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Public Utility Commission of Texas

46302

Annual Statewide Portfolio Report for Program Year 2016—Volume I

Project Number 46302

TETRA TECH

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EM&V team primary report contributors include:

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ACRONYMS/ABBREVIATIONS/DEFINITIONS

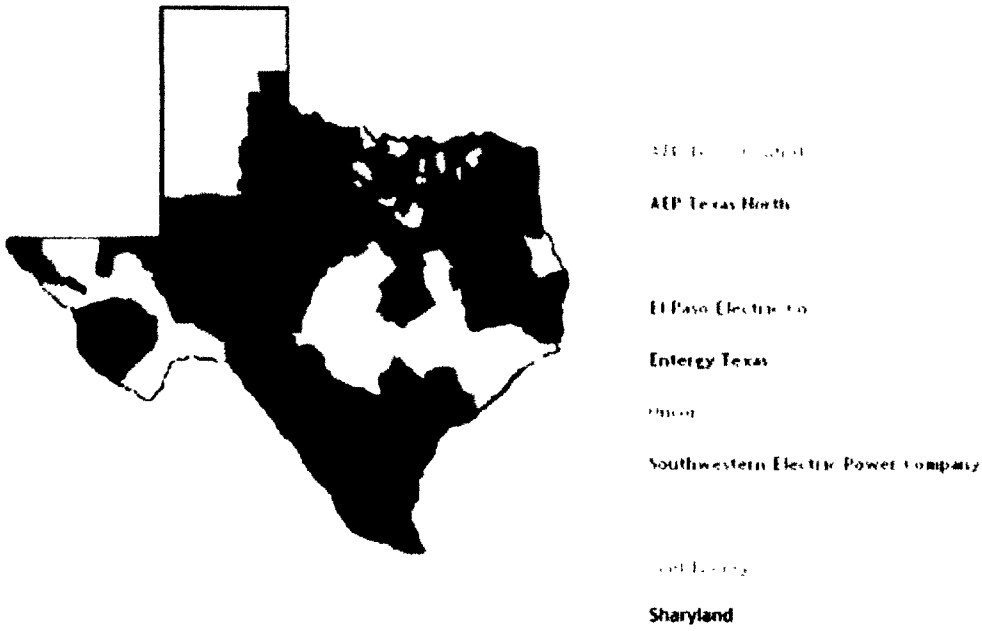
Acronyms/Abbreviations	Definition
AC	Air conditioner
AEP TCC	American Electric Power Texas Central Company
AEP TNC	American Electric Power Texas North Company
CF	Coincidence factor
C&I	Commercial and industrial
CMTP	Commercial Market Transformation Program
CNP	CenterPoint Energy Houston Electric, LLC
CSOP	Commercial Standard Offer Program
DHP	Ductless heat pump
DI	Direct install
ECM	Energy conservation measure
EECRF	Energy Efficiency Cost Recovery Factor
EEIP	Energy Efficiency Implementation Project
EEPR	Energy Efficiency Plan and Report
EESP	Energy efficiency service provider
EISA	Energy Independence and Security Act of 2007
Entergy	Entergy Texas, Inc.
EPE	El Paso Electric Company
ER	Early replacement
ERCOT	Electric Reliability Council of Texas
ERS	Emergency Response Service
ESCO	Energy service company
ESIID	Electric Service Identifier IDENTIFY
ESNH	ENERGY STAR® New Homes
EM&V	Evaluation, measurement, and verification
EUMMOT	Electric Utility Marketing Managers of Texas
GSHP	Ground-source heat pump
HCIF	Heating/cooling interactive factor
HOU	Hours of use
HPwES	Home Performance with ENERGY STAR®
HTR	Hard-to-reach
HVAC	Heating, ventilation, and air conditioning

Acronyms/Abbreviations	Definition
IECC	International Energy Conservation Code
IPMVP	International Performance Measurement and Verification Protocol
kW	Kilowatt
kWh	Kilowatt hour
LED	Light emitting diode
LI	Low-income
LI/HTR	Low-income/hard-to-reach
LM	Load management
mcf	1,000 cubic feet
MF	Multifamily
MTP	Market transformation program
M&V	Measurement and verification
NTG	Net-to-gross
PUCT	Public Utility Commission of Texas
PV	Photovoltaic
PY	Program Year
QA/QC	Quality assurance/quality control
RCx	Retro-commissioning
RFP	Request For Proposals
RMTP	Residential Market Transformation Program
ROB	Replace-on-burnout
RSOP	Residential Standard Offer Program
Sharyland	Sharyland Utilities, L.P.
SIR	Savings-to-investment ratio
SOP	Standard offer program
SRA	Self-report approach
SWEPCO	Southwestern Electric Power Company
TMY	Typical meteorological year
TNMP	Texas New Mexico Power Company
TRM	Technical Reference Manual
WACC	Weighted average cost of capital
Xcel SPS	Southwestern Public Service Company (subsidiary of Xcel Energy)

1.0 EXECUTIVE SUMMARY

The Public Utility Commission of Texas (PUCT) oversees the energy efficiency programs delivered by the state's ten investor-owned electric utilities: American Electric Power Texas Central Company (AEP TCC), American Electric Power Texas North Company (AEP TNC), 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), 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 2016 (PY2016) the ten Texas electric utilities reported statewide energy savings of 595,226,252 kWh and demand reductions of 407,714 kW at a lifetime evaluated savings cost of $0.011 per kWh and $17.26 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 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, nine of the ten utility portfolios include load management programs, which are designed to reduce peak demand.

As shown in Figure 1-2, total statewide savings are approximately half from the commercial sector (CSOP and CMTP categories) and half from the residential sector (RSOP, RMTP and LI/HTR categories). Commercial SOPs continue to be the program type that accounts for the largest percent of statewide energy savings, accounting for about a third. CMTPs and RSOPs account for the next largest percent, with both each accounting for another quarter of total statewide savings.

Load management programs continue to account for more than 60 percent of the statewide gross demand reduction, as shown in Figure 1-3.

Figure 1-2. Evaluated Gross Energy Savings by Program Type (PY2012–PY2016)

(Percent of Total Annual Statewide Savings Contained in Bar)

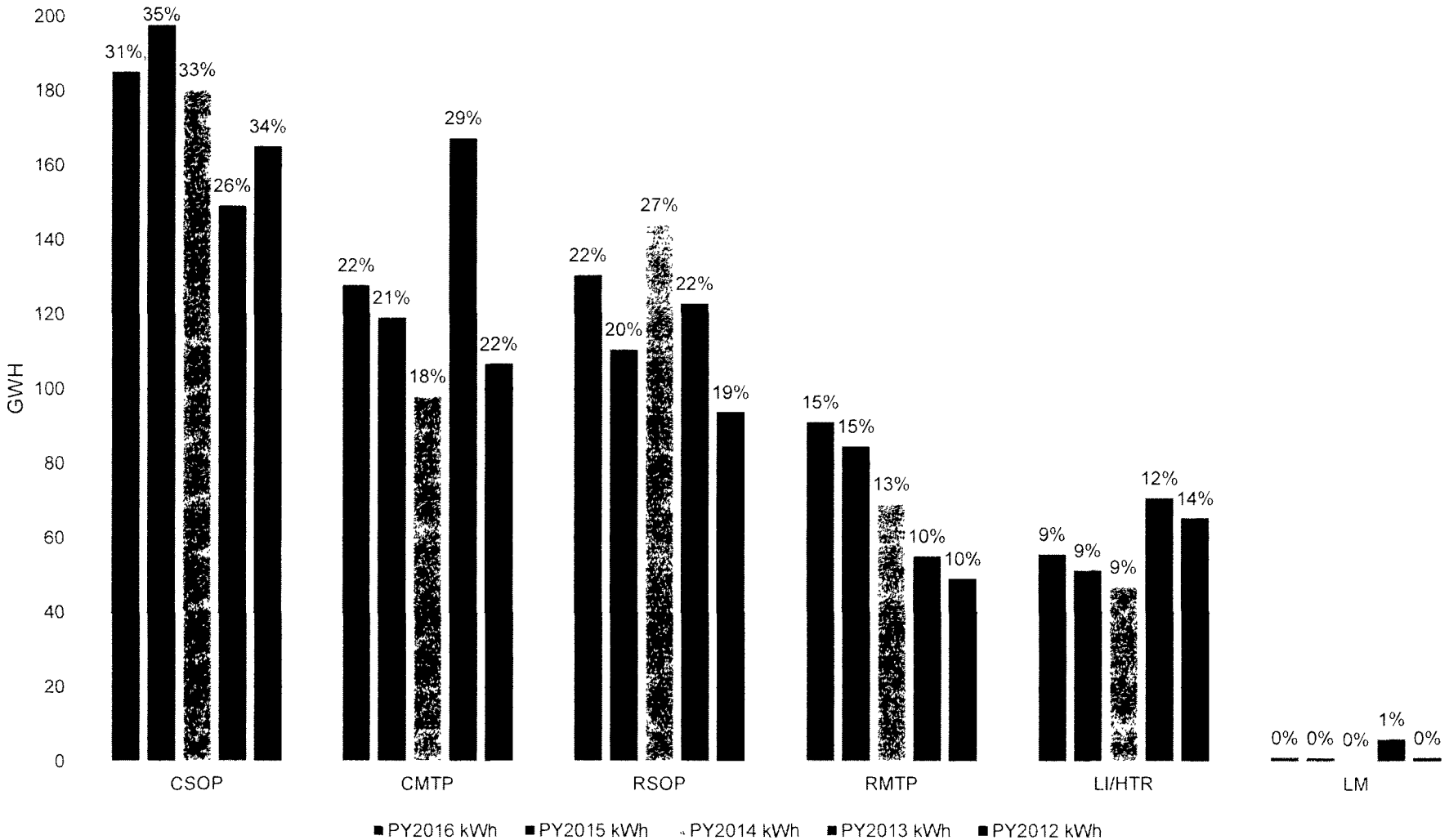
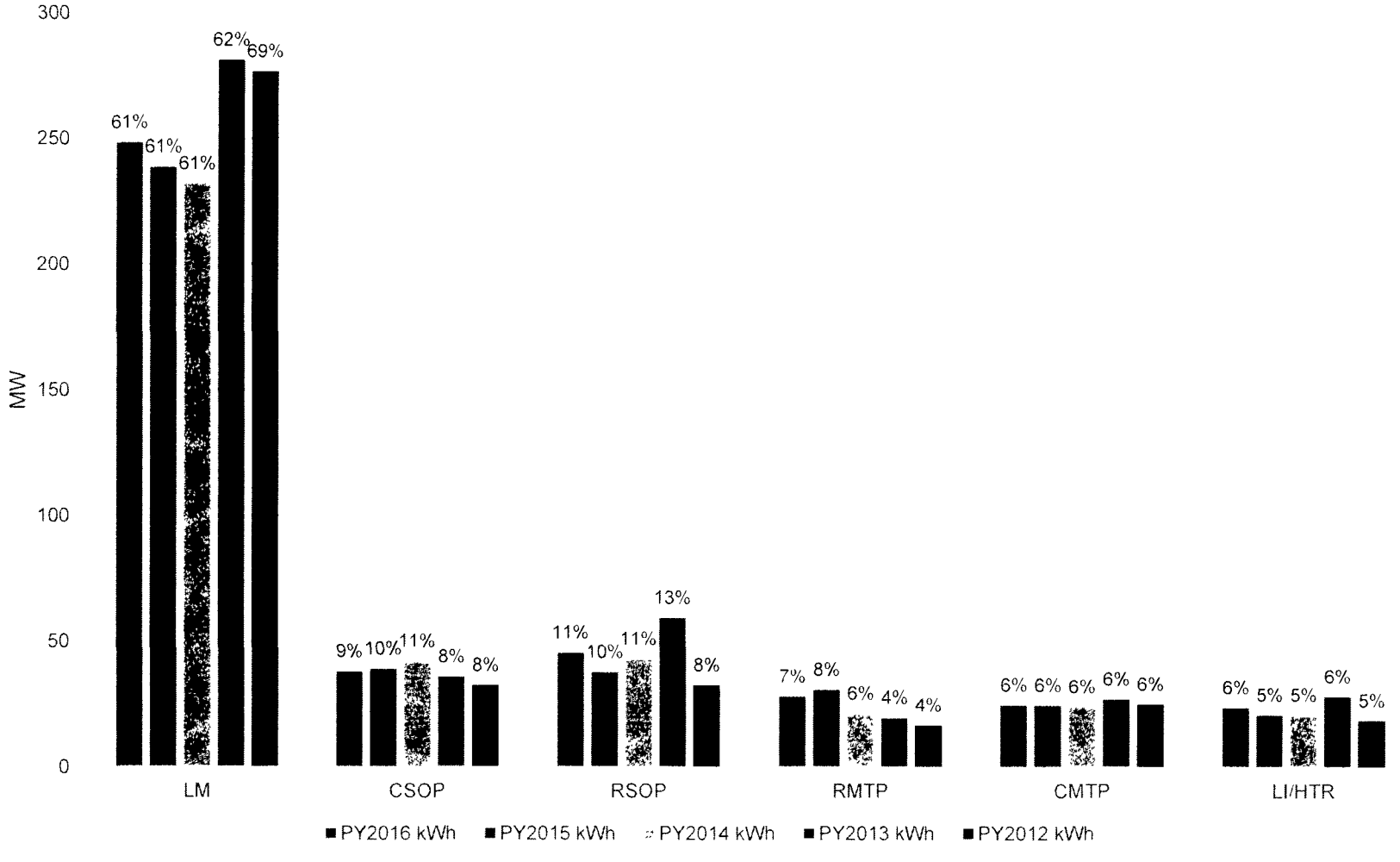


Figure 1-3. Evaluated Demand Reduction by Program Type (PY2012–PY2016)

(Percent of Total Annual Statewide Savings Contained in Bar)



Nine of the ten utilities exceeded their energy and demand savings goals for PY2016. The one utility not meeting both goals recently started offering energy efficiency programs and saw increased participation in PY2016.

1.1 EM&V OVERVIEW

In 2011, the Texas Legislature enacted SB 1125, which requires 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' PY2016 energy efficiency portfolios. The objectives of the EM&V effort were to:

- Document gross and net energy and demand impacts of utilities' individual energy efficiency and load management portfolios
- Determine program cost-effectiveness
- Provide feedback to the PUCT, utilities, and other stakeholders on program portfolio performance
- Prepare and maintain a statewide Technical Reference Manual (TRM).[1]

This Statewide Annual Portfolio Report presents the PY2016 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 addition, it includes findings and recommendations related to measure savings to inform updates to the TRM.

PY2016 is the fifth program year evaluated as part of the PUCT statewide EM&V effort. The PY2016 scope targeted impact evaluation activities to savings areas of the highest uncertainty. These areas were identified in the PY2012 through PY2015 EM&V results. While prior program year EM&V efforts reached broadly across all 130-plus programs in Texas meeting a minimum confidence level of 90% +/- 10% (90/10) at the utility portfolio level, the targeted impact evaluations are concentrated on particular programs and end-uses. At the same time, tracking system verifications provide a due-diligence review of claimed savings for each utility program.

[1] 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).

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

Table 1-1. PY2015 EM&V Priorities and Activities

Program Type	Evaluation Priority	Tracking Data Verification of Claimed Savings	TRM Savings Calculations Verification	Project Desk Reviews	On-site M&V	Interval Meter Data Analysis
Commercial SOPs and largest commercial MTPs	Medium	Census	N/A	98	51	
Load management	Medium	Census	N/A	N/A	N/A	Census
HVAC tune-ups	Medium	Census	Census			
Pool pumps	Medium	Census	Census			
Residential SOPs, hard-to-reach, and low-income	Low	Census	Census			
All other programs	Low	Census				

The EM&V activities:

- Confirmed that the measures installed are consistent with those listed in the tracking system
- Verified that the savings estimates in the tracking system are consistent with claimed savings and the savings calculated in the deemed calculation tools or tables or measurement and verification (M&V) methods used to estimate project savings in accordance with the PY2016 TRM version 3.1
- Reviewed savings assumptions and, when available, utility M&V reports gathered through the supplemental data request for sampled projects, EM&V team on-site M&V results and participants' interval meter data.

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 or M&V protocols and any equipment 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. Utilities are given the opportunity to adjust claimed savings based on EM&V results, thereby improving their realization rates.

A complementary component of the realization rate is the sufficiency of program documentation (i.e., customer invoices with equipment details) provided to the EM&V team to verify claimed savings. This was used to determine an overall program documentation score for each program that received a medium or higher evaluation priority. In each evaluation cycle, the documentation provided by utilities is rated as good, fair, or limited.

The EM&V team conducted cost-effectiveness testing applying the program administrator cost test to PY2016 claimed and evaluated savings results. Low-income programs' cost-effectiveness results were calculated using the Savings-to-Investment Ratio (SIR).

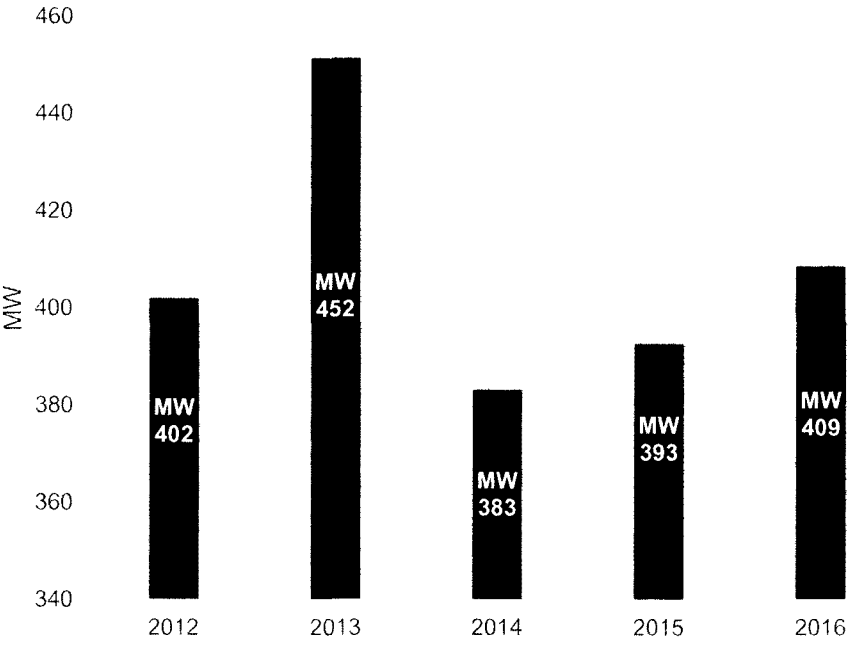
1.2 EVALUATED SAVINGS

Statewide evaluated savings results are shown below, first at the portfolio level, followed by commercial sector, residential sector, load management, and pilot results. Overall, evaluated savings were close to claimed savings as reflected in realization rates that are close to 100 percent. The utilities' proactive engagement of the EM&V 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 the healthy realization rates. The EM&V recommended savings adjustments to which utilities fully responded in PY2016 are identified in Table 1-4.

1.2.1 Portfolio Results

Evaluated gross demand reductions summed across all ten of the utilities' programs were 408,743 kW. As indicated below, the demand reduction is an increase from prior years with the exception of PY2013, which saw the largest reported demand reductions in the last five years.

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



Evaluated gross energy savings were 591,732,612 kWh and PY2016 saw the largest energy savings over the past five years.

Figure 1-5. Total Statewide Portfolio: Evaluated Gross Energy Savings by Program Year

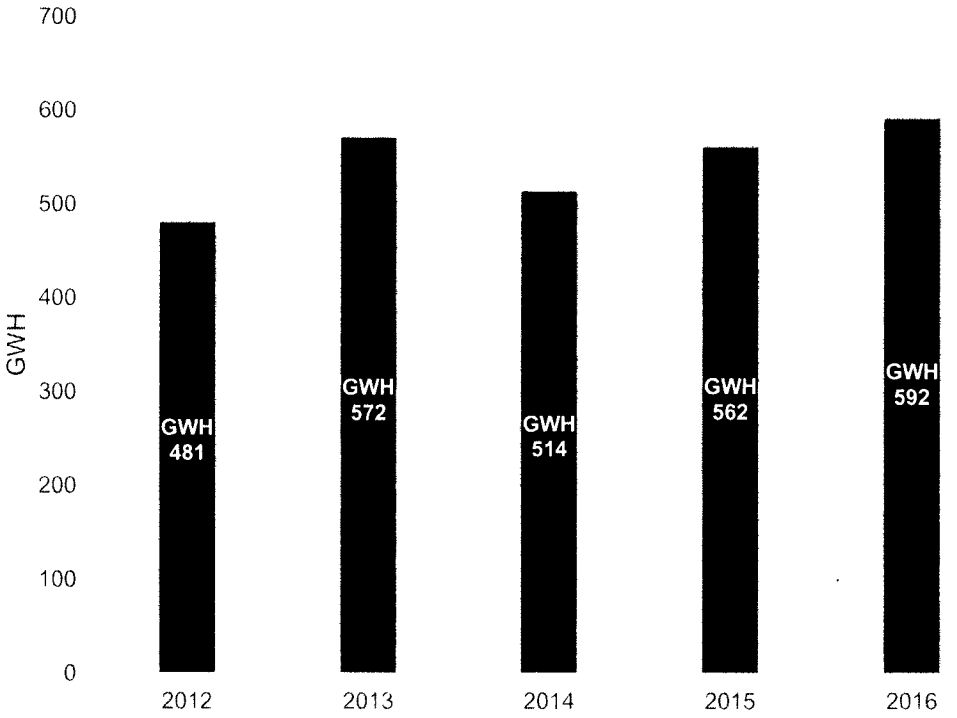


Table 1-2 shows the claimed and evaluated gross demand reduction for each utility's portfolio for PY2016. It also shows the relative precision of the estimates at a 90% confidence level. Overall, evaluated savings were quite close in value to claimed savings. Statewide, the gross demand reduction realization rate is 100 percent, with a low of 99 percent and a high of 101 percent.

Table 1-2. PY2016 Claimed and Evaluated Gross Demand Reduction, by Utility

Utility	Percent Statewide Savings (kW)	Claimed Demand Savings (kW)	Evaluated Demand Savings	Realization Rate	Precision at 90% Confidence
AEP TCC	9.6%	39,321	39,116	99.5%	0.8%
AEP TNC	1.6%	6,381	6,417	100.6%	0.3%
CenterPoint	41.3%	167,671	168,750	100.6%	0.4%
El Paso Electric	3.1%	12,790	12,786	100.0%	0.4%
Entergy	4.8%	19,739	19,578	99.2%	<0.05%
Oncor	31.6%	128,831	129,118	100.2%	0.3%
Sharyland	0.1%	600	600	100.0%	0.1%
SWEPCO	2.9%	11,939	11,939	100.0%	0.3%
TNMP	3.0%	12,253	12,252	100.0%	<0.05%
Xcel SPS	2.0%	8,188	8,187	100.0%	0.9%
Total	**100.0%**	**407,714**	**408,743**	**100.3%**	**0.4%**

Table 1-3 shows the claimed and evaluated gross energy savings for each utility's portfolio. It also shows the relative precision of the estimates at a 90% confidence level. Overall, evaluated savings are again quite close in value to claimed savings with a statewide realization rate of 99 percent. Utility portfolio realization rates for kWh ranged from 98 percent to 100 percent.

Table 1-3. PY2016 Claimed and Evaluated Gross Energy Savings, by Utility

Utility	Percent Statewide Savings (kWh)	Claimed Demand Savings (kWh)	Evaluated Demand Savings (kWh)	Realization Rate	Precision at 90% Confidence
AEP TCC	11.2%	67,789,605	66,304,850	97.8%	0.7%
AEP TNC	1.8%	10,818,500	10,814,035	100.0%	0.3%
CenterPoint	31.8%	190,856,858	188,387,963	98.7%	0.2%
El Paso Electric	3.9%	22,912,025	22,905,591	100.0%	3.4%
Entergy	7.5%	45,044,145	44,616,971	99.1%	3.2%
Oncor	33.7%	198,777,156	199,673,742	100.5%	0.8%
Sharyland	0.4%	2,212,723	2,212,449	100.0%	0.1%
SWEPCO	3.5%	20,648,105	20,647,945	100.0%	3.8%
TNMP	3.7%	21,716,040	21,718,653	100.0%	<0.05%
Xcel SPS	2.4%	14,451,094	14,450,414	100.0%	1.6%
Total	**100.0%**	**595,226,252**	**591,732,612**	**99.4%**	**1.0%**

As mentioned above, another contributor to the overall healthy realization rates was that the utilities responded to evaluation findings in their PY2016 claimed savings where the EM&V team recommended a correction in claimed savings. Below is a summary of utility program claimed savings adjustments. Realization rates were re-calculated to reflect the adjusted savings.

Table 1-4. EM&V Claimed Savings Adjustments by Program

Utility	Program	EM&V Demand Claimed Savings Adjustments (kW)	EM&V Energy Claimed Savings Adjustments (kWh)
AEP TCC	Commercial SOP	-111.9	-564,444
AEP TNC	Hard-to-Reach SOP	-7	-32,079
	Load Management SOP	124	249
	Residential SOP	0	-1,882
	SMART Source Solar PV MTP	-9	0
CenterPoint	Commercial MTP	-57.5	13,972
	Pool Pump Pilot (Com)	12.1	-40,360
	Pool Pump Pilot (Res)	0.2	289
El Paso Electric	Large C&I Solutions MTP	-3.7	-134,685
	Load Management SOP	-187.5	11,116
	Residential Solutions MTP	-1.2	-2,010
	Small Commercial Solutions MTP	-4.1	-6,426
	Texas SCORE MTP	0.3	1,006
Sharyland	Open for Small/Medium Business MTP	4.1	-219,674
Xcel Energy	Commercial SOP	-213.8	410,588

1.2.2 Commercial Sector Results

The statewide evaluated gross savings from commercial sector programs were demand reduction of 57,928 kW and energy savings of 298,151,145 kWh (Table 1-5 and Table 1-6). These savings reflect a decrease from PY2015 commercial evaluated savings, but an increase from PY2012–PY2014 (Figure 1-7 and Figure 1-8).

As indicated in Figure 1-6, lighting measures still account for the majority of the energy savings (63 percent) and demand reduction (56 percent), which is consistent with commercial programs throughout the country. However, this is down from prior years (77 percent of kWh and 65 percent of kW in PY2015 were from lighting). HVAC has increased to approximately a quarter of both energy and demand savings from commercial programs compared to 16 percent of kW and 8 percent of kWh in PY2015.

