for both commercial and residential applications.

Key Finding #1: PV Watts® default values for array losses, module type, DC to AC Sizing, and inverter efficiency were sometimes modified in the submitted documentation and calculations.

The TRM details the selection of the TMY2 data set for every location and specifies the selection of DC System Size, Tilt, Array Type, and Module Type to match installed system. All other inputs should be the PV Watts® default values.

The most significant default values are the values that build up the System Losses, which includes the shading assumption. The default shading value is 3%, however in many projects this value was adjusted in the submitted documentation and calculation. Most adjustments changed the value to 0 percent shading, while a couple increased the value based upon a site-specific shading study.

The module type selection between Standard and Premium panels is not utilized in equipment specifications, but it is required that three components (efficiency, module cover, and temperature coefficient of power) meet or exceed specific benchmarks prior to the selection of “Premium” for the module type.

The Module type selection, DC to AC sizing value, and Inverter efficiency values all are based upon equipment specifications in the system and, if adjusted, can impact the overall savings as calculated by PV Watts®. These combined factors can adjust the savings by up to 4 percent.

The DC System Size, Azimuth and Tilt are project specific and need to be customized for each project. The remaining values do not impact the electricity production estimates in the model.

Recommendation #1: Continue to recommend the defaults values for Module type, Array losses, DC to AC Sizing, and Inverter efficiency in the PV Watts® to calculate the annual kWh production of a solar PV, and specify in the TRM that documentation should be submitted to explain the reason for altering any of those default values.

Key Finding #2: The EM&V team found that claimed energy savings calculations did not always reflect the final installed system.

It is not unusual for the final installed solar PV system to include changes from the original application. However, changes can have a material impact on energy production estimates. For example, the Commercial solar PV sample analysis identified approximately 1/3 of the installed systems (5 of 14 systems) were revised from the application and these revisions were not reflected in a revised savings calculation. The changes were to basic system parameters, such as array tilt, array azimuth, and system capacity. While the majority of these revisions did not create an adjustment to savings, the EM&V team found that in two cases, the claimed project savings did adjust significantly.

Recommendation #2: Utilities should be sure that final project energy savings are based on calculations using the installed PV system parameters.

Key Finding #3: The calculation of peak demand reduction can be impacted by the tilt range tabular breakpoints in the TRM’s standard peak demand

savings calculation approach, with those breakpoints occurring in ranges of tilts commonly found on commercial rooftop systems.

The calculation of the peak demand reduction has a standard and alternate calculation method in the TRM. All the projects reviewed by the EM&V team utilized the standard calculation method to determine peak demand reduction. The standard method uses ranges of tilt and azimuth to determine what percentage of the system's rated capacity can be expected to reduce peak demand. An example below shows summer demand kW savings factors from TRM 4.0 Volume 4.

Table 6-7. Summer Demand kW Savings Factors for Climate Zone 1

Tilt (Degrees)		Azimuth (Degrees, Center and Range)				
		90	135	180	225	270
Center	Range	>67.5-112.5	>112.5-157.5	>157.5–202.5	>202.5–247.5	>247.5–292.5
0	0-7.5	48%	48%	48%	48%	48%
15	>7.5–22.5	35%	40%	49%	56%	58%
30	>22.5-37.5	20%	30%	47%	60%	64%
45	>37.5-52.5	10%	18%	42%	61%	66%
60	>52.5-67.5	7%	10%	34%	59%	65%

Using the standard approach, Table 6-7 shows large changes in peak demand between system tilt ranges. In reality, the differences across systems on the cusp of one bin or other is minor. For example, the difference between a system with 7-degree tilt and 8-degree tilt is minimal, although the table approach can change the claimed Demand kW from +10 percent to -13 percent depending on the azimuth.

Tilts are approximations and actual tilts can vary within an array, or even a single rack. The result is that contractors and utility system inspectors must estimate a reasonable tilt that captures the overall system.

The impact of this mismatch is most prevalent in large systems installed on flat roofs where the tilt measures between 5 degrees and 10 degrees, a common system design. Several of the sampled projects identified situations that required a determination about whether the project was under 7.5 degrees tilt or over 7.5 degrees tilt. The decision tips peak kW savings calculation far more than the minor difference in tilt would suggest is actually occurring.

The EM&V team did not find that azimuth was a significant source of variance. The azimuth break-points in the peak demand savings are relatively large, thus minor observational or measurement differences can lead to large changes in peak demand. On flat roofs with low system tilts, azimuths are consistently estimated well within a reasonable band. Further, flat roofs inherently allow for an optimization of azimuth as the racking systems can be optimally oriented, further muting the effect that small differences can have on peak kW savings.