Figure 1-6. Distribution of Statewide Evaluated Gross Energy Savings and Demand Reduction by Measure Category—Commercial Programs PY2016

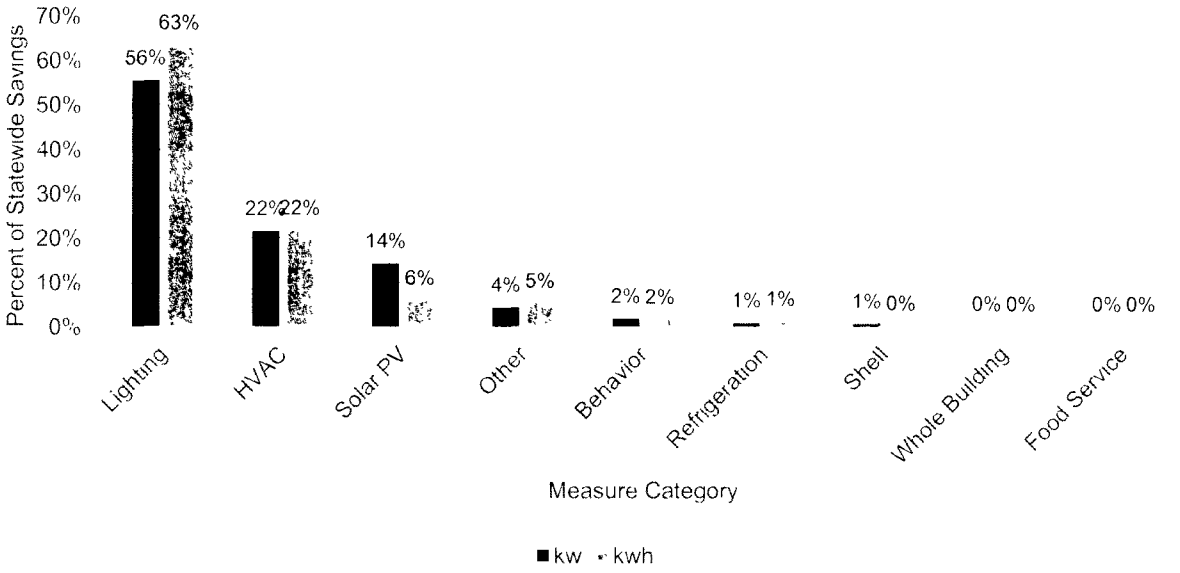


Figure 1-7 and Figure 1-8 show statewide evaluated demand reduction and energy savings, respectively, for commercial programs from PY2012 through PY2016.

Figure 1-7. Total Statewide Evaluated Demand Reduction by Program Year—Commercial Programs

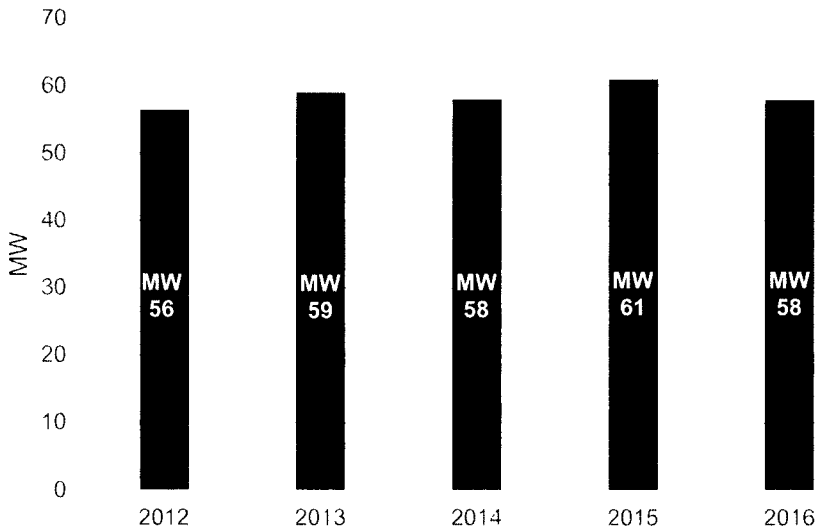
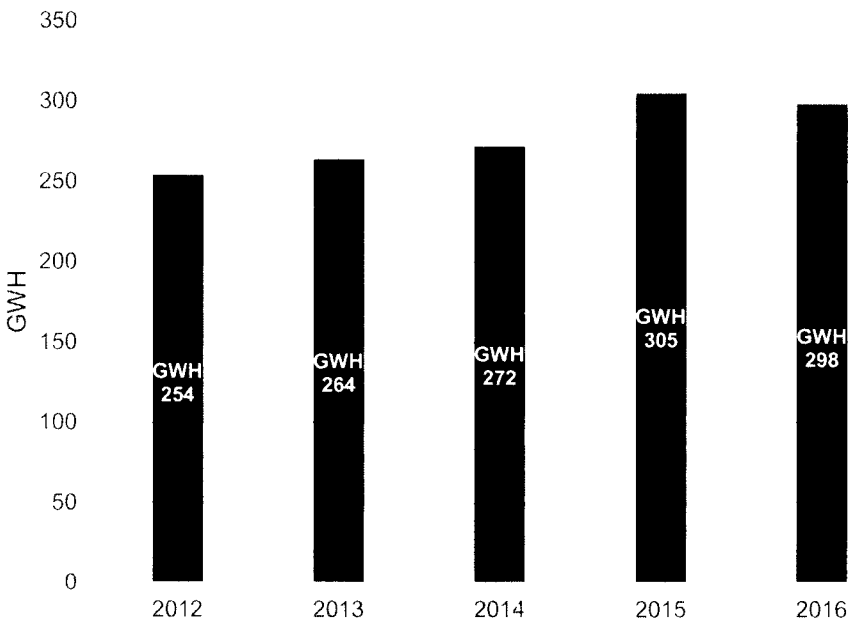


Figure 1-8. Total Statewide Evaluated Energy Savings by Program Year—Commercial Programs



Statewide, realization rates for commercial programs were 99 percent for both demand reduction and energy savings and ranged from 92 to 101 percent. The primary driver of realization rates being different from 100 percent were a difference in the evaluated and claimed savings for HVAC tune-up measures. The EM&V team is working with utilities and the implementation contractor to implement changes to the HVAC tune-up measures' M&V approach in PY2017 to improve the accuracy of claimed savings. Evaluated savings also differed from claimed savings because measure type, quantities, hours of operation, or efficiency levels were found to be slightly different during desk reviews and/or on-site inspection. These adjustments, made at the project level, were typically minor and the utilities received

project-level savings that were both higher and lower than claimed based on the desk and on-site M&V results.

Table 1-5 below shows the claimed and evaluated demand reduction for each utility's commercial portfolio.

Table 1-5. PY2016 Claimed and Evaluated Gross Demand Reduction—Commercial Sector

Utility	Percent Statewide Reduction (kW)	Claimed Demand Reduction (kW)	Evaluated Demand Reduction	Realization Rate	Precision at 90% Confidence
AEP TCC	12%	7,240	6,677	92%	4.5%
AEP TNC	2%	1,427	1,426	100%	1.4%
CenterPoint	27%	15,891	15,680	99%	4.1%
El Paso Electric	6%	3,595	3,591	100%	1.5%
Entergy	9%	5,105	4,945	97%	0.1%
Oncor	34%	19,312	19,599	101%	1.6%
Sharyland	<0.5%	95	95	100%	0.7%
SWEPCO	3%	2,018	2,018	100%	1.5%
TNMP	4%	2,124	2,124	100%	0.1%
Xcel SPS	3%	1,775	1,774	100%	3.9%
Total	**100%**	**58,582**	**57,928**	**99%**	**2.5%**

Table 1-6 shows the claimed and evaluated gross energy savings for each utility's commercial portfolio.

Table 1-6. PY2016 Claimed and Evaluated Gross Energy Savings—Commercial Sector

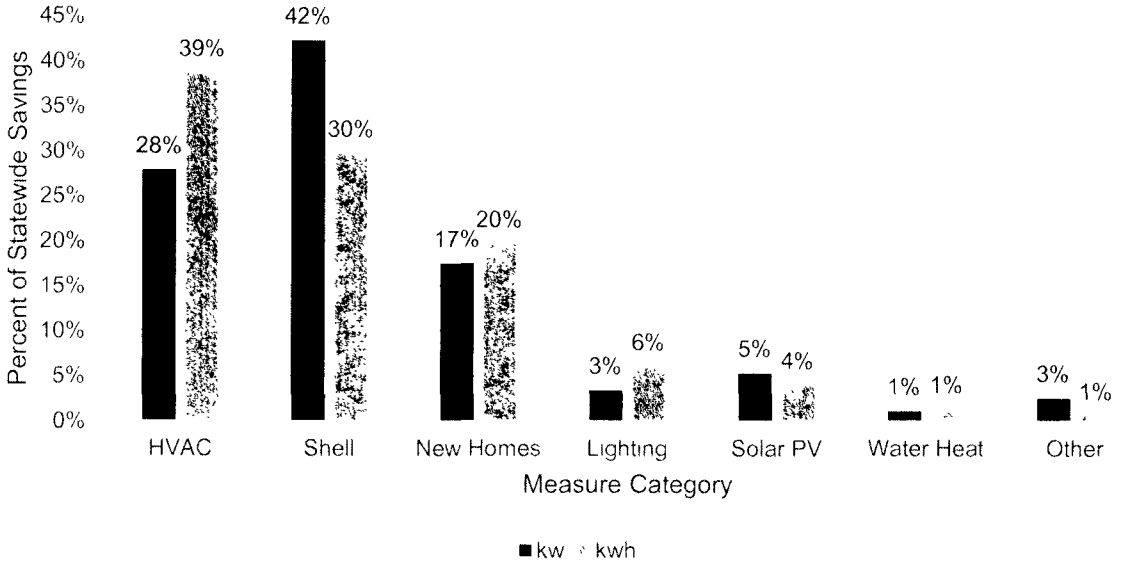
Utility	Percent Statewide Savings (kWh)	Claimed Demand Savings (kWh)	Evaluated Demand Savings	Realization Rate	Precision at 90% Confidence
AEP TCC	12%	36,075,902	34,844,390	97%	1.4%
AEP TNC	2%	6,925,907	6,921,338	100%	0.4%
CenterPoint	31%	93,063,990	92,154,979	99%	0.4%
El Paso Electric	7%	19,886,504	19,880,069	100%	3.9%
Entergy	8%	24,472,842	24,045,667	98%	6.0%
Oncor	30%	89,863,178	90,759,763	101%	0.9%
Sharyland	<0.5%	412,862	412,588	100%	0.3%
SWEPCO	4%	11,216,100	11,215,773	100%	3.8%
TNMP	3%	9,480,574	9,483,187	100%	<0.05%
Xcel SPS	3%	8,434,071	8,433,391	100%	2.8%
Total	**100%**	**299,831,929**	**298,151,145**	**99%**	**1.5%**

1.2.3 Residential Sector Results

Statewide PY2016 evaluated demand reduction from residential sector programs was 93,913 kW and the statewide evaluated energy savings was 270,033,040 kWh. This reflects an increase in annual residential demand and energy savings over the past five years with the exception of PY2013 as seen in Figure 1-10 and Figure 1-11.

The majority of residential demand reduction derived from shell measures (42 percent) and the majority of energy savings was from HVAC (39 percent). The figure below shows the breakdown of savings by measure category and demonstrates that the utilities have been successful in diversifying their residential savings. In PY2015, residential savings were primarily from envelope measures (65% of kW and 77% of kWh in PY2015 were from envelope measures).

Figure 1-9. Distribution of Statewide Evaluated Gross Energy Savings and Demand Reduction by Measure Category—Residential Programs PY2016



Statewide, realization rates for residential programs were 99 percent for both demand reduction and energy savings and ranged from 98 to 100 percent. The primary driver of realization rates being different from 100 percent were a difference in the evaluated and claimed savings for HVAC tune-up measures as also seen in the commercial sector above. The EM&V team is working with utilities and the implementation contractor to implement changes to the HVAC tune-up measures' M&V approach in PY2017 to improve the accuracy of claimed savings. The following two figures show statewide evaluated gross demand reduction and energy savings for residential programs between PY2012 through PY2016.

Figure 1-10. Total Statewide Evaluated Gross Demand Reduction by Program Year—Residential Programs

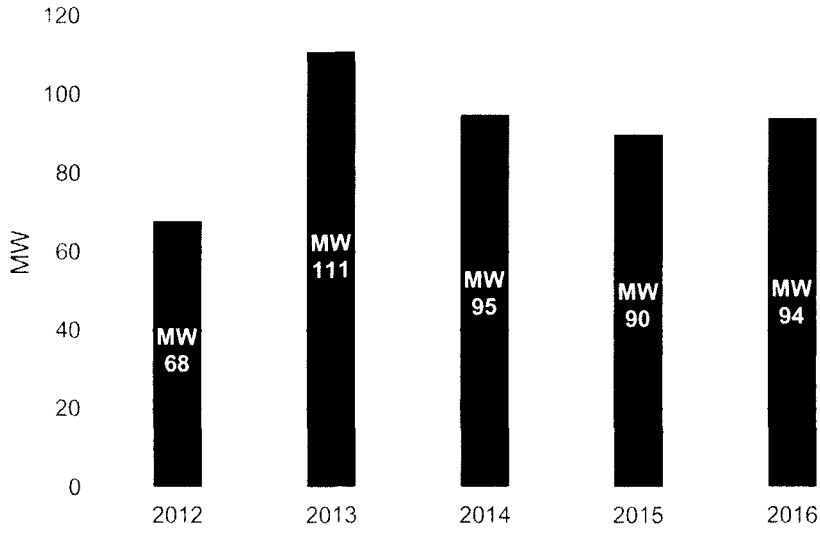


Figure 1-11. Total Statewide Evaluated Gross Energy Savings by Program Year—Residential Programs

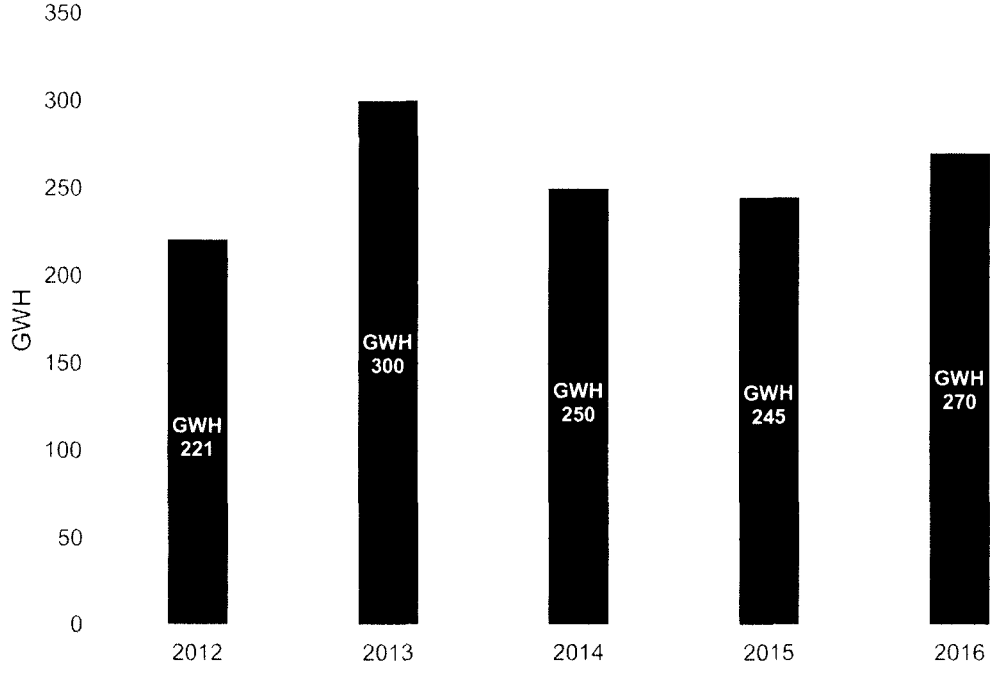


Table 1-7 shows the claimed and evaluated demand reduction for each utility's residential energy efficiency portfolio for PY2016. It also shows the precision levels around the evaluated savings estimates at a 90% confidence level.

Table 1-7. PY2016 Gross Claimed and Evaluated Demand Reduction—Residential Sector

Utility	Percent Statewide Reduction (kW)	Claimed Demand Reduction (kW)	Evaluated Demand Reduction (kW)	Realization Rate	Precision at 90% Confidence
AEP TCC	8%	7,845	7,758	99%	0.4%
AEP TNC	1%	1,061	1,061	100%	N/A
CenterPoint	28%	26,909	26,287	98%	N/A
El Paso Electric	2%	1,596	1,596	100%	N/A
Entergy	6%	5,885	5,885	100%	N/A
Oncor	45%	42,464	42,464	100%	N/A
Sharyland	<0.5%	467	467	100%	N/A
SWEPCO	3%	2,986	2,986	100%	N/A
TNMP	4%	3,809	3,809	100%	N/A
Xcel SPS	2%	1,600	1,600	100%	N/A
Total	**100%**	**94,622**	**93,913**	**99%**	**<0.05%**

Table 1-8 shows the claimed and evaluated energy savings for each utility's residential energy efficiency portfolio for PY2016.

Table 1-8. PY2016 Gross Claimed and Evaluated Energy Savings—Residential Sector

Utility	Percent Statewide Reduction (kWh)	Claimed Demand Reduction (kWh)	Evaluated Demand Reduction (kWh)	Realization Rate	Precision at 90% Confidence
AEP TCC	11%	30,046,911	29,790,671	99%	0.3%
AEP TNC	1%	3,519,481	3,519,481	100%	N/A
CenterPoint	30%	82,191,230	80,619,973	98%	N/A
El Paso Electric	1%	3,002,726	3,002,726	100%	N/A
Entergy	8%	20,553,975	20,553,975	100%	N/A
Oncor	39%	104,789,032	104,789,032	100%	N/A
Sharyland	1%	1,704,764	1,704,764	100%	N/A
SWEPCO	3%	9,348,754	9,348,754	100%	N/A
TNMP	4%	11,425,075	11,425,075	100%	N/A
Xcel SPS	2%	5,278,590	5,278,590	100%	N/A
Total	**100%**	**271,860,538**	**270,033,040**	**99%**	**<0.05%**

1.2.4 Load Management Results

Statewide evaluated demand reduction from load management programs were 239,476 kW and 1,129,095 kWh. As shown in Figure 1-12 and Figure 1-13, load management programs' demand reduction and energy savings increased somewhat in PY2016 compared to the prior years, but were still lower than in PY2012 and PY2013.

Figure 1-12. Total Statewide Evaluated Gross Demand Reduction by Program Year—Load Management Programs

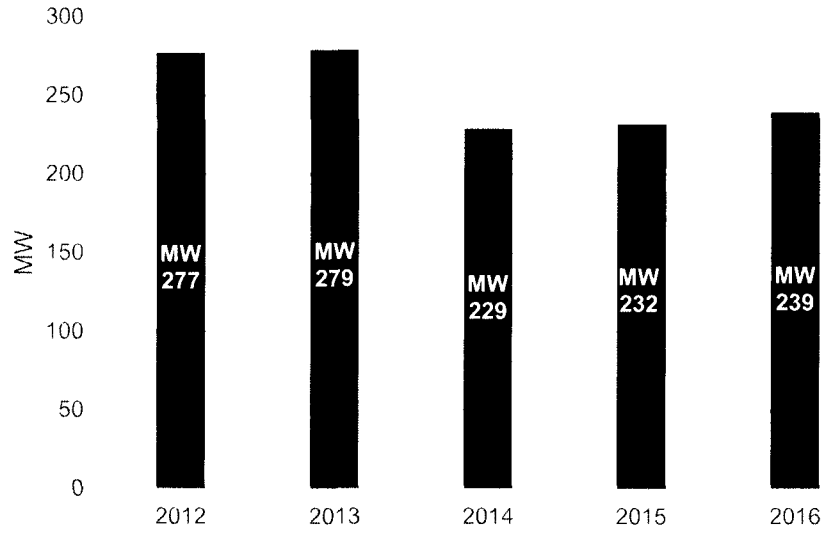


Figure 1-13. Total Statewide Evaluated Gross Energy Savings by Program Year—Load Management Programs

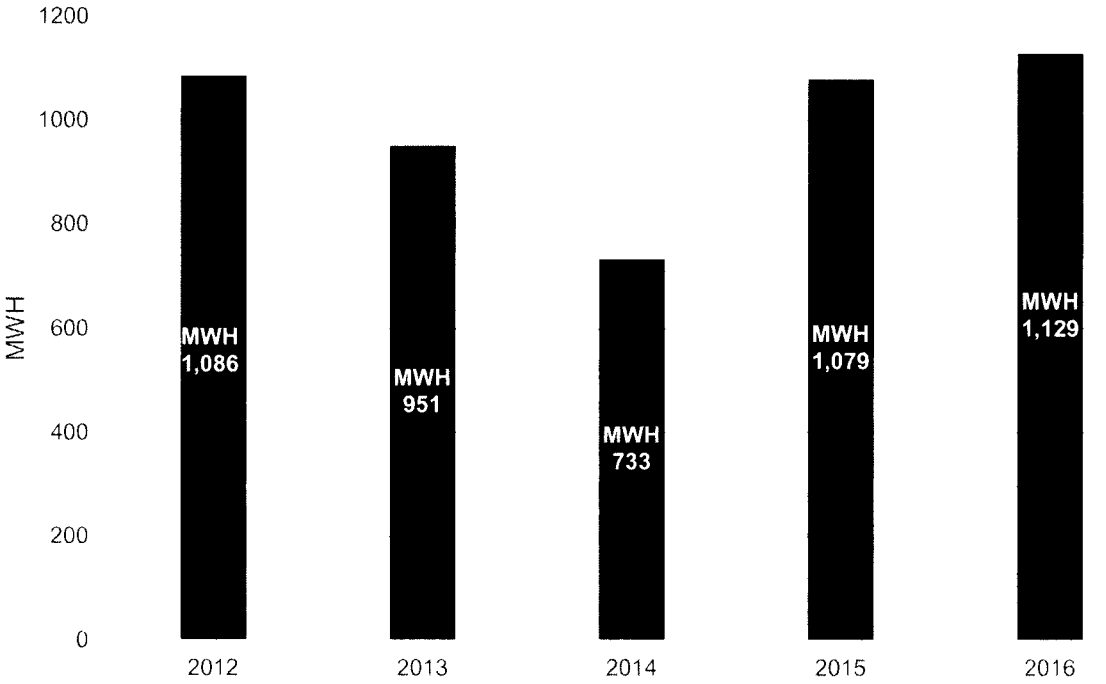


Table 1-9 shows the claimed and evaluated gross demand reduction for each utility's load management portfolio. The EM&V team evaluated a census of participants' interval meter data. Evaluated impacts were effectively the same as claimed impacts across all utilities.

Table 1-9. PY2016 Claimed and Evaluated Gross Demand Reduction—Load Management

Utility	Percent Statewide Reduction (kW)	Claimed Demand Reduction (kW)	Evaluated Demand Reduction (kW)	Realization Rate
AEP TCC	8%	20,234	20,223	100%
AEP TNC	1%	3,378	3,378	100%
CenterPoint	51%	120,219	122,131	102%
El Paso Electric	3%	7,599	7,599	100%
Entergy	4%	8,749	8,749	100%
Oncor	25%	60,017	60,017	100%
SWEPCO	3%	6,935	6,935	100%
TNMP	2%	5,873	5,873	100%
Xcel SPS	2%	4,571	4,571	100%
Total	**100%**	**237,573**	**239,476**	**101%**

Table 1-10 shows the claimed and evaluated gross energy savings for each utility's load management portfolio. As noted above, a census of projects was evaluated.

Table 1-10. PY2016 Claimed and Evaluated Gross Energy Savings—Load Management

Utility	Percent Statewide Savings (kWh)	Claimed Energy Savings (kWh)	Evaluated Energy Savings (kWh)	Realization Rate
AEP TCC	4%	48,673	49,191	101%
AEP TNC	1%	5,767	5,767	100%
CenterPoint	65%	721,411	732,784	102%
El Paso Electric	2%	22,796	22,796	100%
Entergy	2%	17,329	17,329	100%
Oncor	16%	180,050	180,050	100%
SWEPCO	7%	83,251	83,418	100%
TNMP	1%	5,873	5,873	100%
Xcel SPS	3%	31,887	31,887	100%
Total	**100%**	**1,117,037**	**1,129,095**	**101%**

1.2.5 Pilot Results

The statewide evaluated savings from pilot programs were 10,566 kW and 11,070,415 kWh. PY2016 is the largest demand reduction seen in pilot results due to AEP and Oncor's residential demand response pilot. PY2016 kWh savings were similar to PY2015. Figure 1-14 and Figure 1-15 show statewide evaluated gross demand reduction and energy savings, respectively, for pilot programs from PY2012 through PY2016.

Figure 1-14. Total Statewide Evaluated Demand Savings by Program Year—Pilot Programs

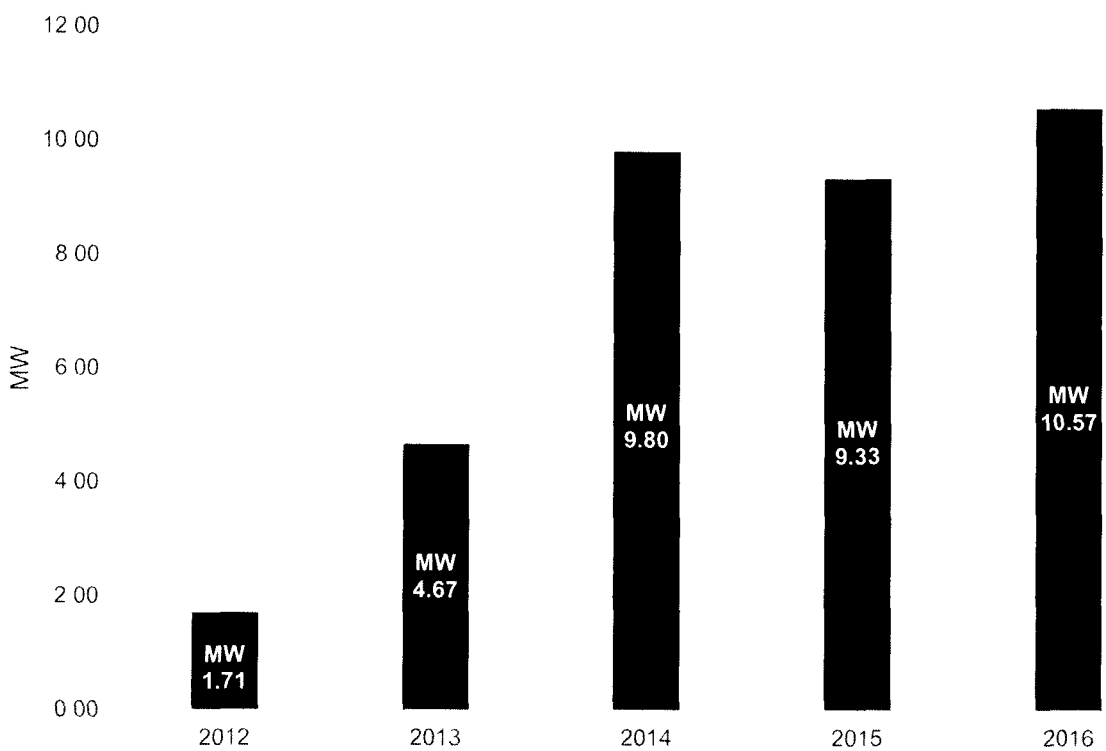


Figure 1-15. Total Statewide Evaluated Energy Savings by Program Year—Pilot Programs

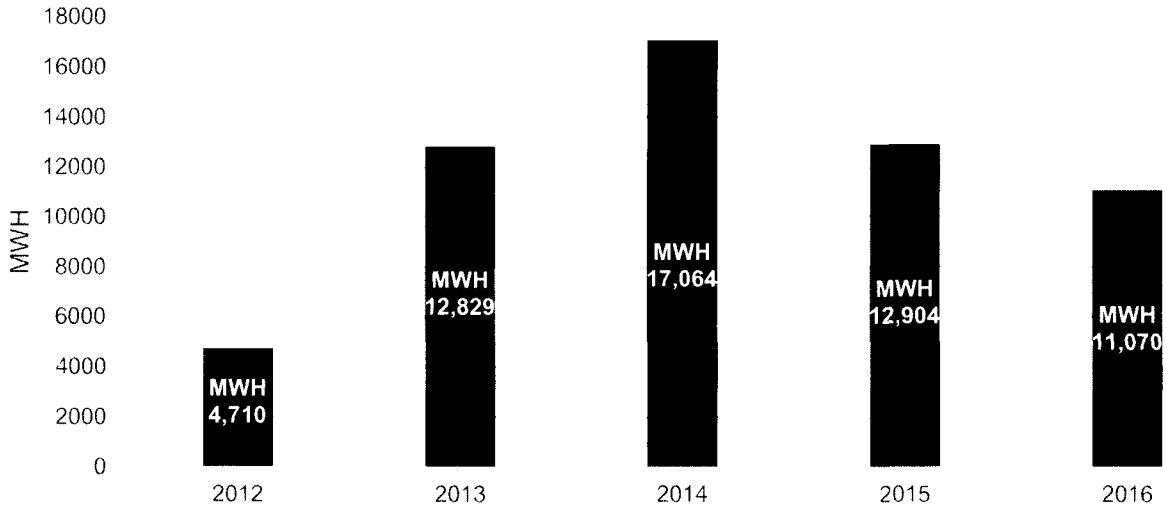


Table 1-11 shows the claimed and evaluated gross demand reduction for each utility's pilot programs, which were 105 percent for kW and 100 percent for kWh.

Table 1-11. PY2016 Claimed and Evaluated Gross Demand Reduction—Pilots

Utility	Percent Statewide Reduction (kW)	Claimed Demand Reduction (kW)	Evaluated Demand Reduction (kW)	Realization Rate	Precision at 90% Confidence
AEP TCC	35%	3,222	3,677	114%	N/A
AEP TNC	4%	421	457	109%	N/A
CenterPoint	15%	1,538	1,538	100%	1.6%
Oncor	46%	4,886	4,886	100%	N/A
TNMP	<0.5%	8	8	100%	N/A
Total	**100%**	**10,075**	**10,566**	**105%**	**0.2%**

Table 1-12 shows the claimed and evaluated gross energy savings for each utility's pilot portfolio for PY2015.

Table 1-12. PY2016 Claimed and Evaluated Gross Energy Savings—Pilots

Utility	Percent Statewide Reduction (kWh)	Claimed Demand Reduction (kWh)	Evaluated Demand Reduction (kWh)	Realization Rate	Precision at 90% Confidence
AEP TCC	2%	230,569	233,048	101%	N/A
AEP TNC	1%	139,443	139,548	100%	N/A
CenterPoint	96%	10,628,790	10,628,790	100%	0.2%
Oncor	<0.5%	29,313	29,313	100%	N/A
TNMP	<0.5%	39,717	39,717	100%	N/A
Total	**100%**	**11,067,832**	**11,070,415**	**100%**	**0.2%**

1.3 COST-EFFECTIVENESS RESULTS

The EM&V team calculated cost-effectiveness based on claimed savings, evaluated savings, and evaluated net savings[2] using the Program Administrator Cost Test (PACT). Overall cost-effectiveness of Texas energy efficiency programs based on evaluated savings was 2.46 including low-income programs and 2.65 excluding low-income programs. The cost-effectiveness for claimed savings were almost identical to evaluated savings results, reflecting the realization rates are very close to 100 percent. The claimed savings cost-effectiveness ratios were 2.46 including low-income programs and 2.66 excluding low-income programs. Finally, the cost-effectiveness when calculated using net savings is 2.08 including low-income programs and 2.23 excluding low-income programs. Cost-Effectiveness ratios remained relatively stable from PY2015 to PY2016.

Cost-Effectiveness results are shown in Table 1-13 below across all utilities first at the portfolio level, followed by commercial sector, residential sector, low-income programs, load management, and pilot programs.

1.3.1 Portfolio Results

Table 1-13 below summarizes the cost-effectiveness of each utility's energy efficiency portfolio both with and without low-income programs. The cost-effectiveness of the utilities' portfolios ranged from 2.2 to 3.4 based on evaluated savings results and from 1.9 to 3.0 based on evaluated net savings results. As expected, cost-effectiveness increases somewhat across all of the utility portfolios that include low-income programs when these programs are excluded from the analysis.[3]

[2] Evaluated net savings are determined by applying the EM&V team's recommended net-to-gross factor to evaluated savings. The net-to-gross factor measures program attribution including free-riders and spillover as defined in 16 TAC § 25.181 (c).

[3] Non-ERCOT utilities are not required to offer low-income programs. Cost-Effectiveness results shown with and without low-income programs do not vary for these utilities except for Xcel Energy, which elects to offer a low-income program.

Table 1-13. PY2015 Cost-Effectiveness Benefit/Cost Ratio—Total Portfolio

Utility	Claimed Savings Results	Evaluated Savings Results	Net Savings Results	Claimed Savings Results Without Low-Income	Evaluated Savings Results Without Low-Income	Net Savings Results Without Low-Income
AEP TCC	2.5	2.4	2.1	2.7	2.7	2.3
AEP TNC	2.2	2.2	1.9	2.4	2.4	2.1
CenterPoint	2.6	2.6	2.1	2.9	2.9	2.3
El Paso Electric	3.4	3.4	3.0	3.4	3.4	3.0
Entergy	3.0	2.9	2.5	3.0	2.9	2.5
Oncor	2.2	2.2	1.9	2.4	2.4	2.1
Sharyland	2.7	2.7	2.3	3.1	3.1	2.5
SWEPCO	2.8	2.8	2.4	2.8	2.8	2.4
TNMP	2.2	2.2	1.9	2.4	2.4	2.0
Xcel Energy	2.4	2.4	2.1	2.6	2.6	2.3
Statewide	**2.5**	**2.5**	**2.1**	**2.7**	**2.7**	**2.2**

Table 1-14 summarizes the cost of lifetime kWh and kW for each utility. The cost per kWh ranges from $0.009 to $0.013, and the cost per kW ranges from $13.54 to $21.00. 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.

Table 1-14. PY2016 Cost-Effectiveness Results—Cost of Lifetime Savings

Utility	kWh	kW
AEP TCC	$0.012	$19.36
AEP TNC	$0.013	$21.00
CenterPoint	$0.010	$17.49
El Paso Electric	$0.009	$14.56
Entergy	$0.009	$14.78
Oncor	$0.011	$17.55
Sharyland	$0.009	$13.54
SWEPCO	$0.010	$15.69
TNMP	$0.010	$15.87
Xcel Energy	$0.011	$18.62
Statewide	**$0.011**	**$17.26**

1.3.2 Commercial Sector Results

Table 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 2.8 statewide based on evaluated savings and 2.4 based on net savings. Utilities' results ranged from 2.3 to 4.7 based on evaluated gross savings and 2.0 to 4.1 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.

Table 1-15. PY2016 Cost-Effectiveness Benefit/Cost Ratio—Commercial Sector

Utility	Claimed Savings	Evaluated Gross Savings	Evaluated Net Savings
AEP TCC	3.0	2.9	2.5
AEP TNC	2.4	2.4	2.1
CenterPoint	2.6	2.6	2.1
El Paso Electric	4.7	4.7	4.1
Entergy	3.5	3.4	2.9
Oncor	2.7	2.7	2.3
Sharyland	2.9	2.9	2.6
SWEPCO	2.9	2.9	2.5
TNMP	2.3	2.3	2.0
Xcel Energy	2.9	2.9	2.4
Statewide	**2.8**	**2.8**	**2.4**

*Evaluated savings results should only be viewed qualitatively due to the small sample sizes at the utility-program level.

Table 1-16 summarizes the cost of lifetime kWh and kW for each utility's commercial sector programs. The cost per kWh ranges from $0.007 to $0.013, and the cost per kW ranges from $10.71 to $19.52. 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.

Table 1-16. PY2016 Cost-Effectiveness Results—Cost of Lifetime Commercial Sector Savings

Utility	kWh	kW
AEP TCC	$0.010	$15.30
AEP TNC	$0.013	$19.52
CenterPoint	$0.011	$18.25
El Paso Electric	$0.007	$10.71
Entergy	$0.008	$13.18
Oncor	$0.009	$13.46
Sharyland	$0.010	$15.34
SWEPCO	$0.010	$16.03
TNMP	$0.011	$17.23
Xcel Energy	$0.010	$17.14
Statewide	**$0.010**	**$14.88**

1.3.3 Residential Sector Results

Table 1-17 below summarizes the cost-effectiveness of each utility's energy residential efficiency portfolio.

Residential sector programs' cost-effectiveness statewide is 2.8 based on evaluated savings and 2.3 based on evaluated net savings. Similarly to the commercial sector, the residential sector varied between utilities, with evaluated savings results ranging from 1.8 to 3.9 and net savings results ranging from 1.6 to 3.0. As with the commercial sector, this is in part due to the differences in the types of programs offered by different utilities.

Table 1-17. PY2016 Cost-Effectiveness Benefit/Cost Ratio—Residential Sector

Utility	Claimed Savings	Evaluated Gross Savings	Evaluated Net Savings
AEP TCC	2.5	2.5	2.1
AEP TNC	2.7	2.7	2.2
CenterPoint	3.9	3.9	3.0
El Paso Electric	1.8	1.8	1.6
Entergy	2.8	2.8	2.3
Oncor	2.4	2.4	2.0
Sharyland	3.1	3.1	2.5
SWEPCO	2.7	2.7	2.4
TNMP	2.6	2.6	2.0
Xcel Energy	2.7	2.7	2.4
Statewide	**2.8**	**2.8**	**2.3**

Table 1-18 summarizes the cost of lifetime kWh and kW for each utility's residential sector programs. The cost per kWh ranges from $0.006 to $0.016, and the cost per kW ranges from $9.87 to $23.29. 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.

Table 1-18. PY2016 Cost-Effectiveness Results—Cost of Lifetime Residential Sector Savings

Utility	kWh	kW
AEP TCC	$0.011	$17.54
AEP TNC	$0.010	$15.43
CenterPoint	$0.006	$9.87
El Paso Electric	$0.016	$23.29
Entergy	$0.009	$14.55
Oncor	$0.010	$15.80
Sharyland	$0.008	$11.55
SWEPCO	$0.009	$13.97
TNMP	$0.008	$11.92
Xcel Energy	$0.009	$14.16
Statewide	**$0.009**	**$13.90**

1.3.4 Low-Income Results

Table 1-19 summarizes the cost-effectiveness of each utility's low-income energy efficiency portfolio.[4]

As expected due to the higher program costs associated with serving this residential sector, low-income programs had a statewide cost-effectiveness ratio of 1.6.[5] There are no separately reported net evaluated savings for low-income programs since all savings are assumed attributable to the program due to the substantial affordability barriers this sector faces to make energy efficiency improvements.

[4] Non-ERCOT utilities are not required to offer low-income programs. These cases are indicated in the table with "N/A."

[5] Unlike other programs that apply the program administrator cost test (PACT), the low-income sector programs are evaluated using the savings-to-investment ratio. This test excludes administrative and other overhead costs and directly compares the cost of installing the measure with estimated customer energy bill reductions.

Table 1-19. PY2016 Cost-Effectiveness Benefit/Cost Ratio—Low-Income Sector

Utility	Claimed Savings	Evaluated Gross Savings
AEP TCC	1.6	1.6
AEP TNC	1.5	1.5
CenterPoint	2.0	2.0
El Paso Electric	N/A	N/A
Entergy	N/A	N/A
Oncor	1.1	1.1
Sharyland	2.7	2.7
SWEPCO	N/A	N/A
TNMP	2.4	2.4
Xcel Energy	2.4	2.4
Statewide	**1.6**	**1.6**

1.3.5 Load Management Results

Table 1-20 summarizes the cost-effectiveness of each utility's load management energy efficiency portfolio.

Load management programs had the lowest cost-effectiveness of non-low-income or pilot programs at 1.5, 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 1.1 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.

Table 1-20. PY2016 Cost-Effectiveness Benefit/Cost Ratio—Load Management Sector

Utility	Claimed Savings	Evaluated Gross Savings
AEP TCC	1.8	1.8
AEP TNC	2.2	2.2
CenterPoint	1.6	1.6
El Paso Electric	1.4	1.4
Entergy	1.6	1.6
Oncor	1.4	1.4
Sharyland	N/A	N/A
SWEPCO	1.9	1.9
TNMP	1.1	1.1
Xcel Energy	1.1	1.1
Statewide	**1.5**	**1.5**

1.3.6 Pilot Results

Table 1-21 summarizes the cost-effectiveness of each utility's pilot energy efficiency portfolio.

The pilot programs' statewide cost-effectiveness is 1.7 based on evaluated savings and 1.4 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.

Table 1-21. PY2016 Cost-Effectiveness Benefit/Cost Ratio—Pilot Sector

Utility	Claimed Savings	Evaluated Gross Savings	Evaluated Net Savings
AEP TCC	1.2	1.3	1.3
AEP TNC	0.9	1.0	0.9
CenterPoint	1.8	1.8	1.5
El Paso Electric	N/A	N/A	N/A
Entergy	N/A	N/A	N/A
Oncor	1.2	1.2	1.2
Sharyland	N/A	N/A	N/A
SWEPCO	N/A	N/A	N/A
TNMP	0.8	0.8	0.7
Xcel Energy	N/A	N/A	N/A
Statewide	**1.6**	**1.7**	**1.4**

1.4 KEY FINDINGS AND RECOMMENDATIONS

The objective of the EM&V recommendations is 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. The Commission 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). For example, recommendations made based on PY2016 evaluation research, which was completed in calendar year 2017, are expected to be implemented in PY2018.

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 utility to agree upon reasonable action plans. However, several of the recommendations may require utility process changes and have administrative cost implications.

Based on findings from the impact evaluations conducted across the ten utilities, as well as other evaluation research conducted as part of the PY2016 EM&V scope, the EM&V team provides recommendations in the following categories:

- Program level recommendations are provided for the commercial load management and residential demand response programs
- Measure level recommendations cover HVAC tune-ups, pool pumps, commercial HVAC and commercial lighting
- Process recommendations include lighting certification, program tracking and reporting, and program performance.

Following each recommendation, the utilities' agreed upon 'action plan' to respond to each recommendation is presented.

1.5 PROGRAM-LEVEL RECOMMENDATIONS

1.5.1 Commercial Load Management

Nine utilities operate Commercial Load Management programs. While these programs are mature and have been operating effectively for many years, PY2016 is the first year of a new TRM baseline methodology to calculate the impacts of the commercial load management programs. Overall, there was close agreement between evaluated and utility calculated savings based on the new TRM methodology.

Recommendation #1: Maintain ongoing communications with the EM&V team to resolve minor calculation differences to ensure continued performance and streamlining data provision and analysis efforts.

By-in-large the utilities all have demonstrated an understanding and ability to manage the TRM's calculation methods for commercial load management programs. However, differences in calculations for individual meters still occur and are the main point for ongoing collaboration and clarification. Opportunities to streamline the provision of data to the EM&V team include providing standard ESIID data files (for ERCOT utilities), with clear documentation on which meters participated in specific events. The specific streamlining opportunities differ for each utility, with the EM&V team ready to work with each utility to improve and simplify the provision and analysis of data on a case by case basis.

Action Plan: The utilities and EM&V team will maintain communications regarding the calculation of load impacts and opportunities to streamline data and analysis.

1.5.2 Residential Demand Response

Residential demand response programs are a fairly new offering in the utilities' portfolios. The first residential demand response program was offered as a pilot by CenterPoint in PY2014. Oncor introduced a residential demand response program in PY2015. Both AEP TCC and AEP TNC now also offer residential demand response with the addition of pilot programs in PY2016. This section summarizes the key findings and recommendations from the evaluation of the Residential Demand Response programs offered by these four utilities. While there was close agreement between evaluated and utility calculated savings, the EM&V team found two primary opportunities for improvement.

Recommendation #1: Clarify the approach for developing aggregate results across the population.

To calculate event savings across the many residential meters that may be participating in a thermostat-driven demand response program, the EM&V team sums the meter level results for a given event. The summation includes meters with both demand and energy consumption reductions and demand and energy consumption increases. In working with one utility to understand calculation differences, the EM&V team found that this approach was not understood nor was it explicit in the TRM. One utility conducted research with their participants with negative savings and discovered the majority were customers who exercised their option to not participate in a curtailment event ("opt out"). The EM&V team will revise the PY2018 TRM 5.0 to reflect the summation of all meters, but also the option to exclude opt outs from the results if program processes capture and document opt outs.

The TRM should be updated to reflect this aspect of aggregating meter results for residential demand response events, including an option to not include

Action Plan: The EM&V team revised the PY2018 TRM 5.0 M&V protocol for residential demand response programs to clarify how to sum meter level results for a given event.

Recommendation #2: Follow the TRM Calculation methodologies.

One of the utility's implementers developed calculations that differed fairly 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. 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 PY2016, the issue is muted by what appears to be a conservative calculation on the part of the implementer. This issue can likely be resolved with communication early in the program year.

Action Plan: The utilities will have the EM&V team review new implementer's calculations early in the evaluation period.

1.6 MEASURE-LEVEL RECOMMENDATIONS

1.6.1 CoolSaver HVAC Tune-Ups

In PY2016, over 13,000 HVAC tune-ups were provided to residential and commercial customers through four Texas utilities across seven different program offerings. Programs provided two different tune-up types: those where the refrigerant charge was adjusted and those where they were not. Air conditioners are designed to operate best with a predetermined charge of refrigerant gas as specified by the manufacturer. They rely on the correct charge, or amount of refrigerant gas in their systems, to work correctly. Refrigerant charging refers to the replenishment of these gases when system repairs or leaks have caused depleted levels. Refrigerant may need to be removed from a system that has been over charged as well.

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.

Recommendation #1: Use a rolling three-year average[6] of the efficiency losses to address that the efficiency losses appear to be reducing over time and to reduce the volatility from year-to-year.

The efficiency losses calculated from M&V data for PY2016 were lower than the stipulated efficiency losses for three of the four categories that were analyzed. In addition, for three of the four categories, the efficiency losses represent a historical low compared to previous years. Finally, the efficiency losses for Residential tune-ups were much lower than the corresponding values for Commercial tune-ups in PY2016. These may represent trends in the marketplace over time, where A/C units are receiving tune ups sooner, or possibly the effects of more accurate testing procedures, such as the adoption of iManifold.

Action Plan: The utilities and implementer will use a rolling three-year average[7] of the efficiency losses starting in PY2017.

Recommendation #2: Calculate efficiency losses by Refrigerant Charge Adjustment and Sector.

The PY2015 tune-ups' claimed savings assumed the same efficiency loss values across residential and commercial sectors. The annual efficiency losses when compared between Residential and Commercial tune-ups and those with and without a refrigerant charge adjustment are significantly different.

Action Plan: The utilities and implementers will calculate efficiency loss by Refrigerant Charge Adjustment and Sector using the previously mentioned rolling three-year average.

Recommendation #3: Determine the deemed peak demand coincidence factor (CF) for commercial projects by Building Type and Climate Zone as Specified in the TRM.

The EM&V team found that residential deemed peak demand CF values for HVAC systems are being used across commercial projects.

Action Plan: The utilities and implementers will review database algorithms and confirm commercial projects are using the proper coincident factor values as specified in the TRM.

Recommendation #4: Continue to collect a robust M&V sample for tune-up measures.

Approximately 10 percent of tune-up measures in Texas collect both test in and test out M&V field measurements by the programs. These M&V samples are used to calculate and calibrate efficiency losses for all tune-ups completed. Since there is a difference in the efficiency loss values observed in recent years between Commercial and Residential, collecting a large enough sample by sector will help determine if the recent observations are part of a trend in the marketplace.

Action Plan: Utilities and implementers will continue to collect at least a 10 percent M&V sample for tune-up measures annually for the commercial and residential populations.

Recommendation #5: Examine trends over time to determine if changes in the marketplace are evident from year-to-year.

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[6] The three year average should use M&V data from the most recent completed program years. For example, PY2017 efficiency losses are to be calculated from the average of PY2014, PY2015 and PY2016, PY2018 from the average of PY2015, PY2016 and PY2017, etc.

[7] The three year average should use M&V data from the most recent completed program years. For example, PY2017 efficiency losses are to be calculated from the average of PY2014, PY2015 and PY2016, PY2018 from the average of PY2015, PY2016 and PY2017, etc.

The divergence of the efficiency losses in recent years may be due to potential changes in the marketplace (e.g., more efficient units, improved accuracy of results from more experienced contractors, new testing tools in use, automation of testing procedures) or other factors. Until these factors are more thoroughly investigated, it is unknown whether efficiency loss values will continue to change from year to year or remain stable.

Action Plan: The utilities and EM&V team will work with the implementer to analyze statewide M&V datasets to understand drivers of the divergence of the efficiency losses calculated for recent years from the aggregated average since PY2011.

Recommendation #6: Assess the average efficiency loss for Residential tune-ups that did not receive a refrigerant charge adjustment to Inform TRM Updates for deemed tune-ups.

The PY2017 TRM version 4.0 includes a new deemed tune-up measure. As part of the deemed tune-up savings approach, a stipulated efficiency loss of 0.05 was assumed for all tune-ups. This assumption is applied to residential tune-ups whether the units received a refrigerant charge adjustment or not. This was based on the tune-up results of the EM&V research efforts to identify a conservative efficiency loss for a deemed tune-up. Since that time, efficiency losses have declined to a point where the Residential tune-ups and in particular, those that did not receive a refrigerant charge adjustment, are lower than the TRM stipulation and an adjustment in the deemed measure may be needed in the near future.

Action Plan: The EM&V team will work with the utilities to continue to assess tune-up efficiency results by sector and update the TRM deemed approach and efficiency loss stipulation to reflect a conservative value as compared to in-situ field measurements.

1.6.2 Pool Pumps

The commercial and residential pool pump programs were implemented by one Texas utility in PY2016. Both programs were launched as pilots in PY2014. These programs provide incentives to registered contractors for the successful sale, installation, calibration and reporting of ENERGY STAR® qualified variable speed swimming pool pumps for commercial and residential customers. Compared to a traditional single speed pump, a properly installed and calibrated variable speed pump can significantly reduce the energy required for the filtration, cleaning and circulation of swimming pool water.

This section summarizes the key findings and recommendations from the evaluation of the Commercial and Residential pool pump measures. The recommendations in this section are useful for downstream programs that also include M&V. The PY2016 EM&V research also informed pool pump proposed deemed savings values. The proposed deemed savings values can be used as planning estimates for delivering pool pumps through either a downstream or midstream delivery and for indoor and outdoor pools.

Recommendation #1: Follow the TRM peak demand savings approach.

The EM&V team found that the custom methodology for both commercial and residential pool pumps used a peak demand savings methodology that was calculated based on an average of the new pumps high and low-speed settings that was applied to both the old and new pump wattages.

Action Plan: The utilities and implementer will use the TRM Volume 1 peak demand savings procedures and collect the baseline or existing pumps operating schedule for a sample of pumps to inform the residential and commercial peak demand probabilities and coincidence factors.

Recommendation #2: Use appropriate key savings parameters for pumps used for non-primary pool operations (e.g., spas, water features).

The EM&V team found that the custom methodology for residential pool pumps used the same stipulated baseline operations for all pumps even if the pumps were installed for non-primary pool operations, such as spas and water features, which have different turn over requirements and significantly lower post installation operating schedules as compared to pool use only pumps. Also, the data showed that these were the only pump replaced at the site and not part of the pool pump replacement. Clearly capturing the baseline pumps operating schedule would confirm whether the program's stipulated values should apply to non-primary pool pumps and inform a separate baseline operating hour assumption if needed.

Action Plan: The baseline or existing pumps operating schedule will be collected and tracked by the program for all non-primary pool pumps.

Recommendation #3: Capture commercial pool usage hours within project documentation.

The EM&V team found many of the commercial pool pumps had significant reductions in post operating hours. This is allowed for commercial pools under the provisions set by the Texas Department of State Health Services[8]. However, the EM&V team found that many pumps had different post operating hours as compared to the business hours of operation captured within the programs tracking systems. Some post pumping hours were found higher and some found lower as compared to the business hours of operation. This may indicate inconsistency for how hours are captured of either the business or the pumps. In addition to the business hours, capturing the pool's usage schedule (i.e., days and hours the pool is open to patrons) may increase the consistency in data captured while directly supporting the reduced post retrofit operating schedules.

Action Plan: The pool's usage schedule will be captured and tracked by the program for all commercial pump projects.

Recommendation #4: Review the make and model number of the old and new pumps for accuracy within project documentation and the tracking data.

The EM&V team found that both the commercial and residential pool pump programs collected and tracked pump make and model numbers, however, the information was not always detailed enough to clearly identify the specific equipment installed. This information is needed to collect manufacturers' pump curve data to confirm equipment performance, such as flow rates and energy factors. This metric changes depending on the size and type of the pumps and such information collected in the field could inform Texas specific performance averages based on the most common pumps installed in the state. Also, material invoices were found collected by the programs, however, these lacked clear detail of the make and model number of the pumps as well. Currently, the new deemed TRM measure based these assumptions from US average pump energy factors by horsepower found in the ENERGY STAR® Pool Pump Savings Calculator. The energy factor is a key driver of savings assumptions and can vary between manufacturers and pump sizes.

Action Plan: Project documentation (e.g., commissioning reports, invoices) and the tracking data will clearly capture the existing and new pumps make and model numbers.

[8] Section 265.203.(c)(2) states circulation pumps shall run continuously 24 hours a day, year round, and not be throttled to reduce circulation below the design flow rate, except that a pool pump may run less than 24 hours a day if: (A) "Pool Closed" sign, with letters at least 1-inch tall, is posted on the exterior side of each entry gate into the pool yard; (B) the pump runs a sufficient number of hours needed to keep the water at required clarity and disinfectant levels; and (C) the pump runs the same number of hours each day.

1.6.3 Commercial HVAC

Multiple calculator tools are used in Texas to simplify the savings estimation process for prescriptive commercial energy efficiency projects. There are two prominently used Excel-based calculator tools to estimate HVAC based savings. The calculator tools are typically updated each year as improvements and updates are needed. During the PY2016 evaluation, the EM&V team found multiple occurrences of misuse, which resulted in significant changes in the evaluated savings for some projects. Several issues found could be caught and corrected during application processing and savings calculation quality control reviews. In addition, the EM&V team offers recommendations for tool usability improvements and areas of recommended focus for tool training.

Recommendation #1: Address common errors and omissions found within the HVAC calculators to avoid inaccurate project savings.

Common errors and omissions of data within the HVAC calculator tools included:

- Not consolidating the indoor and outdoor portions of the split system and listing them separately. This may cause an overstatement in the reported peak demand savings.
- Entering incorrect equipment efficiencies. This can understate or overstate reported energy use and peak demand savings.
- Not entering both the part and full load efficiency. This can understate or overstate reported energy use and peak demand savings.
- Not selecting the correct system type for heat pumps and omission of the heating capacities and efficiencies. This will understate reported savings.