Recommendation #3: The EM&V team should collaborate with the utilities to discuss alternative breakpoints for system tilts. Ideally, tabular breakpoints would not occur across ranges of typical system design.

6.3 DUAL BASELINE

Key Finding #1 Dual baseline methodology needs to be clarified in the TRM.

The EM&V team found inconsistencies between the claimed and evaluated savings for early retirement HVAC and residential lighting measures, both of which require use of the dual baseline methodology found in Appendix B of the PY2017 TRM 4.0 Vol 3. While utilities are deploying the method in the TRM correctly, the method itself appears to not accurately represent savings and needs clarification and revision.

Recommendation #1: Re-assess the dual baseline methodology in the TRM, which is to be reviewed by the EM&V team and Frontier.

7.0 HURRICANE HARVEY SAVINGS IMPACTS

Hurricane Harvey hit the Gulf Coast of Texas at the end of August 2017, dropping several feet of rain and causing extensive flooding particularly between Houston and Louisiana. The evaluation team investigated the damage caused by Harvey as potentially affecting energy efficiency program impacts. The EM&V team conducted data collection activities and geographic analysis to attempt to quantify the impact of the storm on the four utilities with affected service territories (AEP TCC, Entergy, CenterPoint Energy, and TNMP).

7.1 METHODOLOGY

Sampling and Geographic Analysis

Shortly after Hurricane Harvey impacted Southeastern Texas, PUCT staff provided the EM&V team a GIS layer containing official flooding data. The flooding data contained five tiers of flooding categories with the categories being; 0–1 feet, 1–3 feet, 3–6 feet, 6–10 feet, and greater than 10 feet. With the goal of the research being to quantify the impact the hurricane had on energy efficiency projects throughout the state, regardless of utility or territory, an aggregate of customers across all utilities with impact dates in the range from January 1, 2017–September 1, 2017[21] was taken from the EM&V database. After geocoding customer addresses of the full sample, the EM&V team mapped the participant locations on top of the flooding layer provided by the PUCT. The EM&V team then joined the two datasets to produce a list of all customers that were located in flooded areas. This customer list was used to target the CoolSaver program survey. The Commercial survey sample comprised all participants from January–September 2017, and the Residential and Hard-to-Reach survey were both randomly selected.

Data Collection

Tetra Tech conducted three primary data collection activities to estimate the impact of Hurricane Harvey on Texas energy efficiency programs. The evaluation already planned for a survey of customers participating in many of the largest programs, including Commercial SOP, Commercial MTP, SCORE/CitySmart MTP, Residential SOP, and Hard-to-Reach SOP. We used these planned surveys, with additional questions and a higher number of completed interviews to improve the accuracy of the results, to address Hurricane Harvey's impacts on these programs. In addition, we identified CoolSaver A/C Tune-up and High Efficiency New Homes programs as the most likely other programs to be affected, so we conducted interviews with participating customers and builders for these two programs. Tetra Tech interviewed at least 70 customers per sector from each Harvey-affected utility between these survey efforts.

7.1.1 Residential Retrofit

The EM&V team conducted interviews with Residential and Hard-to-Reach SOP customers through the process and net-to-gross survey. Several customers reported that program-installed measures were damaged by the hurricane. Of these, only one AEP TCC customer did not plan to replace the

[21] Projects prior to the 2017 program year were considered finalized and not subject to adjustment; projects after September 1, 2017 were assumed to be completed and reviewed following Hurricane Harvey, so any impacts on projects after this date would have been addressed by contractors or program implementation prior to being entered in tracking data.

equipment with the same level of efficiency. The EM&V team recommended that AEP TCC adjust the program claimed savings to remove this measure, which they did.

7.1.2 Residential New Construction

Tetra Tech contacted the top 8 builders who accounted for half of the homes identified through the geographic analysis as likely to be affected by Hurricane Harvey. None of these builders reported any program homes were affected by the hurricane, so the EM&V team does not recommend any adjustments to savings for Residential New Construction programs.

7.1.3 Residential A/C Tune-up

Tetra Tech implemented a brief survey to verify that the equipment that was tuned up by A/C tune-up programs was still operational following Hurricane Harvey. The survey resulted in 76 completed interviews. Of these, three CenterPoint customers reported that the equipment was damaged beyond repair by the hurricane. Because the original measure was not an equipment installation program, the equipment replacement would not result in the same savings as the original measure. The EM&V team recommended that CenterPoint adjust the program's savings to remove these measures, which they did.

7.1.4 Commercial

The EM&V team conducted interviews with commercial customers through the process and net-to-gross survey. While several customers noted that program equipment was damaged by the hurricane and resulting flooding, all of these customers reported they planned to replace the equipment with the same level of efficiency, so the EM&V team does not recommend any adjustment to commercial program savings.