Action Plan: The utilities will provide calculator training to staff and energy efficiency service providers with focus on common mistakes and errors that can lead to incorrect savings estimates.

Recommendation #2: Conduct QA/QC of equipment efficiencies found within project savings calculations.

The full and part load efficiencies of the cooling equipment (and heating for heat pumps) are requested within the calculator tools. In addition, the manufacturer, model number, and AHRI reference number are also requested within the tools. For some projects, these cells were not filled out and for others the cells were filled out, but not correctly. Those projects with errors were typically found to be lacking AHRI certificates within project file documentation.

Action Plan: The utilities will gather a copy of equipment AHRI certificates and use the documentation as part of internal quality control and project reviews.

Recommendation #3: Examine calculators for further improvements in automation and quality control checks to increase overall usability and potentially limit common user mistakes.

Common errors and omissions were found within the two most prominently used HVAC calculators in the state, which resulted in either understated or overstated project savings. Improvements such as automation, pre-determined drop down selections, and warning signals have helped, but further refinement may help users avoid the common mistakes that were found in PY2016 across the commercial HVAC measures.

Action Plan: Utilities will review their HVAC calculator tools for improvements in usability and ways to assist with limiting user entry errors.

1.6.4 Commercial Lighting

As part of PY2016 evaluation activities, the EM&V team analyzed customer self-reported hours of use from EM&V on-site visits conducted from PY2013 through PY2016 as compared with the current TRM assumptions for annual operating hours (AOH) across building types. The main objective is to provide an assessment that would identify any potential issues with the stipulated variable and savings for lighting measures in Texas to inform potential TRM updates.

Recommendation #1: Consider adding the building type field in program tracking data to track trends of building stock within program participation to better inform whether updates to the building category mix is needed.

Based on the PY2013 through PY2016 analysis of annual operating hours for commercial lighting, the EM&V team will continue to research operating hours with particular emphasis in collecting more information on building types with the most variation from TRM stipulations such as "Lodging, Commons", "Manufacturing", and "Education, Summer" to inform if any updates in the stipulated operating hours for certain building types are needed. Also, the mix of building types represented by the programs may need to be further assessed for some building categories. For example, the "Lodging, Commons" building type may not have a similar portion of all sub categories that were used in initially developing the TRM stipulations. Updates on the proportions or splits may also be warranted for some building types where the sub category populations are either not represented or where there is a higher level of variation. In addition, the projects reviewed during the site visits included a high portion of outdoor lighting with photocell controls that were retrofit as well. It is unknown whether this building type or others have increased in program participation as the building type is not currently tracked in any of the commercial programs tracking system data.

Action Plan: Utilities will consider the feasibility of adding the building type field in the tracking data to allow the utilities and EM&V team to more clearly track trends of building stock.

Recommendation #2: Update TRM Stipulated hours of operation for manufactures that operate different production shifts.

Currently the TRM stipulations for operating hours and coincidence factors for the "Manufacturing" building type represents all manufacturers no matter the production shifts that they operate. The results of the EM&V on-site visits found distinct differences in annual operating hours for manufacturing facilities that operate different production shifts. In particular, production operations and the lighting needed to support those operations are dramatically different from 1 shift, 2 shift and 3 shift operations.

Action Plan: The EM&V team updated the "Manufacturing" building type for the PY2018 TRM version 5.0 to provide separate stipulations for annual operating hours and coincidence factors for 1, 2 and 3 shift operations and guidance on seasonal changes in manufacturing shift schedules.

1.7 PROCESS RECOMMENDATIONS

1.7.1 Nonresidential Lighting Qualification

The TRM has eligibility criteria for nonresidential LED lamps and fixtures to be qualified and listed by at least one of the following organizations: Design Lights Consortium™ (DLC), ENERGY STAR®, Lighting Design Lab (LDL) or DOE LED Lighting Facts. Additionally, at the utilities discretion, LED products may receive approval if results of independent lab testing (e.g., LM-79, LM-80, TM-21) show the products comply with the most current version of the DLC Technical Requirements. With recent changes in LDL and DOE LED Lighting Facts coupled with the new DLC technical requirements, the EM&V team researched the current state of commercial lighting qualification to provide recommendations for eligibility criteria going forward. Key findings and applicable recommendations are presented below based on the EM&V team's research.

Recommendation #1: Establish a standard 12 month grace period for qualification changes to allow the market to respond to changes.

The changes that resulted with DLC V4.0 compared to previous updates to the technical requirements were significant and many manufacturers and other stakeholders were caught off guard even though the new requirements went through a formal, public and lengthy comment and grace period. Manufacturers are making preparations for future updates to the DLC technical requirements and some are already designing future lighting products with the DLC 5.0 in mind. Training with distributors on DLC updates is also taking place as well. While a significant number of products fell off when the DLC V4.0 began, the market is responding and many lighting products have since been added and the qualified product list continues to grow. While a six month grace period has been used before in Texas for qualification changes, this was an agreement between the utilities and the EM&V team and not specified in the TRM. The EM&V team's research also indicates six months is not a sufficient grace period for more sweeping changes in qualifications such as the recent DLC V4.0 change.

Action Plan: The EM&V team added a twelve month grace period when qualifications change in the PY2018 TRM 5.0 eligibility criteria for commercial lighting.

Recommendation #2: Continue TRM commercial lighting eligibility criteria for prescriptive lighting projects with the option of custom non-qualified lighting projects.

Most programs around the country continue to require the Standard DLC qualification with one state requiring the Premium DLC qualifications. However, some utilities in the Northwest have recently specified their own technical requirements that LED fixtures and lamps must meet for program eligibility for products that are not currently qualified by DLC. There are many similarities between these Northwestern utilities' and DLC's criteria such as safety certifications, five-year warranty requirements, minimum efficacy, minimum light output, Correlated Color Temperature (CCT), L70 (lumen maintenance and depreciation that is typically covered by LM-80) requirements, and Total Harmonic Distortion (THDi) limits. In Texas, if the DLC does not have a category for the lighting of interest to the customer, the utilities have worked with the EM&V team to submit these projects as custom lighting on a case-by-case basis.

Action Plan: The EM&V team revised the PY2018 TRM 5.0 eligibility requirements to recognize the option of submitting non-qualified products as custom lighting. If utilities want to pursue non-qualified lighting as a standard program option, utilities will work with the EM&V team to establish clear parameters, information and documentation for non-qualified lighting as part of program requirements.

Recommendation #3: Investigate program strategies to shift beyond one-for-one lighting retrofits to more holistic lighting improvements.

While the evolution of LEDs continues in the short term, there is an anticipated market shift for LEDs to become the standard. Future opportunities for energy savings are likely to be in more holistic lighting improvements such as improvements in lighting designs and integrating advanced controls such as Networked Lighting Control (NLC) systems. ASHRAE 90.1-2016 already models approximately 75 percent of the baseline fixtures as having LEDs. ASHRAE 90.1-2019 is forecasted that their model will contain up to 90 percent of the baseline fixtures as having LEDs. These will have tremendous implications on energy efficiency programs which rely on one-for-one lighting retrofits for a significant portion of program savings. Much of the lighting industry's thought leaders expressed that the definition of quality lighting is evolving and is likely to expand beyond the energy savings component alone.

Action Plan: Utilities will stay abreast of commercial lighting trends and opportunities to inform future program design.

1.7.2 Program Tracking and Reporting

In the PY2014 EM&V, the EM&V team identified inconsistencies with program tracking and reporting. This included the way program tracking data identified measures and programs as well as how utilities reported savings in their annual Energy Efficiency Plans and Reports (EEPRs). The utilities were to respond to PY2014 EM&V recommendations regarding program tracking and reporting in PY2016. Utilities have significantly improved tracking and reporting in response to previous EM&V recommendations. Key findings and applicable recommendations are presented below based on the EM&V team's assessment of PY2016 program tracking data.

Recommendation #1: Tracking data should maintain sufficient detail so that records can be aligned with TRM entries.

Improved tracking data supports EM&V activities such as planning, cost-effectiveness, and reporting and can also help utilities monitor program performance and support other internal needs. While there remains work to be done regarding the level of detail maintained in tracking data, as well as the levels of detail included in utility reporting, the remaining issues are less critical than those raised in earlier evaluations. The PY2016 tracking data clearly identifies measure life for nearly all measures, removing the ambiguity of having to assign a value based on the measure description. Utilities generally track measures at a more detailed level than in earlier years of EM&V so that tracked measures can be tied more directly to a TRM entry. Some utilities still have some ambiguity in tracking data that could be improved. For example, rather than tracking a measure as "Lighting Retrofit" with a 15-year measure life, utilities should report the actual technology in tracking data (e.g., LED, Linear Fluorescent).

Action Plan: Utilities will consider additional tracking data refinements to align measures with the TRM.

Recommendation #2: Ensure that program plans, tracking data, and reporting maintain the same program definitions.

Utilities have almost completely aligned programs in tracking data with those reported in utility reporting as recommended in the PY2014 EM&V Annual Statewide Portfolio Report. There were two exceptions in PY2016, both related to Commercial SOPs. One utility did not distinguish subprograms in its plan, but did report those subprograms separately. Another utility planned and reported subprograms, but the tracking data did not provide a way for the EM&V team to match that level of detail.

Action Plan: Utilities will fully align program tracking data with program reporting.

Recommendation #3: Report claimed savings in EEPRs in kWh and kW.

The EM&V team identified a new issue related to utility reporting in PY2016. Several utilities report savings in their EEPRs in MWh and MW. The EM&V team relies on EEPRs to ensure that EM&V

reports accurately represent utilities' claimed savings. When savings are rounded from kWh and kW and reported as MWh and MW, the EM&V team is unable to verify that the utilities' claimed savings in their EEPRs match those in their program tracking data.

Action Plan: Utilities will report claimed savings in EEPRs in kWh and kW to the one place starting with the April 1, 2018 EEPRs.

1.7.3 Program Performance

In their annual EEPR filing to the Commission, the utilities project for each program in their portfolio demand reduction and energy savings for the upcoming program year. These projections are distinct from their mandated portfolio goals, but instead reflect the utilities' planning related to the mix of programs that will achieve or surpass those goals. The EM&V team compared the evaluated program impacts for each utility program with their EEPR projections. For the most part, utilities' achieved evaluated savings for PY2016 were close to or higher than their projected savings.

Recommendation #1: Continue Commercial Load Management offerings to meet sector demand reduction targets and continue and/or consider Commercial MTP offerings to help achieve expected commercial sector savings.

Load management programs have been key for utilities to achieve their projected kW goals. Some diversity in commercial program offerings appear to help utilities achieve and/or exceed projected sector energy savings goals. For example, in several cases when a CSOP or CMTP program did not perform as planned, another CMTP program was able to make up the difference in savings to still achieve or surpass sector level projected savings.

Action Plan: Utilities will assess their commercial sector offerings and their ability to meet projected savings.

Recommendation #2: Continue RSOP type programs and efforts to expand HVAC offerings and explore other ways to bolster RMTP offerings.

Except for one utility, RSOP type programs are still the main driver of meeting residential sector demand reduction and savings goals. There are fewer RMTP programs across the utilities' portfolios and in several cases they are falling short of projected residential savings. With envelope measures being the primary percent of savings in RSOP type programs in PY2015 and the reduced envelope deemed savings that rolled out in the PY2017 TRM 4.0, the EM&V team recommended in the PY2015 EM&V Annual Statewide Portfolio Report that utilities expand HVAC measures in the residential sector. Utilities have made progress—HVAC accounted for over a quarter of kW and over a third of kWh savings in PY2016. In addition, RMTP offerings that help utilities continue to achieve projected residential savings may be needed with the new baseline for new home programs coming into effect in PY2018 and for some of the underperformance seen in other RMTPs in PY2016.

Action Plan: Utilities will assess their residential sector offerings and their ability to meet projected savings.

1.8 CONCLUSION

Utilities' evaluation results are positive, as demonstrated by the close agreement between claimed and evaluated savings and the resulting realization rates near 100 percent. The positive 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. 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 a number of process improvements, most notably in their program tracking and documentation. At the same time, the PY2016 EM&V research identified some savings improvements, in particular for HVAC tune-ups, pool pumps and residential demand response. The EM&V team is working with the utilities to implement these changes and integrate updates into the PY2018 TRM 5.0.

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 2016 (PY2016).

PY2016 is the fifth program year evaluated as part of the statewide EM&V effort. The PY2016 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 PY2016 EM&V plans[9] 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.

2.1 EVALUATION ACTIVITIES

The following EM&V activities were completed statewide:

- Tracking system review verifying all claimed savings and that residential deemed measures were calculated in accordance with the PY2016 TRM 3.1.
- 98 desk reviews
- 51 commercial on-site M&V

[9] *Public Utility Commission of Texas Evaluation, Measurement, and Verification (EM&V) Plans for Texas Utilities' Energy Efficiency and Load Management Portfolios—Program Year 2016*, January 2017.

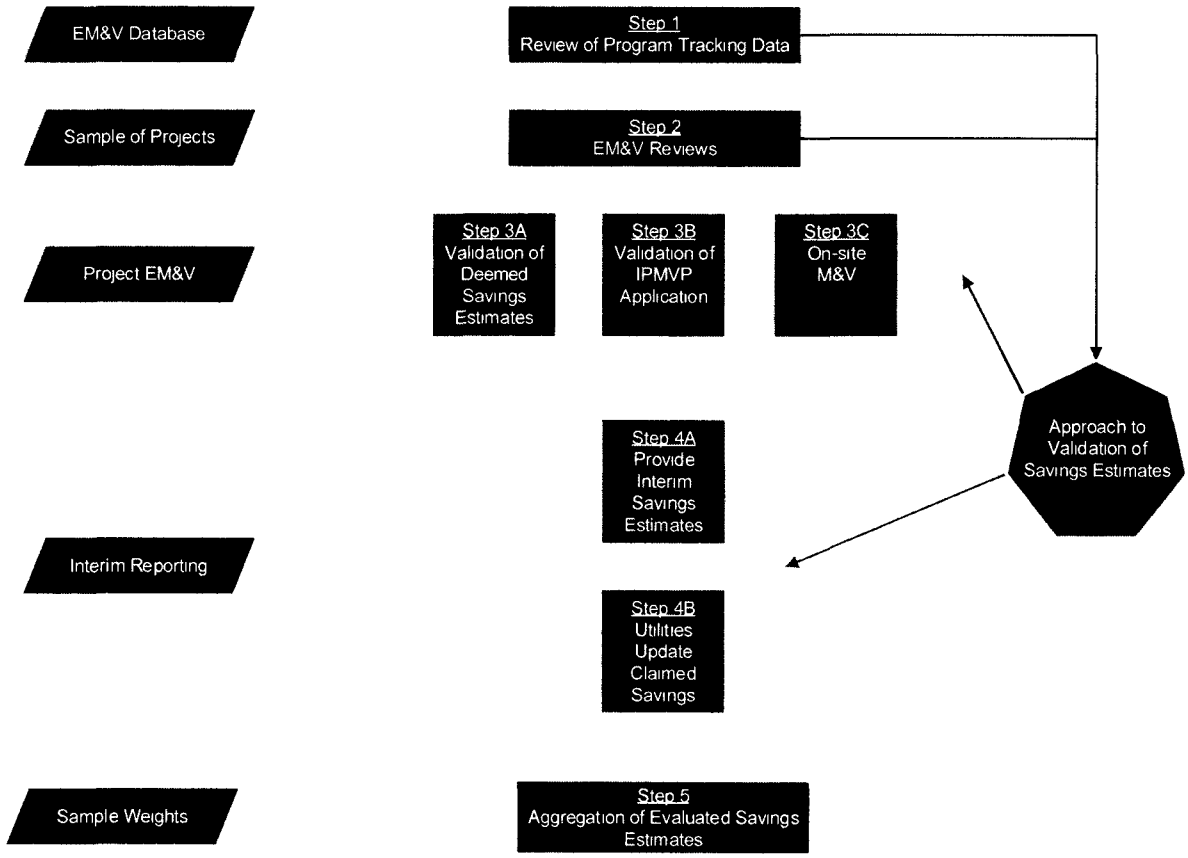
- Calculation of load management impacts using interval meter data
- Census review of M&V data for CoolSaver tune-ups and pool pumps.

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 PY2016 TRM 3.1 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 PY2018 TRM 5.0.

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 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 PY2016 claimed and evaluated results. Low-income programs were also calculated using the Savings-to-Investment Ratio (SIR).

2.2 REPORT ORGANIZATION

Section 3 includes Program-level key findings and recommendations for the load management programs. Section 4 includes Measure-specific results for: CoolSaver HVAC tune-ups, Pool Pumps, Commercial HVAC and Commercial Lighting. Section 5 presents key findings and recommendations regarding three process assessments: LED qualification, Program Tracking and Program Performance. A separate report volume (Volume II) details the EM&V results for each utility's portfolio.

3.0 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.

3.1 COMMERCIAL LOAD MANAGEMENT

This section summarizes the key findings and recommendations from the PY2016 evaluation of the Commercial Load Management programs offered by nine utilities.

3.1.1 Results

The EM&V team applied the method prescribed in the PY2016 TRM 3.1 on a census of records to calculate energy savings and demand reductions. The total evaluated savings between the nine programs were 228,065 kW and 1,060,631 kWh. These results show a rebound compared to PY2015, by roughly one MW (1,000 kW).

Demand savings for each utility were calculated fairly closely to the evaluation. 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 reported kW savings about 10 percent less than those initially 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 a customer 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. In the case of CenterPoint and AEP TCC, the realization rates over 100 percent reflect that the utilities' calculation were slightly more conservative than the EM&V team's calculations, with minor differences left unresolved.

3.1.2 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.

By-in-large the utilities all have demonstrated an understanding and ability to manage the TRM's calculation methods for commercial load management programs. However, differences in calculations for individual meters still differ and are the main point for ongoing collaboration and clarification. Opportunities to streamline the provision of data to the EM&V team include providing standard ESIID data files (for ERCOT utilities), with clear documentation on which meters participated in specific

events. The specific streamlining opportunities differ for each utility, with the EM&V Team ready to work with each utility to improve and simplify the provision and analysis of data on a case by case basis.

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.

3.2 RESIDENTIAL LOAD MANAGEMENT IMPACT ASSESSMENT

This section summarizes the key findings and recommendations from the PY2016 evaluation of the Residential Load Management programs offered by four utilities (AEP TCC, AEP TNC, CenterPoint and Oncor).

3.2.1 Results

The EM&V team applied the method prescribed in the PY2016 TRM 3.1 to calculate energy savings and demand reduction for each utility. The total evaluated savings between the four programs were 20,344 kW and 117,149 kWh. Oncor's program was in its second year of implementation in PY2016. AEP's was offered for the first time in PY2016. CenterPoint's program was operated as a pilot program in the past but is a standard program in PY2016.

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 for PY2015, with calculations matching extremely closely in PY2016. In the case of CenterPoint, the EM&V team worked with the utility to resolve calculation differences, finding that a misunderstanding on the approach to aggregating meter savings differed, but were resolved with fairly similar results—within about two percent. For AEP TCC and AEP TNC, the EM&V team worked with the utilities and found that savings were understated. There appeared to be different approaches to calculations taken by the implementer than the EM&V team, resulting in the evaluated savings being higher than the AEP TCC and AEP TNC, which were not resolved. The result is an overall statewide realization rate of 104.1 percent for kW.

The EM&V team calculated kWh savings somewhat higher than the utilities, similar to the kW savings. In the case of kWh, CenterPoint's savings tracked the same realization rate at the kW savings, with the resolution on the calculation method resulting in a 102.6 percent realization rate. In the case of Oncor, the utility did not initially claim any kWh savings, but with agreement on the kW savings, the evaluation's kWh calculation were accepted, resulting in a 100.0 percent realization rate. For AEP TCC and TNC, kWh calculations tracked the kW, with an exception for one implementer for AEP TCC. This implementer calculated kWh savings based on the average kWh from each event, rather than the sum of kWh across all the events.

In working with the four utilities offering residential demand response programs, the EM&V team was able to apply the PY2016 TRM 3.1 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 3.1 calculation method. With the exception of one implementer working with AEP TCC and TNC, calculation differences were either minor or resolved.

3.2.2 Key Findings and Recommendations

Key findings and applicable recommendations are presented below.

Key Finding #1: How results should be added across the population of participating meters could be misunderstood.

To calculate event savings across the many residential meters that may be participating in a thermostat-driven demand response program, the EM&V team sums the meter level results for a given event. The summation includes meters with both demand and energy consumption reductions and demand and energy consumption increases. In working with one utility to understand calculation differences, the EM&V team found that this approach was not understood nor was it explicit in the TRM. While the other utilities understood the approach, it was clear that the methodological issue was not universally understood. Regardless, the TRM should be updated to reflect this aspect of aggregating meter results for residential demand response events.

Recommendation #1: Clarify the approach to developing aggregate results across the population of participating meters in the TRM.

Key Finding #2: There was one instance of an implementer not following the TRM to calculate program impacts.

One of the utility's implementers developed calculations that differed fairly 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. 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 PY2016, the issue is muted by what appears to be a conservative calculation on the part of the implementer. The issue can likely be resolved with communication early in the program year, an opportunity not available for PY2016 due to re-bid of the evaluation contract.

Recommendation #2: Calculation methodologies should follow the TRM.

4.0 MEASURE RESULTS

This section presents results for the following measures:

- AC and heat pump tune-ups
- Pool Pumps
- Commercial HVAC
- Commercial Lighting.

4.1 COOLSAVER HVAC TUNE-UPS

This section summarizes the key findings and recommendations from the PY2016 evaluation of air-conditioning and heat pump tune-ups. The recommendations in this memo are to be considered by the utilities for PY2017 implementation and will also be incorporated into the PY2018 Texas Technical Reference Manual (TRM) 5.0.

4.1.1 Background

The PY2014 Statewide Portfolio Report detailed findings and recommendations from a census review of CoolSaver heat pump and air conditioning tune-ups in Section 4.5. One of the key recommendations was that calibration of the model used to develop the stipulated efficiency losses[10] should be completed annually with the M&V data collected in the prior program year. In addition, as part of the PY2014 EM&V, the EM&V team worked with the implementation contractor to develop a M&V protocol for tune-ups to include in the PY2016 TRM version 3.1 Volume 4:M&V Protocols. As part of the PY2016 EM&V efforts, a census review of CoolSaver air conditioning tune-ups was again conducted to assess implementation of the PY2014 recommendations as well as any needed updates to the TRM M&V Protocol for this measure.

In PY2016, over 13,000 tune-up measures were provided to residential and commercial customers through four Texas utilities across seven different programs as shown below (Table 4-1).

[10] Efficiency loss is the ratio of the air conditioners measured efficiency before and after a tune-up.

Table 4-1. PY2016 Tune-Up Summary by Utility and Program

Utility	Market Transformation Program	Energy Savings		Tune-Up Count
		Reported kW	Reported kWh	
AEP TCC	CoolSaver[1]	2,460	6,538,402	3,791
CenterPoint	Retail Electric Provider[2]	5,054	12,319,136	8,716
El Paso Electric	Large Commercial Solutions	1	832	1
	Residential Solutions	7	11,974	12
	SCORE	3	3,518	4
	Small Commercial Solutions	14	24,169	27
Entergy	Commercial Solutions	726	2,020,706	544
Total		**8,264**	**20,918,737**	**13,095**

[1] AEP TCC's CoolSaver reported kW, reported kWh, and tune-up counts do not include 53 HVAC replacement measures reported in PY2016 as part of the program.

[2] CenterPoint's Retail Electric Provider reported kW, reported kWh, and tune-up counts do not include 103 lighting measures reported in PY2016 as part of the program.

4.1.2 Reported Tune-Up Savings Methodology

According to the 2016 CoolSaver Option A M&V Plan methodology, a combined state average of Texas and New Mexico efficiency losses from PY2011 through PY2015 were used to estimate the tune-up savings for PY2016, which are presented in Table 4-2 below by two different tune-up types: those where the refrigerant charge was adjusted and those where they were not. Air conditioners are designed to operate best with a predetermined charge of refrigerant gas as specified by the manufacturer. They rely on the correct charge, or amount of refrigerant gas in their systems, to work correctly. Refrigerant charging refers to the replenishment of these gases when system repairs or leaks have caused depleted levels. Refrigerant may need to be removed from a system that has been over charged as well.

Table 4-2. Stipulated Tune-Up Efficiency Losses (PY2011–PY2015 averages)

Refrigerant Charge Adjusted	Efficiency Loss
No	0.149
Yes	0.110

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 4-3 shows the total tune-ups and M&V quantities by utility that were completed in PY2016. Three of the four utilities were slightly lower than 10 percent while the one utility that conducted 100 percent M&V on their tune-up projects brings the statewide total percentage close to 10 percent.

Table 4-3. PY2016 M&V Summary by Utility

Utility	Tune-Up Count	M&V Count	M&V Percent
AEP TCC	3,791	332	8.8%
CenterPoint	8,716	838	9.6%
El Paso Electric	44	44	100%
Entergy	544	48	8.8%
Total	**13,095**	**1,262**	**9.6%**

4.1.3 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 2016. 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. After reporting initial findings, an error in the tracking data was identified and updated tracking system databases were provided by the implementation contractor for three utilities for re-analysis. Finally, the EM&V team requested the full tune-up M&V dataset from 2011 through 2015 to analyze the efficiency losses, which are the key savings assumption for this measure.

As part of the EM&V team's analysis, a comprehensive review of the full M&V sample from 2011 through 2016 was completed. The tracking datasets from 2011 through 2016 were combined into a single dataset for analysis. The combined M&V dataset included 12,010 individual tune-up measures collected by the programs over the last six 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. Six tune-ups were found invalid per the EER check and were excluded from further analysis.
- **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.

A total of 11,919 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 4,934 tune-ups without an RCA and 6,985 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 220 tune-ups were identified as outliers from the compressor power test and excluded from the analysis.

4.1.4 Results

The tracking system reviews of the PY2016 M&V measures found adherence to the 2016 CoolSaver Option A M&V Plan protocols for tune-up measures. However, during the tracking data reviews, the EM&V team also found that the PY2016 efficiency loss values for the Residential sector deviated substantially from the PY2011-PY2015 averages and from the PY2015 efficiency losses, which are described in more detail next. In addition, the EM&V team found that the current CoolSaver Option A M&V Plan does not address the difference between residential and commercial tune-ups. The EM&V team believes this was due to CoolSaver being primarily all residential tune-ups historically, but there is now strong uptake of the measure across both residential and commercial customers and therefore an update for the two different sectors is needed.

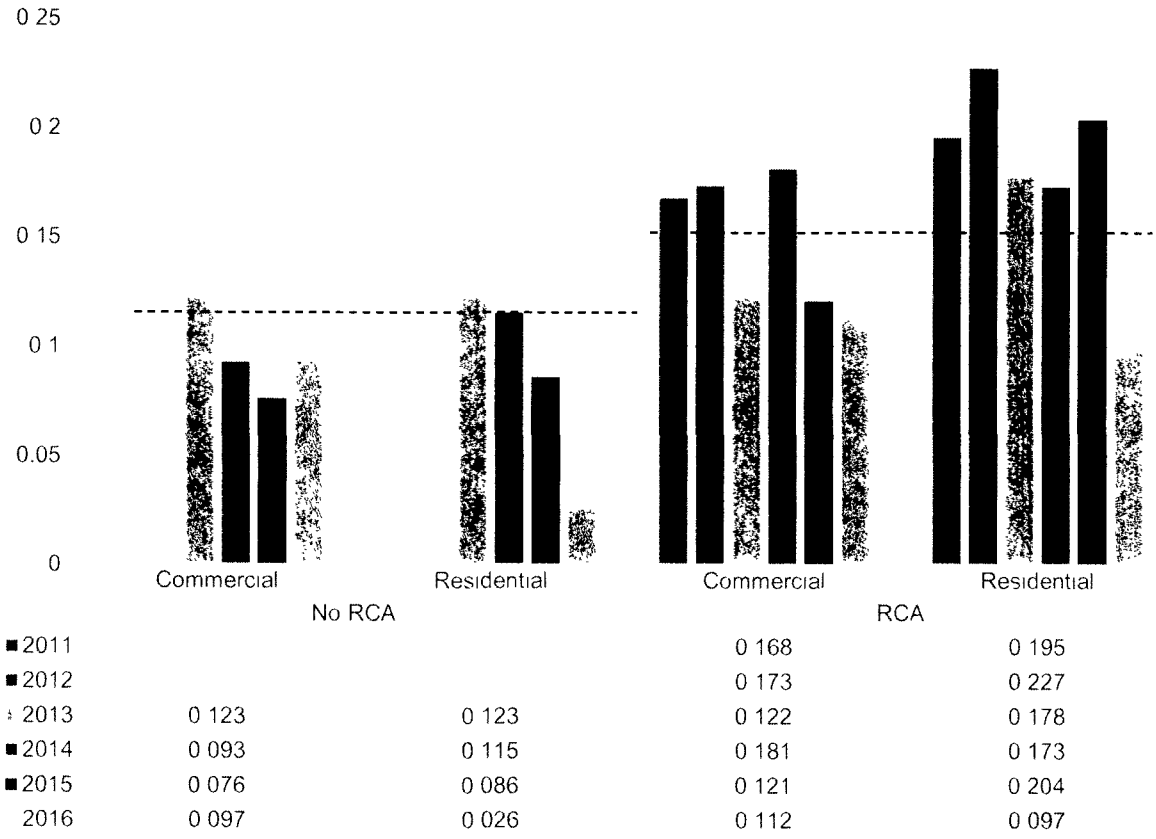
The number of M&V tune-ups validated by year is presented in Table 4-4. The exclusion rate for projects was lower from 2014–2016 (1.3-2.1 percent) compared to 2011-2013 (2.5-4.9 percent). The lower exclusion rate likely reflects the accuracy of the software testing suites, such as iManifold, that have increased in use among trade allies and provides for more accurate data collection.

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

Year	M&V Tune-Ups	Passed Data Checks	Passed Compressor Power Test	Total Tune-Ups Excluded	Exclusion Rate
2011	1,163	1,143	1,106	57	4.9%
2012	638	629	607	31	4.9%
2013	6,063	6,010	5,910	153	2.5%
2014	2,065	2,064	2,029	36	1.7%
2015	819	819	802	17	2.1%
2016	1,262	1,254	1,245	17	1.3%
Total	**12,010**	**11,919**	**11,699**	**311**	**2.6%**

The 11,699 Texas tune-ups that passed the data checks were then analyzed by year, by sector (i.e., residential, commercial), and RCA status. Figure 4-1 shows the resulting efficiency losses by year as compared with the efficiency losses from PY2011–PY2015 (black dashed line). The PY2016 Residential efficiency losses (with and without RCAs) were found much lower than values for any previous year. In addition, all four categories for PY2016 were below the PY2011–PY2015 values.

Figure 4-1. Texas Average Efficiency Losses by Sector and Year



	No RCA		RCA	
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

4.1.5 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 appear to be reducing over time.

The efficiency losses calculated from M&V data for PY2016 were lower than the stipulated efficiency losses for three of the four categories that were analyzed. In addition, for three of the four categories, the efficiency losses represent a historical low compared to previous years. Finally, the efficiency losses for Residential tune-ups were much lower than the corresponding values for Commercial tune-ups in PY2016. These may represent trends in the marketplace over time, where A/C units are receiving tune ups sooner, or possibly the effects of more accurate testing procedures, such as the adoption of iManifold.

Table 4-5. PY2014–PY2016 Texas Efficiency Losses

Sector	Refrigerant Charge Adjusted	Efficiency Loss
Commercial	No	0.086
	Yes	0.149
Residential	No	0.087
	Yes	0.152

Recommendation #1A: The EM&V team recommends using a rolling three-year average[11] of the efficiency losses to reflect this potential change over time and reduce the volatility from year-to-year that is currently seen in the year-to-year efficiency loss values.

Key Finding #1b: Annual efficiency losses were found significantly different between Residential and Commercial tune-ups.

The PY2015 tune-ups' claimed savings in Texas assumed the same efficiency loss values across residential and commercial sectors. The annual efficiency losses when compared between Residential and Commercial tune-ups, are significantly different. The three-year average efficiency losses are similar, but the EM&V team believes this to be coincidental as averaging any other three-year periods or comparing annual results indicate a much larger variation.

Recommendation #1B: Calculate efficiency loss by RCA and Sector using a rolling three-year average.

Key Finding #2: The TRM volume 4 M&V Protocol for A/C Tune-Ups indicate the deemed peak demand coincidence factor (CF) should be determined by Building Type and Climate Zone, while the 2016 CoolSaver M&V Plan provides a default value corresponding to Residential projects only.

The 2016 CoolSaver Option A M&V Plan provides default values for coincident factors for summer and winter of 0.87 and 0.83, respectively, which correspond to the default Residential values for HVAC systems. The tracking system review indicated these are likely being used across commercial projects as well while the TRM volume 4 M&V protocol guides users to apply commercial HVAC deemed peak demand coincident factors based on the applicable Building Type and Climate Zone for commercial tune-up measures.

Recommendation #2: Review database algorithms and confirm all projects are using the proper coincident factor values as specified by TRM volume 4. Make revisions as necessary.

Key Finding #3: Tune-Up measures should continue to collect a robust M&V sample.

Currently, approximately 10 percent of tune-up measures in Texas collect both test in and test out M&V field measurements by the programs. These M&V samples are used to calculate and calibrate efficiency losses for all tune-ups completed. Since there is a difference in the efficiency loss values

[11] The three year average should use M&V data from the most recent completed program years. For example, PY2017 efficiency losses are to be calculated from the average of PY2014, PY2015 and PY2016, PY2018 from the average of PY2015, PY2016 and PY2017, etc.

observed in recent years between Commercial and Residential, collecting a large enough sample of sector will help determine if the recent observations are part of a trend in the marketplace.

Recommendation #3: Continue to collect at least a 10 percent M&V sample for tune-up measures annually for the commercial and residential populations separately.

Key Finding #4: A review of the 2011 through 2016 statewide M&V datasets indicated the efficiency losses calculated for recent years is diverging from the aggregated average since PY2011.

The diverge of the efficiency losses in recent years may be due to potential changes in the marketplace (e.g., more efficient units in current year measures, improved accuracy of results from more experienced contractors, new testing tools in use, automation of testing procedures) or other factors. Until these factors are more thoroughly investigated, it is unknown whether efficiency loss values will continue to change from year to year or remain stable.

Recommendation #4: Trends over time should be examined to determine if changes in the marketplace are evident from year-to-year.

Key Finding #5: The 2016 statewide M&V dataset indicated the average efficiency loss for Residential tune-ups that did not receive a refrigerant charge adjustment (i.e., no RCA) was 0.026. This value is lower than the current stipulated efficiency loss value within the deemed tune-up savings approach in TRM version 4.0.

The PY2017 TRM version 4.0 includes a new deemed tune-up measure in Volume 2: Residential Measures in addition to the M&V Protocol for the CoolSaver tune-ups found in Volume 4:M&V Protocols. As part of the deemed tune-up savings approach, a stipulated efficiency loss of 0.05 was assumed for all tune-ups. This assumption is applied to residential tune-ups whether the units received a refrigerant charge adjustment or not. This was based on the tune-up results of the EM&V research efforts to identify a conservative efficiency loss for a deemed tune-up. Since that time, efficiency losses have declined to a point where the Residential tune-ups and in particular, those that did not receive a refrigerant charge adjustment, are lower than the TRM stipulation and an adjustment in the deemed measure may be needed in the near future. While the average efficiency loss for Residential units without a refrigerant charge was found to be 0.026 in PY2016, the overall average Residential efficiency loss was 0.072, which is still above the 0.05 TRM 4.0 stipulation. However, if efficiency losses continue to decline in PY2017, then the deemed tune-up efficiency loss assumption may need to be adjusted to stay conservative as compared to actual field results.

Recommendation #5: The EM&V team will continue to assess tune-up efficiency results by sector and update the TRM deemed approach and efficiency loss stipulation to reflect a conservative value as compared to in-situ field measurements.

4.1.6 Conclusions

The tune-up measures in Texas have continued to evolve from year to year. The EM&V team will work with the utilities and their implementation contractor(s) to assure that the appropriate savings methods and assumptions are adjusted appropriately. To do so, the EM&V team will again conduct a census review of the CoolSaver tune-ups for PY2017. In addition, the EM&V team will analyze the PY2017 M&V data for tune-ups once it is available at the end of the 2017 program year to provide early

identification of changes occurring in the field and confirm the appropriate PY2018 efficiency loss values for the new program year in order to assist utilities and their implementers in program forecasting. This would also allow the EM&V team to validate the deemed efficiency loss values for updates to the TRM.

The PY2016 tune-up evaluation suggests that the market may be evolving in a way that is resulting in impacts to tune-up measure savings that have not been fully accounted for by the TRM M&V Protocol. Further collaboration between the implementers and EM&V team is needed to develop the stipulated savings assumptions in a manner that provides stability to program savings and allows implementers to plan and act appropriately and to revise the M&V Protocol for the next update of the TRM, PY2018 TRM 5.0.

4.2 POOL PUMPS

This section summarizes the key findings and recommendations from the PY2016 evaluation of the Commercial and Residential pool pump measures. This assessment and review informed Texas based assumptions for key parameters for deemed commercial and residential pool pump measures.

4.2.1 Background

The commercial and residential pool pump programs were implemented by one Texas utility in PY2016. Both programs were launched as pilots in PY2014. These programs provide incentives to registered contractors for the successful sale, installation, calibration and reporting of ENERGY STAR® qualified variable speed swimming pool pumps for commercial and residential customers.

Compared to a traditional single speed pump, a properly installed and calibrated variable speed pump can significantly reduce the energy required for the filtration, cleaning and circulation of swimming pool water. Variable speed pumps provide for greater operational flexibility, quieter operation and a significantly longer useful life. The programs initially focused on the retrofit of existing single-speed pumps for in-ground pools and have recently included a large portion of new construction pumps as well. Demand response devices are not currently addressed at this time.

Residential pool pumps are currently offered for single family homes. Examples of eligible commercial swimming pool types include: apartment complexes, multifamily developments, HOA/community pools, hotels/motels, health clubs, and municipal/public pools.

Examples of the training and outreach activities provided by the program include:

- Ongoing recruitment and training of pool professionals which includes technician training on proper calibration procedures
- Attendance at industry-related meetings and seminars to generate awareness and interest
- Conducting workshops as necessary to explain program elements such as responsibilities of the participating contractors, project requirements, and reporting process; and
- Providing educational campaigns to the consumer about the benefits and payback for efficient pool operation.

Examples of the key program requirements include:

- Installation and calibration of the pumps by pre-qualified and program-trained technicians

- An existing or new construction in-ground pool using a single-speed pump.

4.2.2 EM&V Review

For PY2016, the programs incentivized 615 variable speed pumps as further described the table below.

Table 4-6. PY2016 Smart Pool Pump Program Savings and Participant Summary

Utility	Program	Energy Savings		Participant Count*
		Claimed kW	Claimed kWh	(Pumps)
CenterPoint	Smart Pool Program (Commercial)	59	530,088	42
	Smart Pool Program (Residential)	508	1,824,017	573
Total		**567**	**2,354,105**	**615**

*A total of 321 (35 commercial and 286 residential) pool pumps, or 52 percent, were identified as replacements of existing non-variable speed pumps while 294 (seven commercial and 287 residential) pool pumps, or 48 percent, were identified as new construction installations.

The EM&V team worked with the utility and implementation contractor to obtain program materials and data for PY2016 participants to further assess the programs actions and to better understand the methodologies and their influences on program energy savings.

The Smart Pool Pump programs currently use a custom M&V methodology to assign measure based savings. The custom method uses site specific pump information, operating schedules and post pump measurement data collected by program trained technicians during pump installation and calibration. While the overall savings methodology is similar between commercial and residential pump measures, there are distinct differences between the two sectors in the assumptions that are key drivers of the savings. The custom methodology overall was found to be reasonable and even conservative for demand savings. We summarize specific suggestions for future adjustments in the findings sections. We also compared the existing custom calculation methodologies and assumptions to those of the new deemed approach developed by Frontier.

As the current Smart Pool Pump programs collect a significant amount of primary data from customer sites, the main objective of the comparison was to use Texas specific data to inform key assumptions made by the new deemed approach and to identity any potential issues with either the current custom savings method or new deemed approach and address each with recommendations for improvements if needed. A further description of the key findings and recommendations are provided next.

4.2.3 Key Findings and Recommendations

Key findings and applicable recommendations are presented below based on the information gathered in reviews of both the existing custom methodology and new deemed pool pump savings calculations.

Key Finding #1: The peak demand savings did not follow the new procedures of TRM Version 3.1 Volume 1 peak demand probabilities that were to be implemented in PY2016.

The EM&V team found that the custom methodology for both commercial and residential pool pumps used a peak demand savings methodology that was calculated based on an average of the new pumps high and low-speed settings and a coincidence factor of 0.75 that was applied to both the old and new pump wattages.

Commercial: As the actual pre and post pump operating schedules were captured by the program for commercial measures, the evaluation used this information to apply the appropriate probability analysis from the TRM Volume 1 to complete the evaluated peak demand savings determinations. This was in alignment with the new peak demand methodology which was to be implemented in PY2016. Using the new peak demand methodology resulted in higher peak demand savings for the program as compared to the current assumptions as most commercial pools were clearly documented as set up by technicians to operate during all of the peak demand hours and for which the net difference between the old and new pump loads were verified. The data also supports a higher coincidence factor at this time of nearly 1.0 as compared to the coincidence factor of 0.75 currently assumed. Although, long term persistence of the post retrofit operating schedule could be studied in the future.

Residential: For residential installations, frequently the old pump is no longer in proper operating condition or has completely burned out. Therefore, information on the existing system energy use, or even operation, can be difficult to gather. Due to these issues, the residential program began to stipulate the baseline pumps operating hours. These stipulated assumptions are based on a PY2014 survey that was conducted by the program which collected data for 52 installations to inform the baseline operating conditions, including hours of operation across both summer and winter seasons. From the research that was completed, the old residential pumps operating hours were found to average 10.66 hours across 226 summer days and 6.58 hours across 139 winter days for an average of 9.1 daily operating hours. However, as the stipulations were limited to providing total hours of operation and the specific pre retrofit operating hours were not captured by the program, the evaluation was not able to apply the appropriate probability analysis from the TRM Volume 1 to update the evaluated peak demand savings determinations. Based on the new pump operating schedules, there is a high likelihood that many of the residential pool pumps may have higher peak demand coincidence factors for the program as many residential pools were found to operate during most of the peak demand hours in the post installation case. However, the EM&V team could not verify this from the tracking system and documentation review, as the old pump operating schedules were not always collected within the documents and none were reported within the tracking system. Also, the tracking system notes whether the old pump was still in operation for which 86 existing units were identified as operational. This may be an opportunity for the program to track the pre retrofit operating hours information in the future.

Recommendation #1: The peak demand savings should follow the new procedures described in TRM volume 1. Also, the baseline or existing pumps operating schedule should be collected and tracked by the program for a sample of residential pumps where such information is available. This would inform the residential peak demand probabilities and coincidence factors. The long term persistence of the post retrofit operating schedules could be studied in the future as well.

Key Finding #2: Key savings parameters were not always found appropriate for pumps used for non-primary pool operations (e.g., spas, water features) that have different turn over requirements.

The EM&V team found that the custom methodology for residential pool pumps used the same stipulated baseline operations for all pumps (retrofit and new construction) even if the pumps were installed for non-primary pool operations, such as spas and water features, which have different turn over requirements and significantly lower post installation operating schedules as compared to pool use only pumps. Also, the data showed that these were the only pump replaced at the site and not part of the pool pump replacement. This may suggest that baseline operating schedules are different for non-primary pool pumps that were not originally included in the PY2014 survey research that established the stipulated baseline hours. Clearly capturing the baseline pumps operating schedule would confirm

whether the program's stipulated values should apply to non-primary pool pumps and inform a separate baseline operating hour assumption if needed.

Recommendation #2: The baseline or existing pumps operating schedule should be collected and tracked by the program for all non-primary pool pumps.

Key Finding #3: Projects should capture commercial pool usage hours within project documentation.

The EM&V team found many of the commercial pool pumps had significant reductions in post operating hours compared to existing. This is allowed for commercial pools under the provisions set by the Texas Department of State Health Services.[12] However, the EM&V team found that many pumps had different post operating hours as compared to the business hours of operation captured within the programs tracking systems. Some post pumping hours were found higher and some found lower as compared to the business hours of operation. This may indicate inconsistency for how hours are captured of either the business or the pumps. In addition to the business hours, capturing the pool's usage schedule (i.e., days and hours the pool is open to patrons) may increase the consistency in data captured while directly supporting the reduced post retrofit operating schedules.

Recommendation #3: The pool's usage schedule should be captured and tracked by the program for all commercial pump projects.

Key Finding #4: The make and model number for the old and new pumps should be reviewed for accuracy and captured within project documentation and the tracking data.

The EM&V team found that both the commercial and residential pool pump programs collected and tracked pump make and model numbers, however, the information was not always detailed enough to clearly identify the specific equipment installed. This information is needed to collect manufacturers' pump curve data to confirm equipment performance, such as flow rates and energy factors. This metric changes depending on the size and type of the pumps and such information collected in the field could inform Texas specific performance averages based on the most common pumps installed in the state. Also, material invoices were found collected by the programs, however, these lacked clear detail of the make and model number of the pumps as well. Currently, the new deemed TRM measure based these assumptions from US average pump energy factors by horsepower found in the ENERGY STAR® Pool Pump Savings Calculator. The energy factor is a key driver of savings assumptions and can vary between manufacturers and pump sizes.

Recommendation #4: Project documentation (e.g., commissioning reports, invoices) and the tracking data should clearly capture the existing and new pumps make and model numbers. While the programs currently require an Energy Star® certified pool pump to be installed, this information would allow the EM&V team to assess the effectiveness of pump selection in Texas specifically, provide program feedback on technician pump selection procedures, and calibrate the TRM deemed methodology energy factor and flow rate assumptions.

[12] Section 265.203.(c)(2) states circulation pumps shall run continuously 24 hours a day, year round, and not be throttled to reduce circulation below the design flow rate, except that a pool pump may run less than 24 hours a day if: (A) "Pool Closed" sign, with letters at least 1-inch tall, is posted on the exterior side of each entry gate into the pool yard; (B) the pump runs a sufficient number of hours needed to keep the water at required clarity and disinfectant levels; and (C) the pump runs the same number of hours each day.

4.3 HVAC TOOL

This section summarizes the key findings and recommendations from the PY2016 evaluation of the Commercial HVAC projects that primarily use HVAC calculator tools to estimate prescriptive HVAC savings in Texas.

4.3.1 Background

Multiple calculator tools are used in Texas to simplify the savings estimation process for prescriptive energy efficiency projects. There are two prominently used Excel-based calculator tools in Texas used to estimate HVAC based savings. These are the Air Conditioning Evaluator (ACE) tool that was developed and is maintained by Frontier Associates and the E-3 Deemed Cooling method that was developed and is maintained by Oncor. The calculator tools are typically updated each year as improvements and updates are needed. During the PY2016 evaluation, the EM&V team found multiple occurrences of misuse, which resulted in significant changes in the evaluated savings for some projects. Examples of issues found are described below for the purposes of informing utilities on the usability issues that may be caught and corrected during application processing and savings calculation quality control reviews to reduce the potential for savings adjustments during the evaluation of these projects. In addition, the EM&V team offers recommendations for tool usability improvements and areas of recommended focus for tool training as well.

4.3.2 EM&V Overview

In PY2016, the EM&V team found the following usability issues, which pertain to potential mistakes for all prescriptive HVAC energy savings estimations and their tools.

- **Split air conditioner system inventories.** Some projects with air-cooled direct exchange (DX) air conditioning units were found documented with the indoor and outdoor portions of the split systems on separate lines of the calculator inventory. These types of systems should be consolidated for the indoor and outdoor portions of the split system and listed on the same line item within the calculator for accuracy. Listing them separately has the potential to cause an overstatement in the reported peak demand savings.
- **HVAC system efficiency.** The full and part load efficiencies of the cooling equipment (and heating for heat pumps) are requested within the calculator tools. In addition, the manufacturer, model number, and AHRI reference number are also requested within the tools. For some projects, these cells were not filled out and for others the cells were filled out, but not filled out correctly. This can lead to multiple errors such as:
    - Some projects were found to have entered incorrect equipment efficiencies. In some cases this was due to entry of the efficiency in the incorrect units. Care should be taken to make sure the efficiencies entered match those of the AHRI certification and represent the units needed within the tools. Projects found with incorrect efficiency entries typically lacked AHRI documentation. Projects with a copy of the AHRI certificate provided as part of the project file documentation were found to include correct equipment information within project calculators.
    - Some projects were found to have entered incorrect equipment types. In particular, heat pumps were entered as air conditioners which then lacked pertinent information on heating capacity and efficiencies and resulted in understated project savings.

- The Oncor E-3 sheet requires efficiency entry in the units of kilowatts per ton (kW/ton) for cooling systems and coefficient of performance (COP) for heating systems. However, when the efficiencies on the AHRI certificate are in EER, SEER and HSPF, this makes quality control reviews more difficult. While a conversion calculator is provided within the tool, this requires a lengthy process when numerous units are listed on the inventory and incentivized. The ACE allows the user to choose the units used by the entry for which a clear match to the AHRI certificate is capable for each unit on the inventory sheet. This provided ease to the evaluability of the projects.
- Some projects using the ACE did not fill in both the cooling full load efficiency and part load efficiency ratings for the equipment. Care should be taken that this information is gathered and entered into the calculator tools as energy use (kWh) savings are based on part load efficiencies and peak demand (kW) savings are based on full load efficiencies.

4.3.3 Key Findings and Recommendations

Key findings and applicable recommendations are presented below based on the information gathered in reviews of prescriptive and tool based HVAC savings calculations.

Key Finding #1: Common errors and omissions were found within the HVAC calculators which resulted in either understated or overstated project savings.

Common errors and omissions of data within the HVAC calculator tools included:

- Not consolidating the indoor and outdoor portions of the split system and listing them separately. This may cause an overstatement in the reported peak demand savings.
- Entering incorrect equipment efficiencies will understate or overstate reported energy use and peak demand savings.
- Not entering both the part and full load efficiency will understate or overstate reported energy use and peak demand savings.
- Not selecting the correct system type for heat pumps and omission of the heating capacities and efficiencies will understate reported savings.

Recommendation #1: Provide calculator training to staff and energy efficiency service providers with focus on common mistakes and errors that can lead to incorrect savings estimates.

Key Finding #2: Incorrect equipment efficiencies were found within some project savings calculations.

The full and part load efficiencies of the cooling equipment (and heating for heat pumps) are requested within the calculator tools. In addition, the manufacturer, model number, and AHRI reference number are also requested within the tools. For some projects, these cells were not filled out and for others the cells were filled out, but not filled out correctly. This led to incorrect savings calculations for some projects. Also, those projects with errors were typically found to be lacking AHRI certificates within project file documentation.

Recommendation #2: A copy of equipment AHRI certificates should be gathered and included as part of the project supporting documentation. This documentation should be used as part of internal quality control and project reviews.

Key Finding #3: Calculators should be examined for further improvements in automation and quality control checks to increase overall usability and potentially limit common User mistakes.

Common errors and omissions were found within the two most prominently used HVAC calculators in the state, which resulted in either understated or overstated project savings. Improvements such as automation, pre-determined drop down selections, and warning signals have helped, but further refinement may help users avoid the common mistakes that were found in PY2016 across the commercial HVAC measures.

Recommendation #3: Utilities and tool developers should review their HVAC calculator tools for improvements in usability and ways to assist with limiting user entry errors.

4.4 COMMERCIAL LIGHTING

The EM&V team analyzed customer self-reported hours of use, based on the building hours, as compared with the current PY2016 TRM version 3.1 stipulated assumptions for annual operating hours (AOH) across building types. The main objective is to provide an assessment that would identity any potential issues with the stipulated variable and savings for lighting measures in Texas to inform potential TRM updates.

4.4.1 Background

The commercial lighting analysis is based on data collected from commercial participants through on-site M&V surveys as well as tracking system and desk reviews that were conducted from PY2013 through PY2016. The EM&V team performed a comparison for hours of operation and attempted to find any discrepancies that may guide TRM adjustments needed or needs for future evaluation research efforts.

Note that the lighting analysis incorporates self-reported use characteristics (e.g., hours of use) obtained via participant interviews while on-site. The EM&V team understands the limitations of the self-reported hours but, barring long-term metering, the self-report hours are the most reliable data source to determine opportunities for calculation improvements.

The operating hours for lighting projects compared the stipulated hours of use for each building type (specified in PUCT Docket 39146) and the customer self-reported hours of use, based on the building hours. The team only included calculations for energy; the primary variable under review is hours of use, which does not affect the estimation of demand savings.

The self-reported hours per building type were calculated using a straight average of hours by building type. This comparison compiled 369 total projects across PY2013 to PY2016. Note that the EM&V team did not sample specifically to inform the analysis by building type; therefore, not all building types had sufficient samples to be represented in the table. For this reason, along with the smaller sample sizes for some building types, the results in this section should be viewed qualitatively and for informational purposes only.

4.4.2 Results

Table 4-7 provides a comparison of the stipulated and self-reported lighting hours by building type. The table also documents the percentage change and number of sample points included in the analysis. Note that only building types with sample sizes of nine or greater are included. Many building types were within 10 percent of the stipulated operating hours. However, the three building types listed below had the most variation with a difference of ±17 percent or larger between the stipulated and self-reported operating hours.

- "Lodging, Common" varied by +30 percent (9 sample points)
- "Manufacturing" varied by -21 percent (32 sample points)
- "Education, Summer" varied by -17 percent (17 sample points).

Two other buildings types, "Non-24 Hour Retail" and "Service (Non-Food)", had a variation of +15 percent and +16 percent respectively. However, in both cases the variation was driven by an anomaly with one building in each of the samples for the two building categories. The anomalies were building operations that required nearly 8,760 hours per year of lighting due to staff at the facility beyond the open customer hours. The extended hours of lighting were due to needs such as store clean-up and stocking which was reported as taking place during closed hours. Without these anomalies, each building category resulted in an average +10 percent and +7 percent respectively as compared to the current stipulated operating hours. Therefore, the difference between self-reported hours and stipulated hours were not currently determined to be significant at this time.

Table 4-7. Comparison of Stipulated and Self-Reported Operating Hours by Building Type

Building Type Code	Building Type Description	Stipulated Operating Hours	Self-Reported Operating Hours	Percent Variation	Number of Sample Records
Education K-12, No Summer	Education (K-12 without Summer Session)	2,777	2,594	-7%	48
Education, Summer	Education: College, University, Vocational, Day Care, and K-12 with Summer Session	3,577	2,964	-17%	17
Lodging, Common	Lodging (Hotel/Motel/Dorm), Common Area	6,630	8,622	30%	9
Manufacturing	Manufacturing	5,740	4,522	-21%	32
Non-24 Hour Retail	Food Sales—Non-24 Hour Supermarket/ Retail	4,706	5,422	15%	14
Non-Refrigerated Warehouse	Warehouse (non-refrigerated)	3,501	3,708	6%	26
Office	Office	3,737	3,357	-10%	30
Outdoor	Outdoor Lighting Photo-Controlled	3,996	4,033	1%	123
Parking	Parking Structure	7,884	7,740	-2%	18
Public Assembly	Public Assembly	2,638	2,417	-8%	16
Retail Non Mall/ Strip	Retail (excluding mall and strip center)	3,668	3,367	-8%	19
Service (Non-Food)	Service (excluding food)	3,406	3,956	16%	17

The results for each of the building type with the most variation were further assessed.

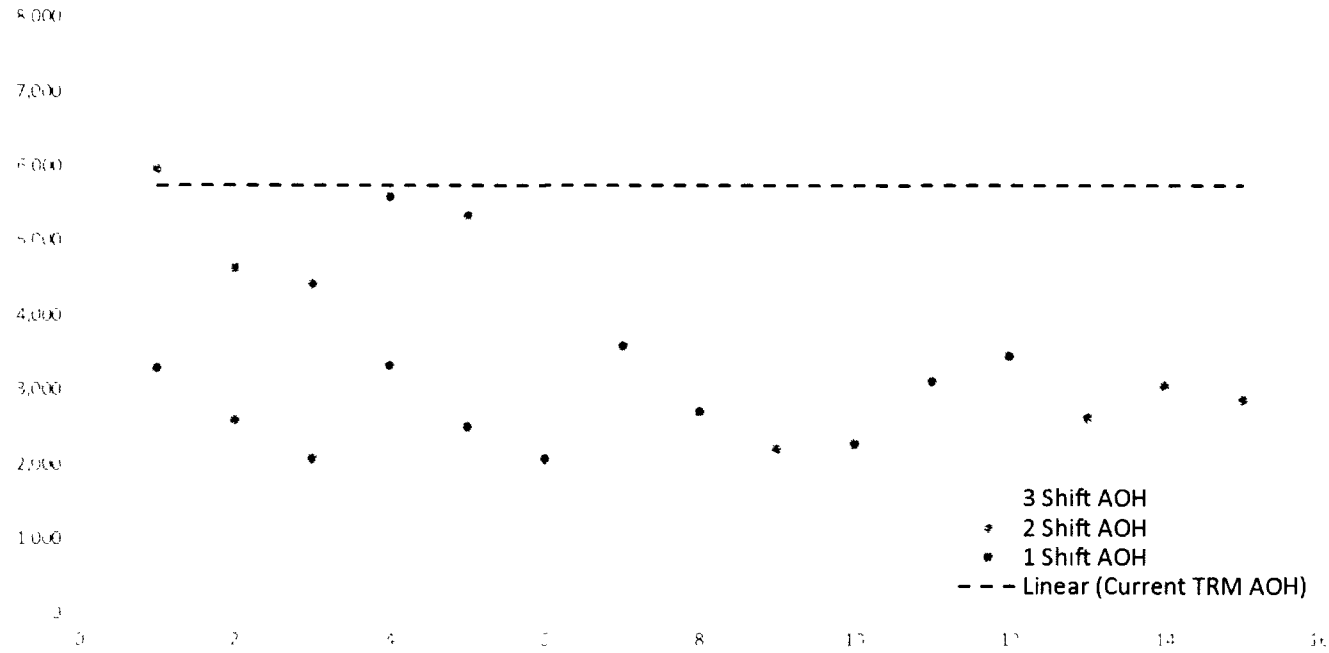
4.4.2.1 "Lodging, Common" Building Type

The "Lodging, Common" building type had a small sample size with the self-reported hours averaging 8,622 hours which were significantly higher hours (+30 percent) as compared to the TRM stipulated hours of 6,630. The higher self-reported values were likely due to the building type that was represented most within the sample of lighting retrofits. For this building type, all samples were lighting projects in hotel/motel facilities where the common areas such as halls, stairs, and entrances were mostly found to operate 24/7 and 365 days per year as they remain open continuously and do not close for weekends or holidays. The TRM stipulated hours were based on a mix of building types in this category that offer multiple accommodations for short-term or long-term residents, including dormitories, skilled nursing and other residential care buildings, retirement homes, shelters, convents or monastery, and correctional facilities. Unlike hotels/motels within the sample, these other types of lodging facilities may shutdown lighting in common areas more frequently, such as during evenings and holidays.

4.4.2.2 "Manufacturing" Building Type

The "Manufacturing" building type had a fairly robust sample size of 32 sampled projects and the self-reported hours were found on average to be 4,522 hours per year, which is much lower (-21 percent) than the TRM stipulated hours of 5,740 hours per year. The TRM "Manufacturing" building type is an average for all manufacturing facilities, which can vary tremendously between one, two and three shift operations. As the number of shift operations was captured during the site visits, the sample was stratified to compare average hours by shift, which is presented in Figure 4-2 and Table 4-8 below. Figure 4-2 provides a scatter plot of the data points captured to visually display the relationship between annual hours and shifts to compare their correlation.

Figure 4-2. Plot of Self-Reported Operating Hours by Shift for Manufacturing Building Types



The data suggests that one shift operations varied most as compared to the TRM "Manufacturing" building type average . Since the sample included a high proportion of single shift operation facilities, this led to the lower self-reported average. Also, there is a clear distinction in the amount of weekly operating hours between shift types and this should be used as a guide in conjunction with the site information captured when determining shift category selection. Some projects in the past have claimed that three shift or 24 hour operations would be an indicator for 8,760 operating hours per year. However, the data suggests that even when operations may be 24 hours per day, this is usually not the typical operations for all days of the week as all of the facilities visited with three shift operations did not maintain a three shift schedule during weekends, with most operating either five or six days per week. Also, most manufacturing facilities shut down for at least five holidays per year, which resulted in no site with a true 8,760 operation, or continuous lighting needs. If these cases are found challenged in the field, then the EM&V team guides that clear data on operating schedules, production data, or directly metered data should be collected to substantiate such claims.

As building and lighting operations is dependent on the number of shifts in operation, having just one average stipulation for operating hours in the TRM does not clearly represent the variation of facilities found in the field. Separating the building type to coincide with their shift operations would more closely align the equipment such as lighting that is needed to support the building operations. The results of the

EM&V investigations found the "Manufacturing, 1 Shift" operations should be stipulated at 2,786 hours per year, the "Manufacturing, 2 Shift" operations should be stipulated at 5,188 hours per year, and the "Manufacturing, 3 shift" operations should be stipulated at 6,414 hours per year. The EM&V team used the Comnet Appendix C schedules[13] to inform the fraction of lighting in operation for manufacturing facilities to define the shift based coincidence factors. An average of the lights in operation from 1pm to 7pm was used to calculate the 1 shift coincidence factor which resulted in 1 shift coincidence factor of 0.78. This is in alignment to how coincidence factors were established for the building types currently in the TRM. Since the Comnet schedule suggests a one shift load shape, the 2 and 3 shift coincidence factor was assumed to be 0.85 which was derived from extending the daytime fraction of lights in operation beyond 6pm (i.e., 0.85 from 1pm–7pm). The new recommended manufacturing AOH and CF by shift are shown in Table 4-8 below.

Table 4-8. Comparison of Self-Reported and Stipulated Operating Hours for Manufacturing Building Types

Building Type Code	Building Type Description	Stipulated Operating Hours	Self-Reported Operating Hours	Percent Variation	Number of Sample Records
Manufacturing (ALL Samples)	Manufacturing	5,740	4,522	-21%	32
Manufacturing, 1 Shift	Manufacturing, 1 shift operations is typically 9.5–11.5 hours per day and 4–6 days per week (<70 hours per week)	5,740	2,786	-51%	15
Manufacturing, 2 Shifts	Manufacturing, 2 shift operations is typically 18–20 hours per day and 5–6 days per week (70-120 hours per week)	5,740	5,188	-10%	5
Manufacturing, 3 Shifts	Manufacturing, 3 shift operations is typically 24 hours per day and 5–6 days per week (>120 hours per week)	5,740	6,414	12%	12

4.4.2.3 "Education, Summer" Building Type

The "Education, Summer" building type had a smaller sample size with the self-reported hours averaging 2,964 hours per year which was fairly lower (-17 percent) than the TRM stipulated hours of 3,577 for this building type. A large number of projects captured by the sample were college/university facilities where the hours of operation during the evenings was difficult for the site to clearly define. In particular, the classroom schedule at the facilities was not consistent and therefore a set operation during evenings was not captured in detail. This is likely one of the leading reasons why the self-reported hours were lower than the TRM stipulation as they may not have accounted for all operations that take place in the evenings or weekends. Further care will need to be taken during site surveys to collect this detail.

[13] https://comnet.org/appendix-c-schedules updated July 25, 2016.

4.4.3 Key Findings and Recommendations

Based on the PY2013 through PY2016 findings, the EM&V team recommends continued research of operating hours in PY2017 with particular emphasis in collecting more information on building types with the most variation from TRM stipulations such as "Lodging, Commons", "Manufacturing", and "Education, Summer" to inform if any updates in the stipulated operating hours for certain building types are needed. Also, the mix of building types represented by the programs in Texas may need to be further assessed for some building categories. For example, the "Lodging, Commons" building type may not have a similar portion of all sub categories that were used in initially developing the TRM stipulations as dorms were missing from the site sample as compared to the quantity of hotels/motels within the lodging building category. Perhaps updates on the proportions or splits may be warranted for some building types where the sub category populations are either not represented or where there is a higher level of variation. In addition, the projects reviewed during the site visits included a high portion of outdoor lighting with photocell controls that were retrofit as well. It is unknown whether this building type or others have increased in program participation as the building type is not currently tracked in any of the commercial programs tracking system data. Adding the building type field in the tracking data would allow the utilities and EM&V team to more clearly track trends of building stock within program participation. This could further inform whether updates to the building category mix is needed and specifically describe the proportions to use for Texas as well.

Key Finding #1: The EM&V on-site visits found distinct hours of operation in Texas for manufactures that operate different production shifts.

Currently the TRM stipulations for operating hours and coincidence factors (for) for the "Manufacturing" building type represents all manufacturers no matter the production shifts that they operate. The results of the EM&V on-site visits found distinct differences in annual operating hours for manufacturing facilities that operate different production shifts. In particular, production operations and the lighting needed to support those operations are dramatically different from 1 shift, 2 shift and 3 shift operations. Therefore, for TRM version 5.0, the EM&V team recommends that the stipulated lighting operating hours and coincidence factors for the "Manufacturing" building type should be split between shifts based on the research and data collected by the EM&V team in Texas as provided in the table below.

Table 4-9. Recommended Operating Hours and Coincidence Factor Stipulations for Manufacturing Building Types for TRM 5.0

Building Type Code	Building Type Description	Operating Hours	Summer Peak CF
Manufacturing, 1 Shift	Manufacturing, 1 shift operations is typically 9.5–11.5 hours per day and 4–6 days per week (<70 hours per week)	2,786	78%
Manufacturing, 2 Shifts	Manufacturing, 2 shift operations is typically 18–20 hours per day and 5–6 days per week (70–120 hours per week)	5,188	85%
Manufacturing, 3 Shifts	Manufacturing, 3 shift operations is typically 24 hours per day and 5–6 days per week (>120 hours per week)	6,414	85%

Recommendation #1: Update the "Manufacturing" building type for TRM version 5.0 to provide separate stipulations for annual operating hours and coincidence factors for 1, 2 and 3 shift operations.

5.0 PROCESS ASSESSMENTS

This section documents key findings and recommendations from the following PY2016 process assessments:

- Commercial lighting qualification
- Program tracking and reporting
- Program performance.

5.1 COMMERCIAL LIGHTING QUALIFICATION

This section provides implementation guidance on the eligibility criteria for qualified commercial lighting products given the recent installation of the new technical requirements version 4.0/4.1/4.2 by the DesignLights Consortium™ (DLC). The EM&V team conducted benchmarking research, attended the DLC Stakeholder meeting and spoke with manufacturers, distributor and industry thought leaders to inform the key findings and recommendations presented.

5.1.1 Background

The PY2017 Texas Technical Reference Manual version 4.0 (TRM 4.0) has the following eligibility criteria on pages 2-6 of Volume 3: Nonresidential Deemed Measures:

> LED lamps and fixtures must be qualified and listed by at least one of the following organizations: *DesignLights Consortium™ (DLC)*, *ENERGY STAR®*, Lighting Design Lab (LDL),[14] or DOE LED Lighting Facts.[15] Links to these organizations and their qualified product lists are provided on the Texas Energy Efficiency website. Additionally, at the utilities discretion, LED products may receive approval if results of independent lab testing[16] (e.g., LM-79, LM-80, TM-21, ISTMT) show the products comply with the most current version of the DLC Technical Requirements.[17]

Effective April 1, 2017, DLC updated their qualified product list (QPL) for solid state lighting products that meet the new version 4.0/4.1 (V4.0/V4.1) requirements. Products that do not meet the V4.0/V4.1 requirements were removed from the active QPL. However, as with previous de-listings, products not meeting the new V4.0/V4.1 requirements would still be searchable using the "Include De-Listed Products" feature of the DLC search page.

Prior to V4.0/V4.1, DLC had last updated their technical requirements with versions 2.1 in 2014 and 3.0/3.1 in 2015. These prior revisions in 2014 and 2015 focused on restructuring the technical requirements table, adoption of additional product categories, establishing guidelines and requirements for the DLC Premium classification, and provided direction under new Specialty Use designations for products to be effectively qualified. The previous revisions over the last three years were not as significant in the changes to the efficacy levels as those found with the V4.0 updates. The last

[14] LDL's LED QPL has been discontinued. Products submitted by the April 30, 2017 deadline will be posted on the LDL website until a products expiration or final QPL removal on July 31, 2018.

[15] As of December 16, 2016 LED Lighting Facts no longer lists replacement lamps, but luminaires and retrofit kits continue to be listed.

[16] DLC test lab requirements: https://www.designlights.org/content/QPL/ProductSubmit/LabTesting.

[17] DLC tech. requirements: https://www.designlights.org/content/qpl/productsubmit/categoryspecifications.

significant change in efficacy levels were from technical requirements version 2.0 adopted in April of 2013.

Since the original release of V4.0 on June 1, 2016, V4.1 was released on November 1, 2016 and V4.2 was released on April 28, 2017. Both the V4.1 and V4.2 revisions were more minor updates to the technical requirements as compared to the efficacy changes that resulted between V3.1 and V4.0. The focus with V4.0 was primarily on increasing the efficacy performance requirements. Over the last three years, the solid-state lighting market has experienced major growth and the performance of products has improved significantly. With that, the number of products on the QPL grew significantly as well. The new standard performance levels in V4.0 were intended to focus the QPL moving forward on the top 50th percentile of energy efficient lighting. The new premium performance levels were targeted to push the QPL for this classification to the 95th percentile. In other words, an attrition rate of between 40-60 percent was expected from the new V4.0 requirements.

Some of the performance criteria are not all directly related to the energy use of the products. This has challenged DLC with a difficulty to define "quality" parameters and not to exclude high quality products from the QPL. However, the DLC V4.0/V4.1/V4.2 update is essentially a 're-set' in DLC qualification. No LEDs formerly certified through DLC 3.1 were carried forward, regardless if they meet or do not meet the V4.0/V4.1 criteria as well. They were required to resubmit applications and payment to confirm meeting V4.0 and to stay on the QPL. In addition, manufacturers and other stakeholders are concerned whether the investment in testing and qualification will payback. Therefore, early in PY2017, it was unknown at that time of the effects V4.0 would have on the market and whether those products would continue to seek DLC qualification. In addition, there will always be a period through which these prior qualified products will continue to be in the supply chain.

5.1.2 Results

The EM&V team attended the 2017 DLC Stakeholder Meeting[18] where many of the major lighting stakeholders were in attendance (e.g., DLC staff, utilities, lighting manufacturers, implementers), it was found that even major manufacturers were still coordinating efforts to re-qualify products. Much of this delay was in part due to a new learning curve for manufacturers who have not had to complete the requalification process for so many products. The delay was also due to the way products are qualified by DLC. The qualification process allows for "family grouping" applications—when this is used, the poorest performing product is the basis for the testing and qualification of multiple products. If the poorest performer which initially qualified for one DLC version does not meet the new technical requirements of the latest version, then the entire family of products gets delisted even if other products in the family are known to meet or surpass the latest DLC version. The cost to potentially retest products and/or resubmit a new application is costly. It is possible under the "Updating Listed Products" procedure to resubmit the family without the de-listed products at a lower price, however, many manufacturers were still learning about this process during the stakeholder meeting itself.

At the end of 2016 and before the V4.0 delisting, over 278,000 products were on the QPL. After the de-listing on April 1, 2017, over 100,000 products fell off the QPL. Since that time, over 50,000 products have been re-listed and more continue to get re-listed as manufacturers learn the process for DLC re-qualification. In addition, manufacturers are already focusing on the V5.0 requirements as part of product design. Draft versions of policy updates such as those for the QPL are developed by a technical committee and released to those on the DLC distribution list to gather technical comments for consideration. The drafts are finalized after that process has been well vetted which may take a few

[18] The 2017 DLC Stakeholder Meeting took place on July 10–July 12, 2017.

iterations. As performance criteria is more thoroughly updated on a three year cycle (such as the case with efficacy in V4.0), the next major revision is likely to be released in 2019.

In addition, during the stakeholder meeting, the EM&V team gained information on how distributors dealt with updates to V4.0/V4.1/V4.2. Some manufacturers had completed their own surveys of distributors to find out how much they were preparing for V4.0 and one manufacturer indicated that a significant portion of distributors were unprepared. This lead to training and even the shift of products that were to be de-listed to areas or locations of service territories that did not have energy efficiency programs with DLC requirements. This indicates that manufacturers and distributors may be reacting in a way that supports DLC qualified products in service territories where they are required. This reaction could also have a tremendous influence on the availability of energy efficient lighting products stocked locally as well across the US.

- Further background of the DLCs work and clarity of responsibilities for maintaining the QPL were also gained from presentations during the stakeholder meeting. Those most noteworthy included: The DLC does not certify or test any residential lighting products; DLC only qualifies particular commercial lighting products (i.e., LED luminaires, retrofit kits, linear replacement lamps, mogul (E39) screw-base replacement lamps, and four pin-base replacements lamps for CFLs)
- The DLC QPL should be viewed as a central list of solid state lighting products with clearly tested and documented performance
- The DLC has developed and launched a Surveillance Testing Program
    - The Surveillance Testing Program is for qualified products to monitor the validity of data submitted to the Solid-State Lighting QPL pre- and post-qualification
    - The performance verification system was created to protect the value of the QPL by minimizing potential threats of gaming or fraud
    - A third party lab will complete the testing, however, DLC will be completing the sampling or selection of products to be tested and will monitor surveillance test results
    - Surveillance testing began in January 2017
- DLCs technical and testing requirements provide clear direction for testing of commercial lighting products which ensure tests for lighting products are completed under common installed conditions
- Manufacturers are responsible for product testing and application submission to the DLC.

Throughout the stakeholder meeting, panelists and thought leadership in the lighting and energy efficiency industry provided input on the effects of LEDs in the market and offered suggestions on future program development in conjunction with the DLC QPL:

- A significant amount of manufacturer's resources have shifted to product compliance (e.g., testing) since the DLC was formed
- There is a significant need for specialized education and training to support the needs for future lighting based energy efficiency projects and programs
- Some programs are re-defining the definition of quality lighting and promoting the benefits beyond just the energy savings component

- Some lighting programs are focusing on good lighting design which puts DLC certification as a floor for performance
- Lighting will need to evolve from one-for-one retrofits to a focus on good lighting design with more comprehensive solutions
- Future lighting will need to move beyond static lighting and energy efficiency and shift to a dynamic model to support dynamic building needs of the future.

5.1.3 Key Findings and Recommendations

Key findings and applicable recommendations are presented below based on the information gathered in review of state of the DLC QPL and insight gathered during the recent DLC Stakeholder Meeting.

Key Finding #1: S significant number of products fell off the DLC QPL when DLC V4.0/4.1/4.2 began, however, the market is responding and many lighting products have since been added and the QPL continues to grow.

The changes that resulted with V4.0 compared to previous updates to the technical requirements were significant and many manufacturers and other stakeholders were caught off guard even though the new requirements went through a formal, public and lengthy comment and grace period. Manufacturers have indicated earlier preparations for future updates to the DLC technical requirements and some are already designing future lighting products with the DLC 5.0 in mind. Training with distributors on DLC updates is also taking place as well.

Recommendation #1: Establish a standard 12 month grace period for qualification changes to allow the market to respond to changes.

Key Finding #2: While some utilities are contemplating changing QPL requirements for lighting projects in commercial programs, DLC qualification is still the industry standard.

Most programs around the country continue to require the Standard DLC qualification now requires the DLC Premium qualification as part of lighting based energy efficiency project requirements. Some utilities in the Northwest have recently changed QPL requirements. While products on the QPL are still an option, they also specify their own technical requirements that LED fixtures and lamps must meet for program eligibility for products that are not currently on a QPL or may have fallen off. In comparing the non-QPL parameter requirements, it appears that they continue to support none energy parameters such as requiring safety certifications such as UL and ETL listings and also require the same 5-year warranty requirement as DLCs. The DLC required parameters that are not addressed by these programs are the minimum efficacy, minimum light output, Correlated Color Temperature (CCT), L_{70} (lumen maintenance and depreciation that is typically covered by LM-80) requirements, and Total Harmonic Distortion (THDi) limits. Also, while LM-79 documents are required for submission, the metrics provided by this test method such as total flux (light output), electrical power, efficacy, chromaticity and intensity distribution are not specified as having to meet particular levels and for which the lighting design and energy dependence is directly related.

Below is an example[19] of the requirements for a program that has recently foregone DLC requirements for all LEDs in 2017:

- LED fixtures and lamps not on a QPL are captured within the commercial lighting calculator as custom fixtures and lamps, which require input of specific lighting product information (i.e., Manufacturer, catalog number, total system watts, LED lamp/fixture type) for all lamps and fixtures not on the QPL. This is different from QPL LED fixtures and lamps which only require entry or selection of the generic product information in the calculator's lighting inventory.
- The utility program requirements for LED fixtures and lamps are clearly specified as:
    - Safety certifications such as requiring UL/ETL listings (this matches DLCs requirements)
    - Power Factor ≥0.9 (this matches DLCs requirements)
    - Manufacturer's warranty ≥5 years (this matches DLCs requirements).
- CRI is listed as a recommendation rather than a requirement with recommended CRI rating targets:
    - LED Interior Fixtures: > 80 CRI, except > 70 CRI for High and Low Bay fixtures in warehouse and industrial/manufacturing facilities (this matches DLCs requirements)
    - LED Exterior and Parking Garage fixtures: > 65 CRI (this matches DLCs requirements)
    - HID --> LED replacement Lamps: > 75 CRI (this matches DLCs requirements)
    - CFL --> LED pin base replacement Lamps: > 80 CRI (this matches DLCs requirements)
    - TLED: > 80 CRI (this matches DLCs requirements)
    - No CRI recommendation for Specialty LED fixtures (Grow Lights and Theatrical fixtures).

Recommendation #2a: TRM eligibility requirements should continue for prescriptive projects with the option of submitting non-qualified products as custom lighting projects.

Recommendation #2b: If utilities implement a regular allowance for non-qualified lighting, clear specifications on the parameters that the LEDs must perform should be described as part of the program requirements. Utilities should also require submission of key documentation to support the LEDs have been tested and that they meet the program requirements such as manufacturers catalog cut (specification) sheets, LM79 and LM80. The documentation should show all of the parameters required by the program (e.g., UL/ETL listing, power factor, warranty, input watts, CRI). Non-certified LEDs should be separated from certified LEDs by either using separate calculators or preparing separate lighting calculator inventories. Detailed information on these LEDs should be provided such as the Manufacturer, catalog number (must match specification sheet), total system watts, and LED lamp/fixture type.

Key Finding #3: As LEDs are becoming the standard, programs will need a strategy for shifting beyond one-for-one lighting retrofits.

[19] Puget Sound Energy, Business Lighting Incentive Program application: Business Lighting 2017 v1.1d, valid through 12/31/2017. https://pse.com/savingsandenergycenter/ForBusinesses/lighting/Documents/PSE_2017_Business_Lighting_Incentive_Application1230.pdf.

While the evolution of LEDs continues in the short term, there is an anticipated market shift for LEDs to become the standard. This will likely have an impact on program requirements. Opportunities for energy savings are likely to be in more holistic lighting improvements such as improvements in lighting designs and integrating advanced controls such as Networked Lighting Control (NLC) systems. ASHRAE 90.1-2016 already models approximately 75 percent of the baseline fixtures as having LEDs. ASHRAE 90.1-2019 is forecasted that their model will contain up to 90 percent of the baseline fixtures as having LEDs. In the future, these will have tremendous implications on energy efficiency programs which rely on one-for-one lighting retrofits for a significant portion of program savings. Much of the lighting industries thought leadership during the DLC conference expressed that the definition of quality lighting is evolving and is likely to expand beyond the energy savings component alone. Programs should prepare to embrace this as part of program strategies. Although, leaders had varied opinions on just how to do so.

Recommendation #3: Utilities should start planning for programs beyond one-for-one lighting retrofits to more holistic improvements.

5.2 PROGRAM TRACKING AND REPORTING

This section summarizes progress and opportunities for additional improvement in program tracking and reporting recommendations from the PY2014 EM&V that were to be implemented in PY2016.

5.2.1 Background

In the PY2014 EM&V, the EM&V team identified inconsistencies with program tracking and reporting. This included the way program tracking data identified measures and programs as well as how utilities reported savings in EEPRs.

One key finding related to the level of detail maintained in tracking data was that initially tracking data did not contain sufficient detail to associate tracking records with TRM entries. This affected the EM&V team's ability to sample projects by measure, and also caused discrepancies in cost-effectiveness analysis since the EM&V team had to make assumptions regarding measure life.

Additionally, there were instances where tracking data did not align with utilities' reporting. For example, a utility might provide data for a single program, while reporting it as two separate programs. The EM&V team recommended that utilities align the tracking data and reporting so they are clearly tied together, with a preference for maintaining sub-programs to provide more insight into program performance when a larger programs has different program delivery mechanisms.

5.2.2 Key Findings and Recommendations

Key findings and applicable recommendations are presented below based on the EM&V team's assessment of PY2016 program tracking data.

Key Finding #1: Utilities have significantly improved tracking and reporting in response to previous EM&V recommendations.

While there remains work to be done regarding the level of detail maintained in tracking data, as well as the levels of detail included in utility reporting, the remaining issues are less critical than those raised in earlier evaluations. Tracking data clearly identifies measure life for nearly all measures, removing the ambiguity of having to assign a value based on the measure description. Utilities generally track measures at a more detailed level than in earlier years of EM&V so that tracked measures can be tied

more directly to a TRM entry. Some utilities still have some ambiguity in tracking data that could be improved. For example, rather than tracking a measure as "Lighting Retrofit" with a 15-year measure life, utilities should report the actual technology in tracking data (e.g., LED, Linear Fluorescent).

Recommendation #1: Tracking data should maintain sufficient detail so that records can be aligned with TRM entries. This affects various EM&V activities such as planning, cost-effectiveness, and reporting, and can also help utilities monitor program performance and support other internal needs.

Key Finding #2: Utilities have aligned program tracking data with program reporting.

Utilities have almost completely aligned programs in tracking data with those reported in utility reporting. There were two exceptions in PY2016, both related to Commercial SOPs. One utility did not distinguish subprograms in its plan, but did report those subprograms separately. This affected EM&V planning. Another utility planned and reported subprograms, but tracking data did not provide a way for the EM&V team to match that level of detail.

Recommendation #2: Ensure that program plans, tracking data, and reporting maintain the same program definitions. Mismatches can lead to confusion, or at least differences between utility and EM&V reporting.

Key Finding #3: Rounding of claimed savings in EEPRs hinder the ability of the EM&V team to verify savings with program tracking data.

The EM&V team identified a new issue related to utility reporting in PY2016. Several utilities report savings in their EEPRs in MWh and MW. The EM&V team relies on EEPRs to ensure that EM&V reports accurately represent utilities' claimed savings. When savings are rounded from kWh and kW and reported as MWh and MW, the EM&V team is unable to verify that the utilities' claimed savings in their EEPRs match those in their program tracking data.

Recommendation #3: Report claimed savings in EEPRs in kWh and kW.

5.3 PROGRAM PERFORMANCE

This section summarizes utility actual performance against projected goals at the program level as well as the overall portfolio level. Comparisons are presented at the utility level and then key findings and recommendations overall.

5.3.1 Background

In their annual Energy Efficiency Plan and Report (EEPR) filing to the Commission, the utilities publish for each program in their portfolio projections about demand reduction and energy savings for the upcoming program year. These projections are distinct from the state mandated portfolio goals, but instead reflect the utilities' planning related to the mix of programs that will achieve or surpass those goals. The EM&V team compared the evaluated program impacts for each utility with their EEPR projections to provide process insight into how well programs are performing compared to projections and if any adjustments in planning may be warranted.

5.3.2 AEP TCC

5.3.2.1 Demand Reduction

In Figure 5-1, the projected and evaluated demand reduction for 2016 AEP TCC programs are shown. For PY2016, AEP TCC projected a total demand reduction of 46,821kW. This compares with 39,117 kW in evaluated demand reduction, or 83 percent of the projected savings. Commercial evaluated savings (26,901kW) were 22 percent lower than commercial projected savings (34,294 kW). The greatest commercial program demand reduction divergence was found to be Load Management SOP, where evaluated savings were 25 percent lower than projected. Overall residential evaluated savings (12,215kW) were 2 percent lower than residential projected savings (12,527kW).

5.3.2.2 Energy Savings

AEP TCC's projected and evaluated energy consumption is presented in

Figure 5-2. Total evaluated energy savings (66,311 MWh) were 6 percent greater than projected savings (62,528 MWh). In the commercial sector, the SCORE/City Smart MTP program outperformed projections by 78 percent. CoolSaver A/C Tune-Up, however, achieved only 48 percent of its projected savings, largely due to adjustments the EM&V team made to savings in PY2016. In the Residential sector, Hard-to-Reach SOP outperformed projections by 27 percent.

Figure 5-1. Projected and Evaluated Demand Reduction for 2016 AEP TCC Programs

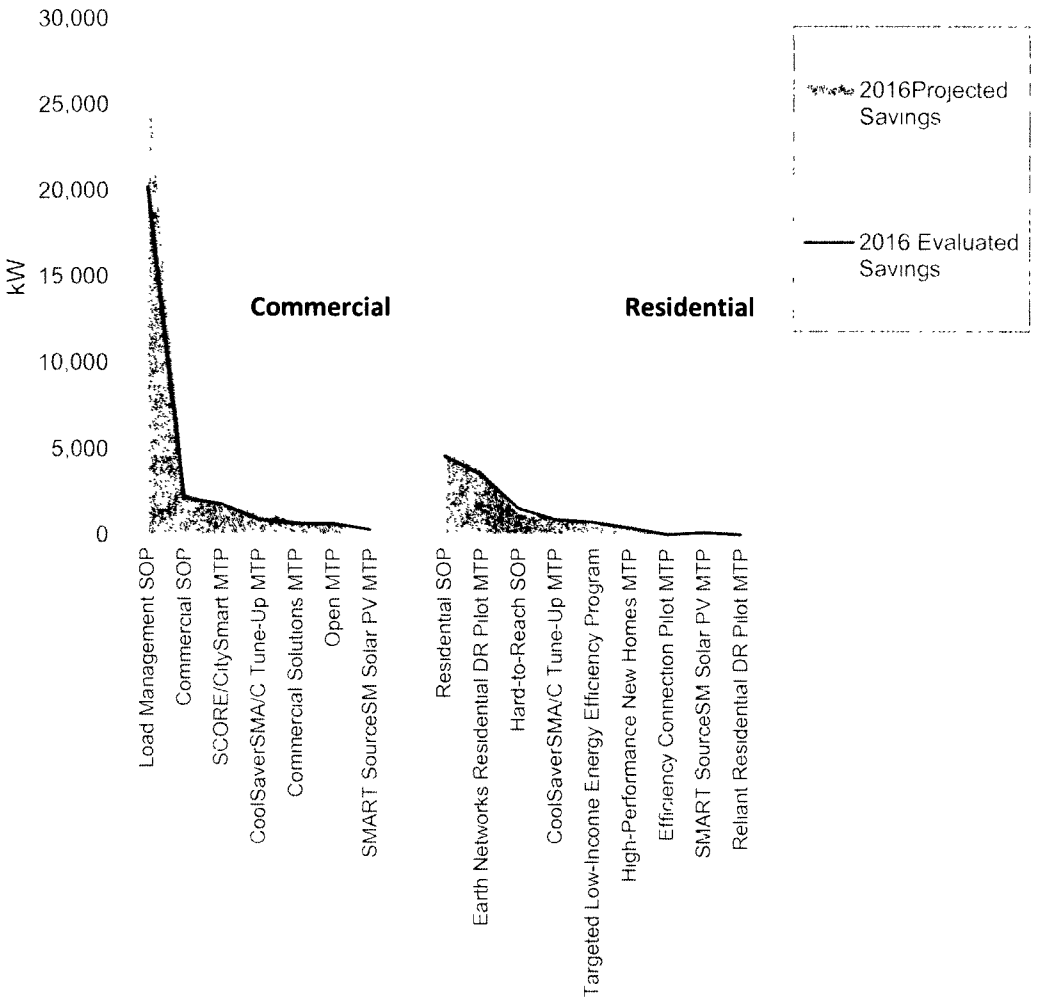
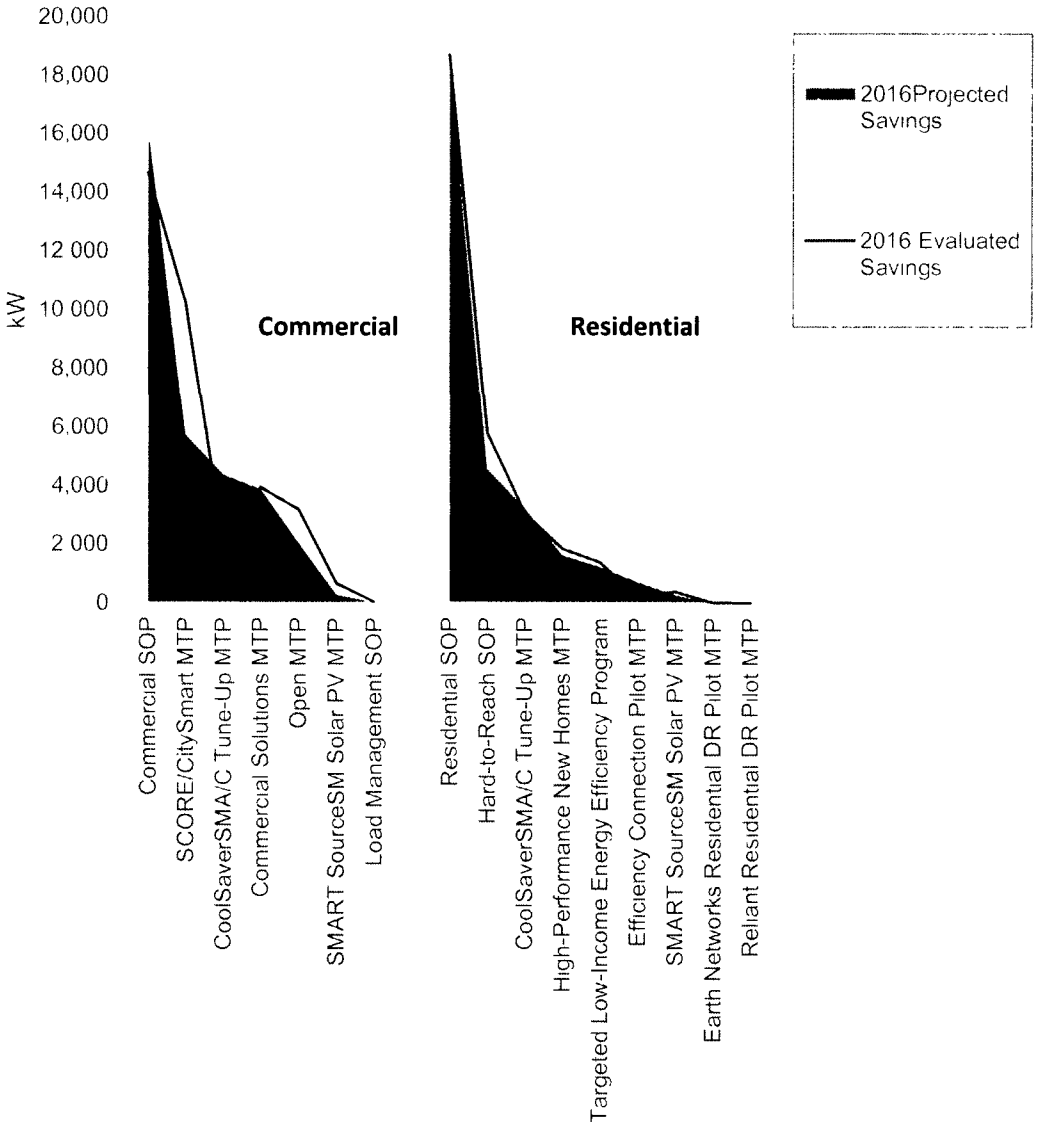


Figure 5-2. Projected and Evaluated Consumption Savings for 2016 AEP TCC Programs



5.3.3 AEP TNC

5.3.3.1 Demand Reduction

PY2016 projected and evaluated demand reduction for AEP TNC is shown in Figure 5-3. Overall, commercial evaluated savings (4,804 MWh) were 43 percent higher than projected savings (3,352 MWh). The largest difference between projected and evaluated demand savings was for the Load Management SOP, which outperformed projected savings by 68 percent. Residential evaluated savings (1,623 MWh) were 11 percent higher than projected (1816 MWh). Evaluated savings of the Efficiency Connection Pilot MTP were 73 percent less than the projected savings.

5.3.3.2 Energy Savings

Figure 5-4 shows the projected and evaluated consumption savings for 2016 AEP TNC programs. AEP TNC's PY 2016 overall projected energy savings (11,192 MWh) were 3 percent higher than evaluated savings (10,814 kWh). In the commercial sector, Commercial SOP underperformed projections by 30 percent. This was compensated, however, by the performance of Commercial Solutions MTP and Open MTP, which achieved 111 percent and 137 percent of projections, respectively. In the residential sector, the total evaluated energy savings (6,932 MWh) were 7 percent lower than projected. The Efficiency Connection program presented the largest discrepancy between evaluated and projected savings, achieving only 21 percent of what had been projected.

Figure 5-3. Projected and Evaluated Demand Reduction for 2016 AEP TNC Programs

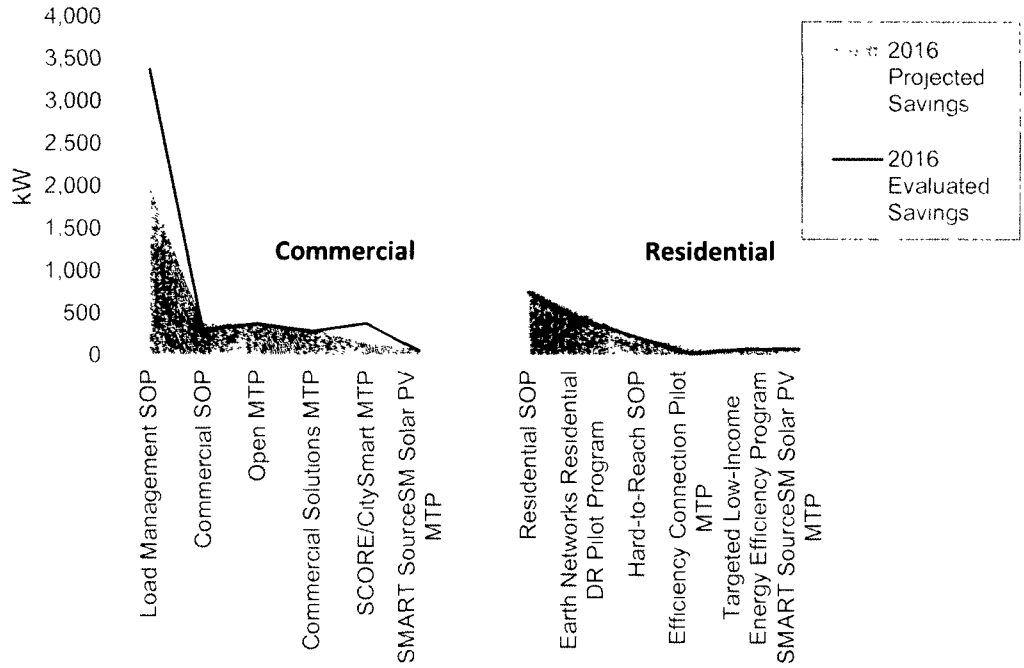
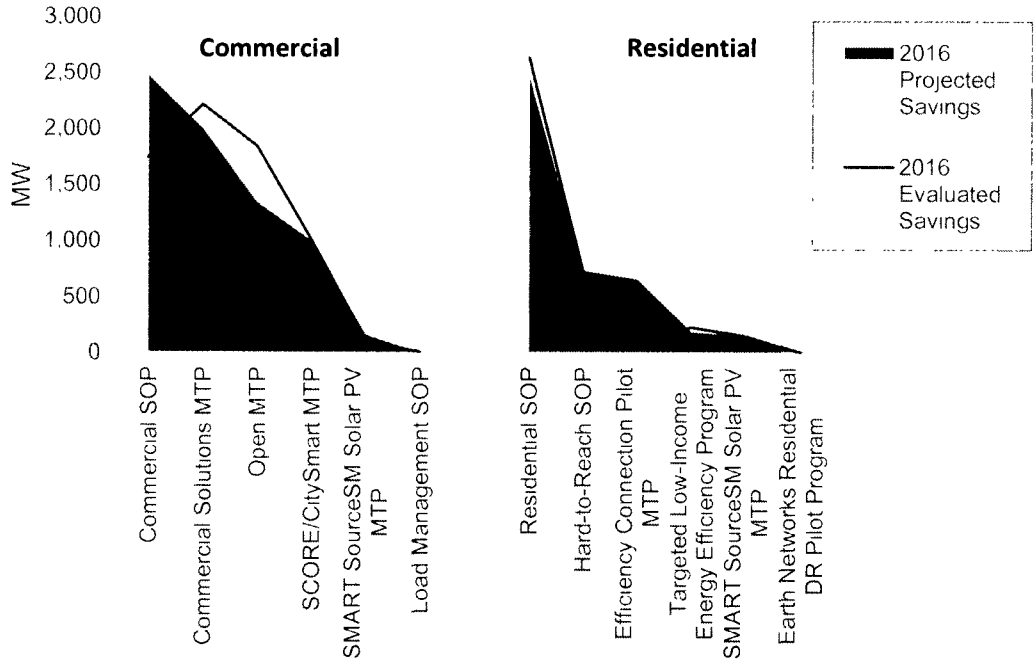


Figure 5-4. Projected and Evaluated Consumption Savings for 2016 AEP TNC Electric Programs



5.3.4 CenterPoint Energy Houston Electric, LLC

5.3.4.1 Demand Reduction

Figure 5-5 shows the projected and evaluated demand reduction for 2016 CenterPoint Energy Houston Electric programs. CenterPoint's total projected demand reduction for PY2016 was 141.23 MW. The portfolio actually achieved a 166.08 MW reduction, which is 18 percent greater than projected. For the commercial sector,[20] the evaluated savings for each program were generally consistent with projected savings, with an overall commercial evaluated demand reduction of 127.01 MW, 8 percent higher than the projected value of 116.51 MW. This was driven primarily by the largest saver, the Large Commercial Load Management program. On the residential[21] and small commercial side, the evaluated demand reduction of 39.07 MW was 58 percent higher than the projected value (24.72 MW). This was driven largely by the performance of New Homes MTP and Targeted Low Income MTP, though a number of programs surpassed their projected savings.

5.3.4.2 Energy Savings

Projected and evaluated energy savings for CenterPoint is shown in Figure 5-6. Total evaluated energy savings of 182,333 MWh surpassed projected savings of 160,717 MWh by 13 percent. Commercial programs outperformed projections by 4 percent, with 101,711 MWh evaluated savings compared to projections of 97,955 MWh. Commercial MTP (Texas Score & Healthcare) generated the bulk of the additional evaluated savings, at 149 percent of the projected value. Retrocommissioning MTP underperformed compared to projections, achieving only 57 percent of projections. In the residential sector, program outperformed projections by 28 percent, driven largely by New Homes MTP and Advanced Lighting Residential, which achieved 156 percent and 198 percent of projections, respectively. Residential & Small Commercial A/C Distributor MTP underperformed against projections, achieving only 296 MWh in savings compared to a projected value of 5,452 MWh.

[20] The commercial sector only refers to large commercial entities.
[21] The residential sector refers to both residential and small commercial entities.

Figure 5-5. Projected and Evaluated Demand Reduction for 2016 CenterPoint Electric Programs

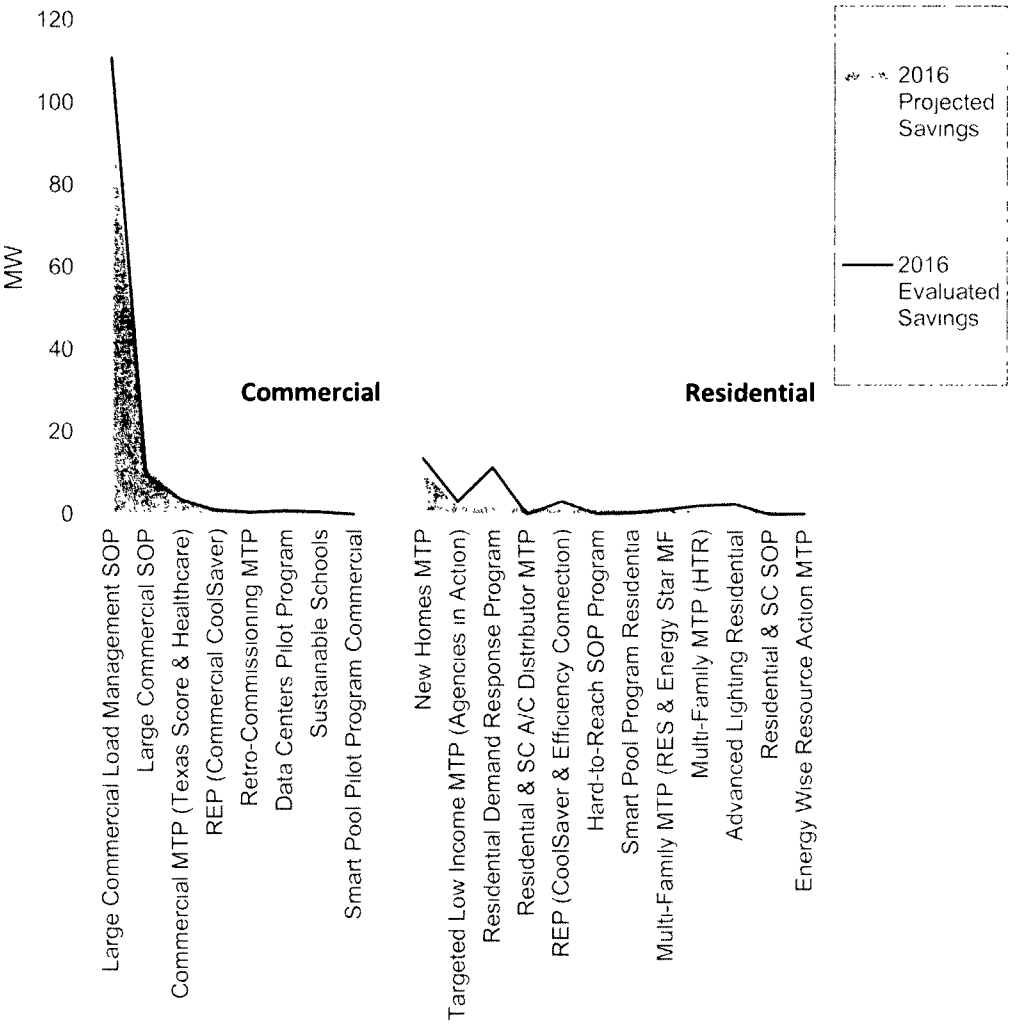
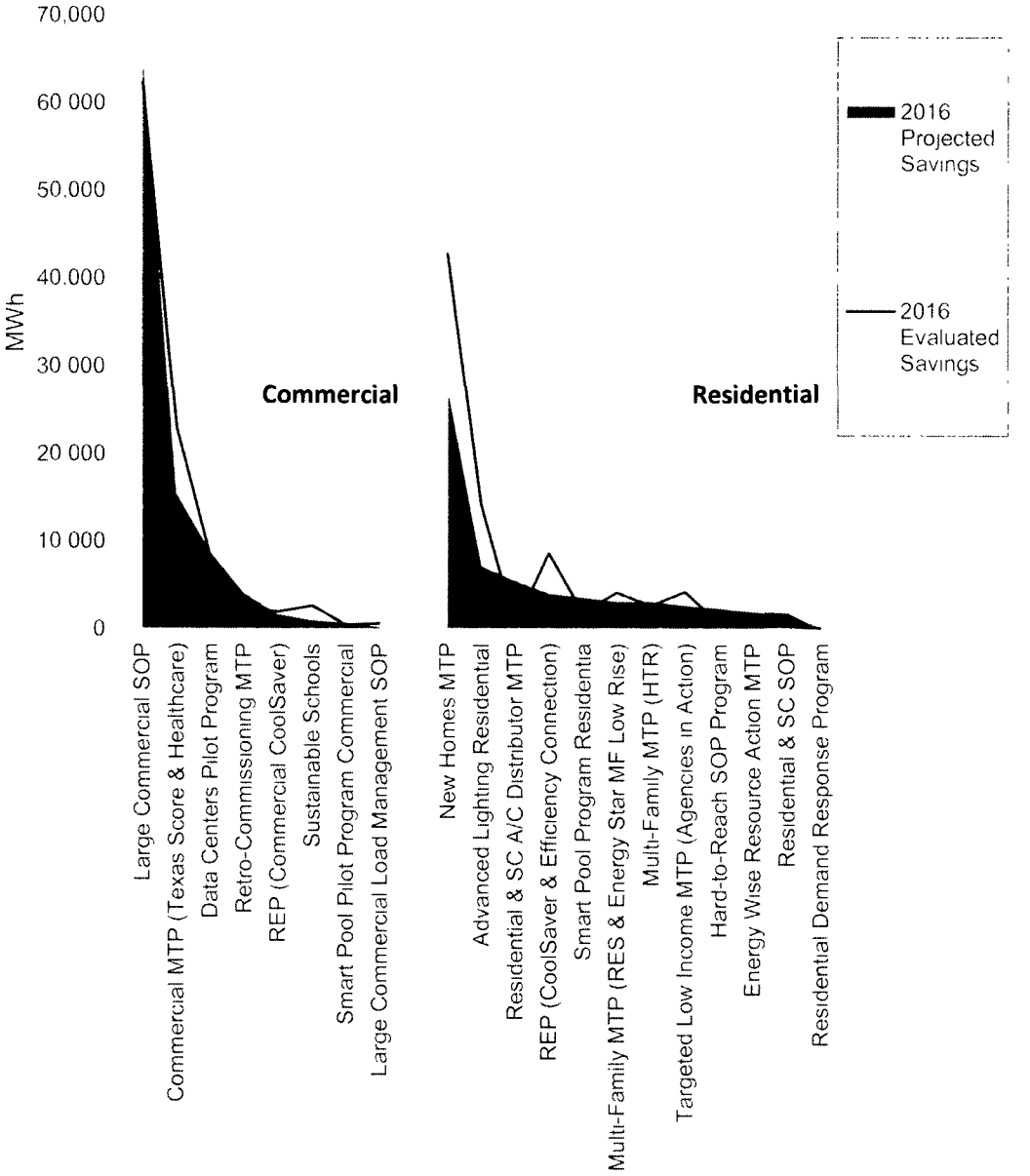


Figure 5-6. Projected and Evaluated Consumption Savings for 2016 CenterPoint Electric Programs



5.3.5 El Paso

5.3.5.1 Demand Reduction

PY2016 projected and evaluated demand reductions for El Paso are displayed in Figure 5-7. The portfolio evaluated reduction (12,785 kW) was 2 percent greater than projected (12,565 kW). Commercial energy efficiency programs generated a total evaluated savings of 11,190 kW, which was 0.1 percent less than 11,207 kW in projected savings. Commercial SOP generated the largest gap, achieving only 4 percent of projected savings: 30 kW compared to a projection of 700 kW. In the residential sector, total evaluated savings of 1,596 kW were 18 percent greater than projected savings of 1,358 kW, with all residential outperforming projections by a small margin.

5.3.5.2 Energy Savings

Figure 5-8 shows the projected and evaluated energy savings for 2016 El Paso programs. El Paso's total projected savings for PY2016 were 21,230 MWh, compared to evaluated savings of 22,917 MWh, or 8 percent more savings than were projected. Total commercial evaluated savings (19,914 MWh) were 10 percent higher than commercial projected savings (18,105 MWh). Program activity that had been projected for Commercial SOP appears to have been absorbed by Large C&I Solutions MTP and Small Commercial Solutions MTP, because the former achieved only 6 percent of its projected energy savings, but the latter achieved 145 percent and 120 percent respectively, for a net residential performance that was 4 percent lower than projections (3,002 MWh compared to 3,125 MWh).

Figure 5-7. Projected and Evaluated Demand Reduction for 2016 El Paso Programs

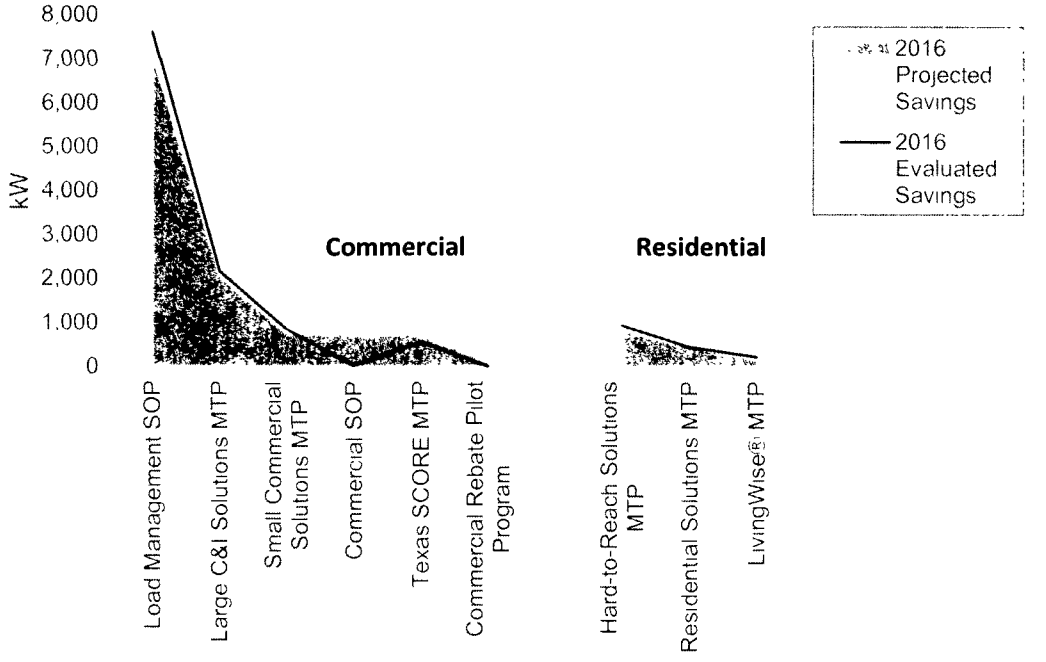
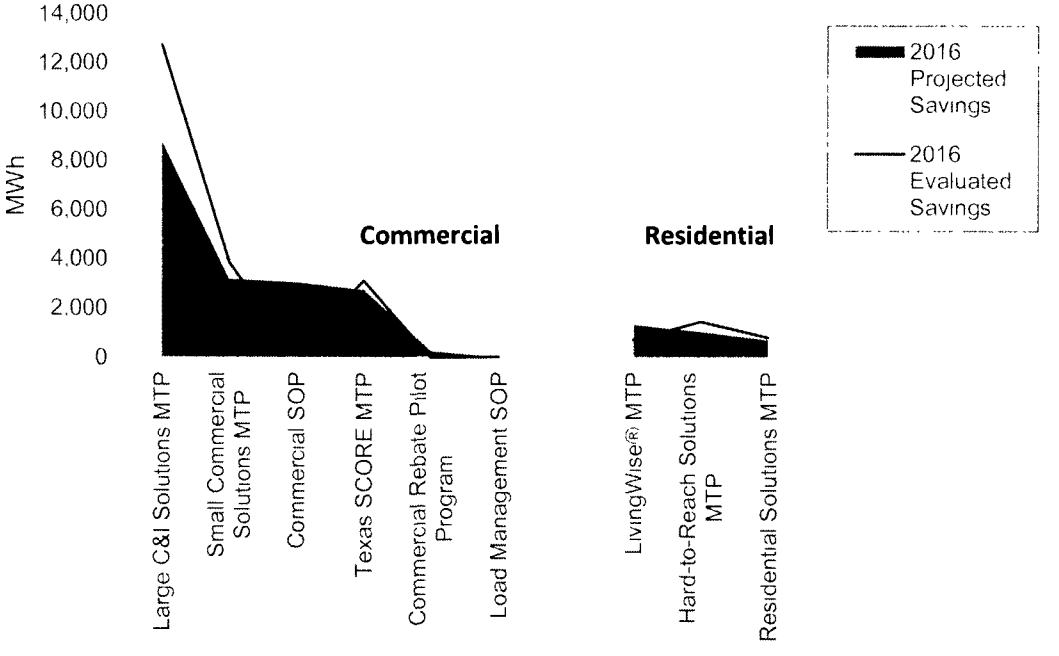


Figure 5-8. Projected and Evaluated Consumption Savings for 2016 El Paso Programs



5.3.6 Entergy

5.3.6.1 Demand Reduction

Projected and evaluated demand reduction for Entergy is shown in Figure 5-9. Total projected savings are 15,500 kW, compared to achieved savings of 19,578, a performance improvement of 26 percent. In the commercial sector, City Smart MTP did not claim demand savings, therefore creating the greatest inconsistency between projected and evaluated reductions. Load Management SOP and Commercial Solutions MTP both surpassed their projections, however, for a net commercial sector performance that was 31 percent above projections. Total projected residential savings (5,040 kW) are roughly equivalent to evaluated residential demand savings (5,885 kW). The Residential SOP shows the largest difference between evaluated (3,378 MW) and projected (2,240 MW) demand reduction, a 51 percent increase.

5.3.6.2 Energy Savings

On the energy side, as shown in Figure 5-10, Entergy's programs outperformed projections by 64 percent, with total projected savings for PY2016 of 27,202 MWh compared with evaluated savings of 44,617 MWh. The commercial sector was projected to save 15,152 MWh, but the evaluation found energy savings of 24,063 MWh, nearly all of which originated from Commercial Solutions MTP. The residential sector programs outperformed their projections by 71 percent, with projected energy savings of 12,050 MWh compared to evaluated savings of 20,554 MWh.

Figure 5-9. Projected and Evaluated Demand Reduction for 2016 Entergy Programs

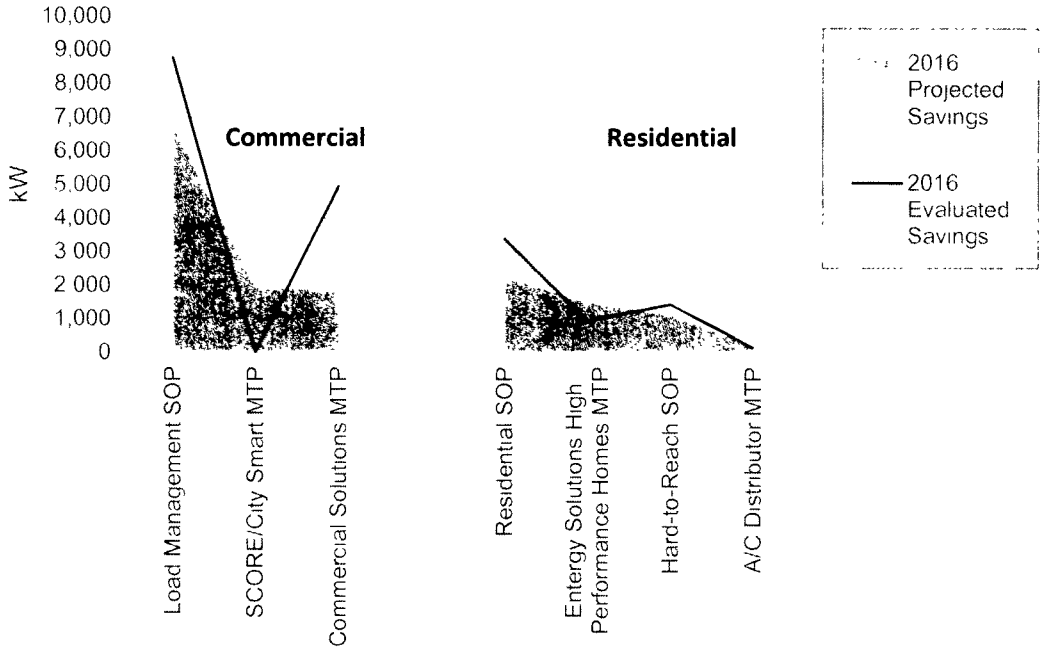
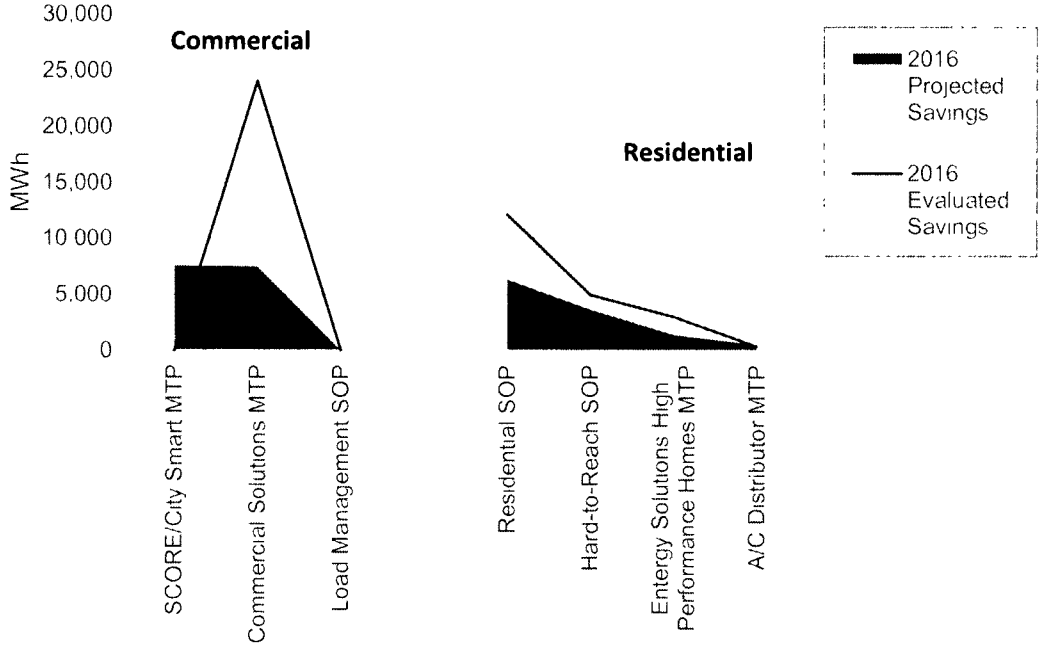


Figure 5-10. Projected and Evaluated Consumption Savings for 2016 Entergy Programs



5.3.7 Oncor

5.3.7.1 Demand Reduction

Figure 5-11 shows the projected and evaluated demand reduction for 2016 Oncor programs. The total PY2016 evaluated demand reduction of 249,151 kW outperformed by 80 percent the projected demand reduction of 138,086 kW. Commercial sector evaluated savings (196,477 kW) were 240 percent higher than projected savings (85,284 kW), driven by the performance of the Commercial Load Management SOP program. The residential sector correspond closely with projected energy savings. The largest difference between residential projected and evaluated savings was observed for the Solar PV SOP program, where evaluated savings were 124 percent higher than projected savings. Overall residential projected were 52,802 kW and evaluated savings were 52,674 kW.

5.3.7.2 Energy Savings

Projected and evaluated energy consumption savings for Oncor are shown in Figure 5-12. On the energy side, the portfolio did not achieve its projected savings. The total evaluated energy savings of 192,588 MWh) were 15 percent lower than the projected energy savings (225,783 MWh.) The total evaluated energy savings (83,853 MWh) for the commercial sector programs were 23 percent lower than the projected energy savings (108,844 MWh), driven by Commercial SOP. In the residential sector, total evaluated energy savings (108,734 MWh) were 7 percent lower than projected savings, driven by Home Energy Efficiency SOP which achieved 82 percent of its projected savings. The other, smaller residential programs all surpassed their goals.

Figure 5-11. Projected and Evaluated Demand Reduction for 2016 Oncor Programs

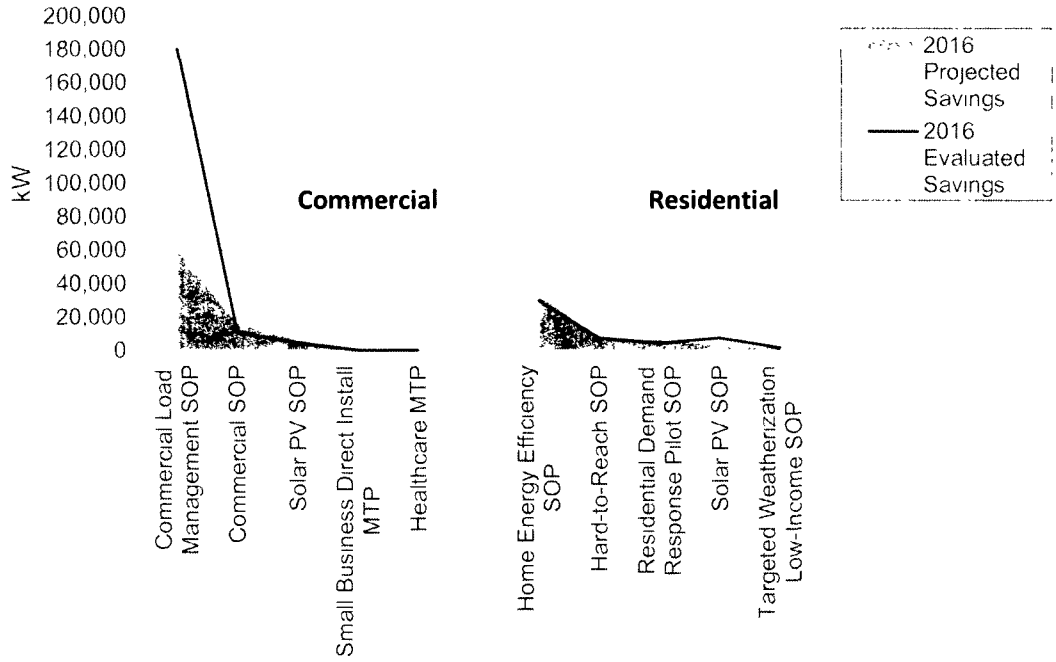
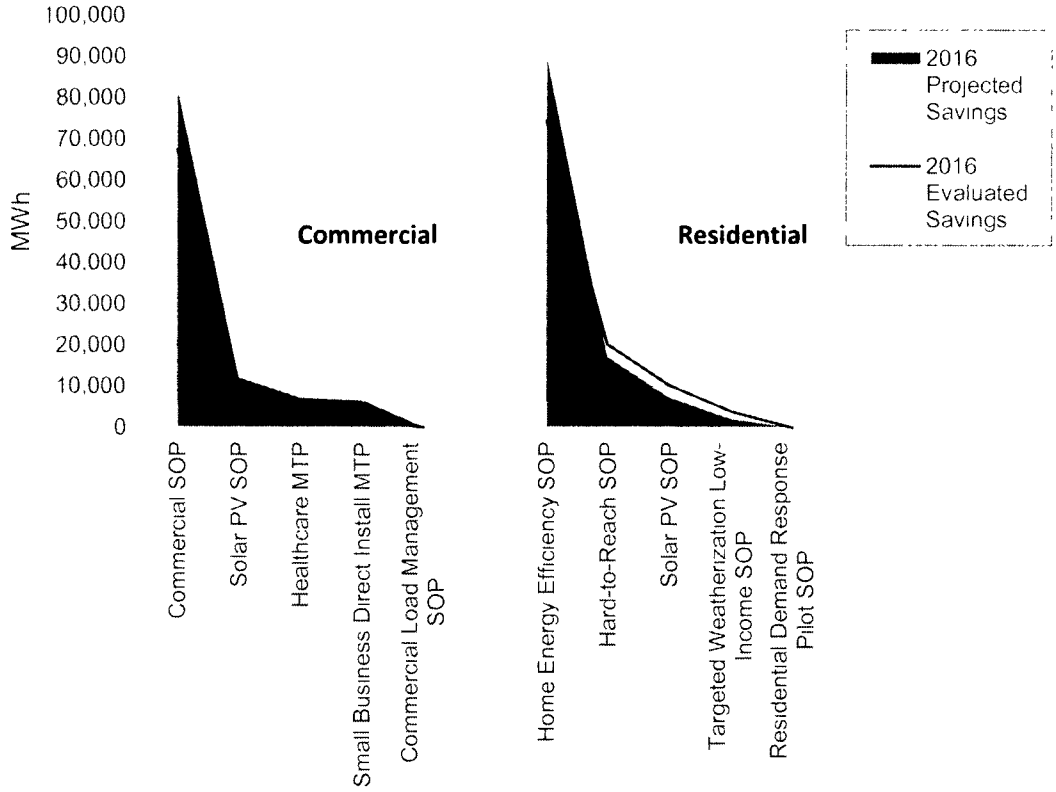


Figure 5-12. Projected and Evaluated Consumption Savings for 2016 Oncor Programs



5.3.8 Sharyland

5.3.8.1 Demand Reduction

Projected and evaluated demand reduction for Sharyland's portfolio is shown in Figure 5-13. Total evaluated demand reduction (604 kW) was 14 percent higher than projected (532 kW). This was driven by residential program performance. On the commercial side, Total evaluated savings (99 kW) were 18 percent lower than projected savings (122 kW). Projected savings for Customized Commercial MTP did not materialize: the program achieved only 9 percent of its projected value. Open for Small/Medium Business MTP, however, greatly over performed projections, achieving 229 percent of its projected savings. The residential portfolio outperformed projections by 23 percent: 505 kW achieved compared to a projection of 410 kW. This was driven by Residential SOP, which achieved 128 percent of its projected value.

5.3.8.2 Energy Savings

Figure 5-14 shows the projected and evaluated energy savings for 2016 Sharyland programs. Total portfolio savings achieved for PY2016 were 1,898 MWh , which is 6 percent lower than projected savings of 2,027. Commercial programs underperformed projections, achieving only 30 percent of the projected value: 193 MWh achieved compared to a projection of 643 MWh. Residential programs outperformed projections by 30 percent, achieving savings of 1,800 MWh compared to projected savings of 1,384 MWh, with all programs outperforming projections.

Figure 5-13. Projected and Evaluated Demand Reduction for 2016 Sharyland Programs

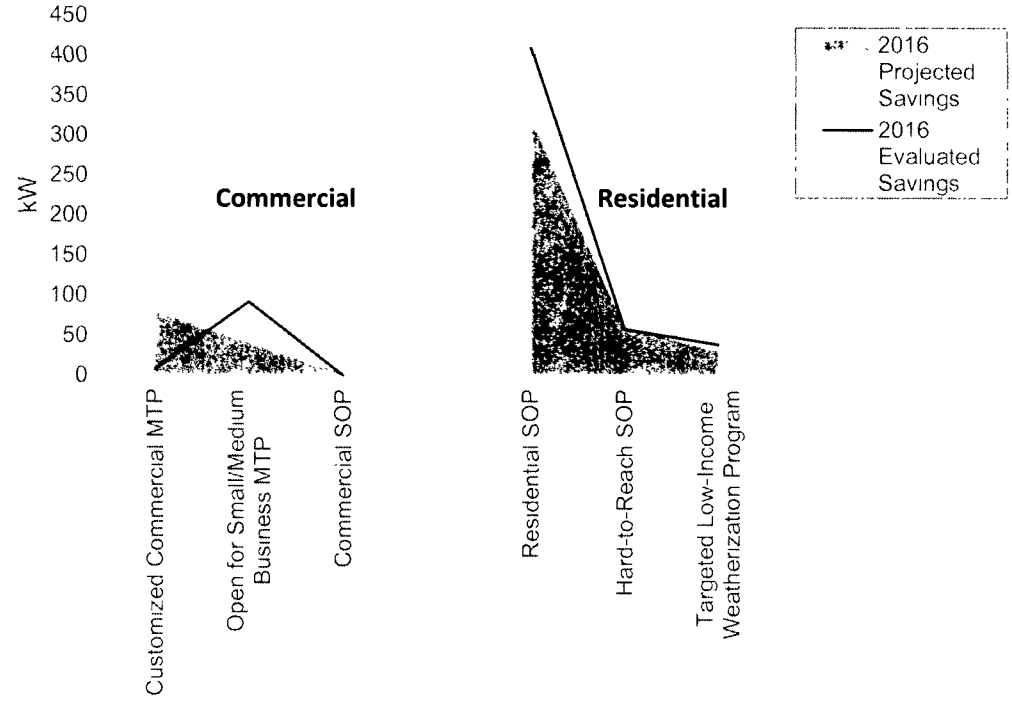
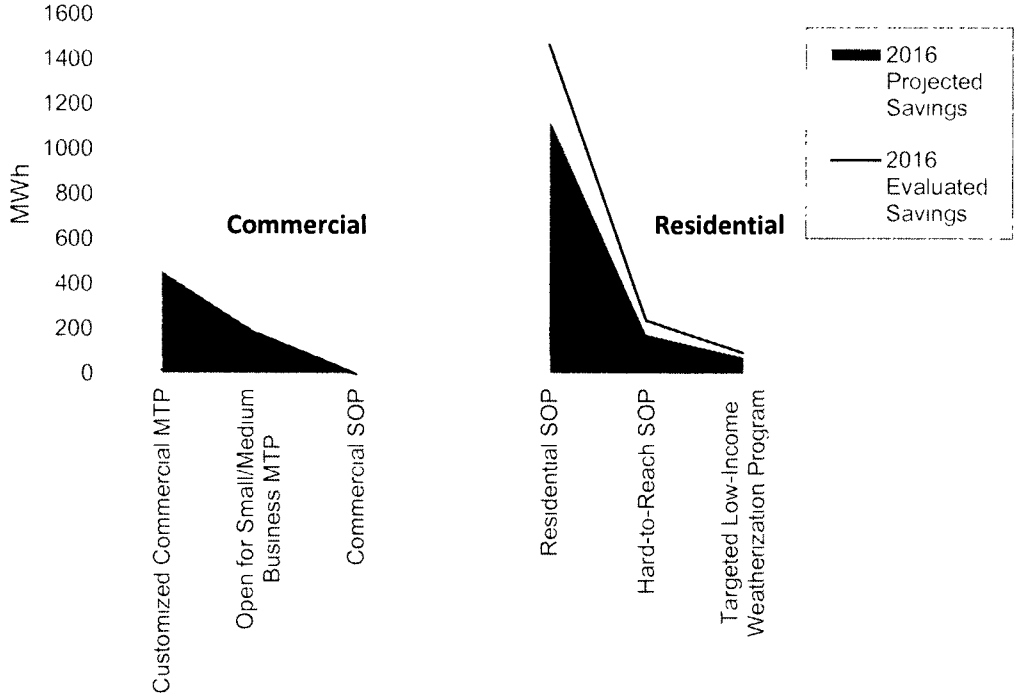


Figure 5-14. Projected and Evaluated Consumption Savings for 2016 Sharyland Programs



5.3.9 SWEPCO

5.3.9.1 Demand Reduction

Figure 5-15 shows the projected and evaluated demand reduction for the PY2016 SWEPCO portfolio. The portfolio outperformed projections by 4 percent, achieving a reduction of 11,939 kW compared to a projected value of 11,515 kW. Total commercial evaluated savings of 8,953 kW was 5 percent higher than the projected value of 8,527 kW. This was driven by Load Management SOP, which over performed its projection by 11 percent, offset somewhat by Commercial SOP, which achieved only 77 percent of its projection. The residential portfolio closely matched its projected savings, achieving 2,986 kW reduction compared to a projection of 2,988 kW.

5.3.9.2 Energy Savings

Projected and evaluated energy savings for SWEPCO are shown in Figure 5-16. Overall, the portfolio exceeded projections by 6 percent, achieving 20,648 MWh in savings compared to projected savings of 19,429 MWh. Total evaluated energy savings of 11,299 MWh for commercial sector programs were 5 percent higher than projected savings of 10,792 MWh. This was driven by Commercial Solutions MTP, where evaluated savings were 75 percent higher than projected savings, and by SCORE MTP, which outperformed projections by 29 percent. In the residential sector, both programs outperformed projections, with total energy savings of 9,349 MWh compared to projected savings of 8,638 MWh, an 8 percent increase.

Figure 5-15. Projected and Evaluated Demand Reduction for 2016 SWEPCO Programs

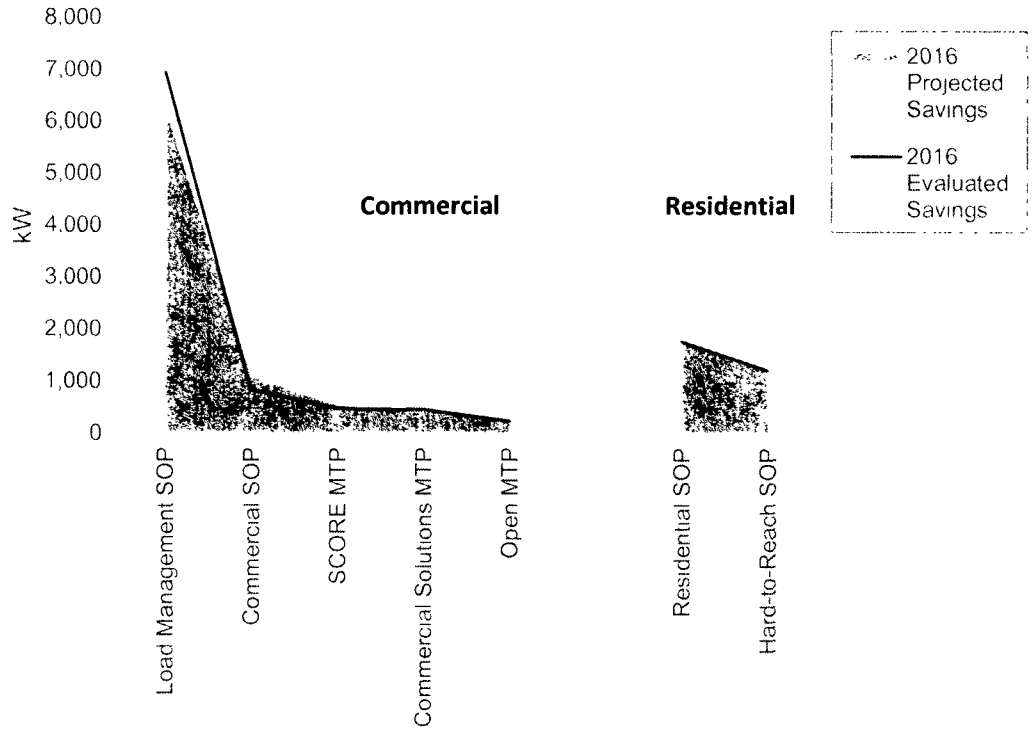


Figure 5-16. Projected and Evaluated Consumption Savings for 2016 SWEPCO Programs